Azadi Ka Amrit Mahotsav

G20 भारत 2023 INDIA
वसुधैव कुटुम्बकम्
ONE EARTH • ONE FAMILY • ONE FUTURE

29th PFAM

06 - 08 Sept., 2023
IIT Tirupati, India

www.pfam29.com

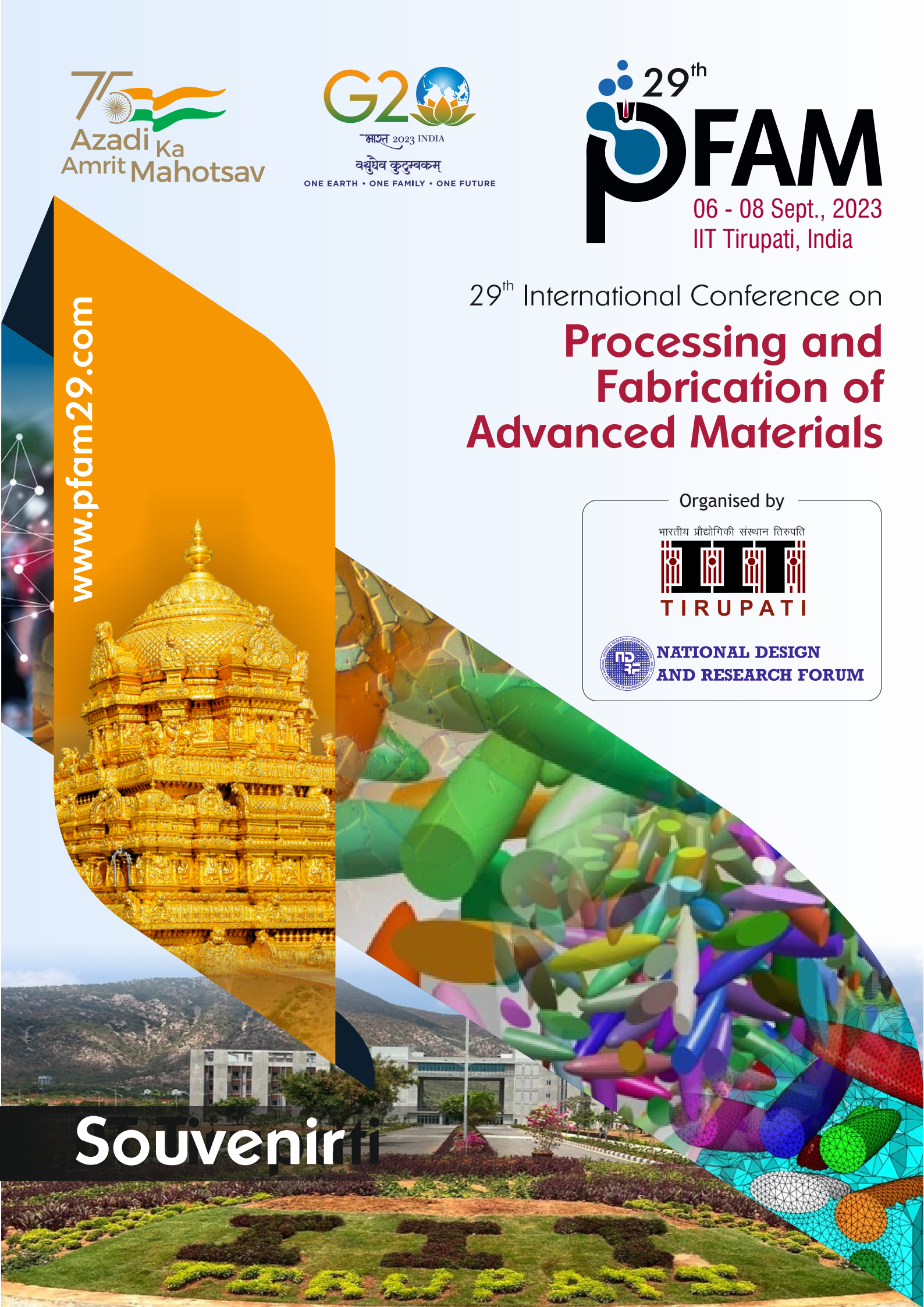
29th International Conference on

Processing and Fabrication of Advanced Materials

Organised by

भारतीय प्रौद्योगिकी संस्थान तिरुपति
IIT TIRUPATI

NATIONAL DESIGN AND RESEARCH FORUM



Souvenir

डॉ. वाई. श्रीनिवास राव
विशिष्ट वैज्ञानिक एवं
महानिदेशक (एनएस एवं एम)
Dr. Y. Sreenivas Rao
Distinguished Scientist &
Director General (NS & M)

सत्यमेव जयते

स्वच्छ भारत
एक कदम स्वच्छता की ओर

रक्षा मंत्रालय
MINISTRY OF DEFENCE
रक्षा अनुसंधान तथा विकास संगठन
DEFENCE RESEARCH & DEVELOPMENT ORGANISATION

Message

It is heartening to note that the 29th International Conference on Processing and Fabrication of Advanced Materials (PFAM-XXVII) is being organized by the Departments of Mechanical Engineering at Indian Institute of Technology Tirupati (A.P.) Tirupati India. With focus on recent advances in materials and their civilian/defence applications, the Conference will surely benefit the participants. I am also glad that Prof Dr RK Ray Symposium is also being organised during the conference.

The primary purpose of any inter-disciplinary conference is to bring together state-of-the-art developments on all aspects related to the theme. I am sure that PFAM will provide an ideal platform for discussion on the latest advances on aspects related and relevant to materials processing and fabrication by researchers and engineers from industries, research laboratories, and academic institutions.

I wish the conference all success.

Jai Hind.

Y Sreenivas Rao

भारतीय प्रौद्योगिकी संस्थान तिरुपति
INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI
भारतीय प्रौद्योगिकी संस्थान तिरुपति
Yerpedu - Venkatagiri Road, Yerpedu Post, Tirupati District, A.P - 517619

Prof. Kalidindi N. Satyanarayana
Director

Phone: +91 877 2503000
Email: director@iittp.ac.in

31st Aug 2023

Message

I am happy that the Department of Mechanical Engineering, Indian Institute of Technology Tirupati (A.P.) India is organizing the 29th International Conference on Processing and Fabrication of Advanced Materials (29thPFAM) in our campus. Materials and Manufacturing is one of the thrust areas of IIT Tirupati and 29thPFAM 2023 is well aligned with the Institute thrust area. The conference focuses on recent advances made in the field of materials and their manufacturing for various industrial applications such as Aerospace, Automobile, Marine, Defence, Biomedical and Healthcare, Electronics and Communications, Energy Storage/Harvesting, Heavy Equipment, Machinery & Goods and Semiconductor Materials Manufacturing.

The primary purpose of this inter-disciplinary conference is to bring together state-of-the-art developments on all aspects related to the processing and fabrication of advanced materials, spanning the entire spectrum of materials. The conference will provide an attractive forum for presenting the latest advances on aspects related and relevant to materials processing and fabrication by researchers and engineers from industries, research laboratories, and academic institutions.

I would like to welcome all conference delegates to our campus. I wish all the best to the organizers to this international conference at IIT Tirupati.

Best Regards

(K.N. Satyanarayana)

Message

At this opportune moment, I afford upon myself the intrinsic liberty to convey my warmest greetings, cheers and an enthusiastic welcome to all the attendees, comfortably positioned on-site as active and contributing participants, or suitably positioned offsite as patient listeners and enthusiastic observers, of the intricacies specific to this historic scholarly technical event on the topic of Processing and Fabrication of Advanced Materials, the 29th in a series, having international stature, recognition and scholarly impact. This scholarly technical event is being organized by the Department of Mechanical Engineering at Indian Institute of Technology Tirupati (IIT Tp) [Tirupati, Andhra Pradesh, India] and held very much within the intellectual confines of the institute. This scholarly technical event, since its inception way back in 1991, is being co-sponsored by the National Design and Research Forum (NDRF) based in Bangalore (Karnataka, India).

The primary purpose of this scholarly technical event is to bring together scientists, technologists, researchers, engineers, potential end users, and entrepreneurs, having a desirous interest in becoming aware of the novel advances, inspiring innovations and potentially viable applications, in both the near-term and long-term future, the family of materials, spanning both the engineering materials, and engineered materials, have to offer. Several aspects to include: (i) recent advances on aspects specific to innovations in processing, (ii) advances in fabrication, and (iii) a healthy synergism of the two to make available new and improved materials, fondly referred to as "emerging" materials, for a spectrum of applications, spanning both performance-critical and non-performance critical, will be presented and discussed by the contributing authors and participants.

Since its inception in the city of Cincinnati (Ohio, USA), way back in 1991, this scholarly technical event has gradually grown in stature, strength, significance and importantly its impact on the technology sector and has over the years [1992 onwards up until 2022] gradually moved its way through the nations of (i) Hong Kong, (ii) Japan, (iii) India, (iv) Korea, (v) New Zealand, (vi) Singapore, and (vii) Sweden. On each occasion this scholarly technical event was held it was possible to have increased participation quantified both by way of (i) contributions, and (ii) physical presence and participation. Each and every technical event culminated in the compilation, publication and release of an impressive bound volume that neatly contained all of the intricacies presented, discussed and highlighted at the scholarly technical event and thus having archival value.

The sizeable number of abstracts contributed [number 360 plus] in synergism with the physical presence and participation of both the contributors and "interested" attendees is a glowing testimony to the "outstanding" success of this scholarly technical event, the 29th International Symposium. The presentations, discussions, sharing of knowledge and ideas, and potential collaborative efforts in the domain specific to Processing and Fabrication of Materials to ensure in the development and emergence of new and improved materials for a spectrum of products and/or applications.

As the initiator or "founder" of this scholarly technical event I extend ceaseless and endless thanks to (a) the co-organizers [under the diligent, dedicated and dynamic leadership of Dr. Ajay Kumar], (b) the sponsors [(i) IIT Tirupati, and (ii) NDRF], (c) the concerned participating faculty, staff and students of this glorious academic institution for their invaluable contributions on the innumerable tasks assigned to them, and (d) importantly to you the attendees and participants for providing your valuable input by way of novel contribution, to ensure that this scholarly technical event is successful, productive and importantly worthy of remembrance.

As we come together to celebrate the 29th episode of this scholarly technical event, I salute you the participants and attendees, the host institution [IIT Tirupati], the co-organizers in doing the needful to ensure Precision and Perfection in orchestrating all of the intricacies essential for success of this event and thereby bring Pride to all concerned and involved. Cheers and congratulations I extend to each one of you.

Dr. T. S. Srivatsan
Co-Organizer
["Initiator/Founder" of the 'PFAM' Conference Series]
University of Akron
Akron, Ohio 44325, USA

भारतीय प्रौद्योगिकी संस्थान तिरुपति
TIRUPATI

Dr. MAMILLA RAVI SANKAR
ASSOCIATE PROFESSOR & HOD
DEPARTMENT OF MECHANICAL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI
ANDHRA PRADESH–517506 (INDIA)

Message

With great enthusiasm, I extend my heartfelt welcome you to the Twenty-Ninth International Conference on Processing and Fabrication of Advanced Materials (PFAM-XXIX), during 6th to the 8th of September 2023, at Indian Institute of Technology Tirupati, Andhra Pradesh, India. As the Head of the Department of Mechanical Engineering, I take immense pride in welcoming you to the vibrant department of IIT Tirupati with excellence in education and research.

The PFAM-XXIX conference underscores our commitment to advancing materials science and engineering. This platform facilitates a convergence of minds from academia, industry, and research organizations, providing a space to delve into the intricate realms of processing, fabrication, characterization, and evaluation of traditional, advanced, as well as emerging materials. The materials under discussion span domains ranging from performance-critical to non-performance-critical, with applications spanning a diverse range of products.

The Department of Mechanical Engineering, with its dedicated team of 18 faculty members and over 70 research students, embodies our commitment to basic, applied, and interdisciplinary research. From manufacturing to thermal, design to robotics, the department's research domains exemplify our dedication to pushing the boundaries of knowledge. The state-of-the-art facilities available foster networking and collaboration, offering opportunities to engage with cutting-edge research.

As we embark on PFAM-XXIX, I invite you to contribute your insights and expertise to this collective endeavor of exploration and discovery. Your presence will undoubtedly enrich the discourse and contribute to the broader goal of advancing materials science and engineering.

I eagerly look forward to your active participation in PFAM-XXIX and to the transformative discussions that will shape the future of processing and fabrication of advanced materials field.

M. Ravi Sankar

Dr. Mamilla Ravi Sankar
Associate Professor & HOD
Mechanical Engineering Department
Indian Institute of Technology Tirupati, Andhra Pradesh
Homepage : https://iittp.ac.in/dr-mamilla-ravi-sankar

Message

I express my sincere gratitude to take the responsibility of organizing the 29th International Conference on Processing and Fabrication of Advanced Materials (29thPFAM) at Department of Mechanical Engineering, Indian Institute of Technology Tirupati (A.P.) India. It's a learning experience for me. The conference focuses on recent advances made in the field of materials and their manufacturing for various industrial applications such as Aerospace, Automobile, Marine and Defence, Biomedical and Healthcare, Electronics and Communications, Energy Storage/Harvesting, Heavy Equipment, Machinery & Goods, Semiconductor Materials Manufacturing and Academia-Industry Interaction. I am happy to share that Prof. Dr. R. K. Ray Symposium is also being organized by PFAM 2023 for his great contribution in crystallographic textures of materials, advanced high strength steels, structure and properties of materials etc. The conference is well aligned with the Institute thrust area i.e. Materials and Manufacturing.

The primary purpose of this inter-disciplinary conference is to bring together state-of-the-art developments on all aspects related to the processing and fabrication of advanced materials, spanning the entire spectrum of materials. The conference will provide an attractive forum for presenting the latest advances on aspects related and relevant to materials processing and fabrication by researchers and engineers from industries, research laboratories, and academic institutions. I would like to welcome all conference delegates.

I'm genuinely excited to be part of this mega international conference at IIT Tirupati.

Best Regards,

[Ajay Kumar]
(Convener and Organizing Secretary 29thPFAM 2023)

Message

It gives me immense pleasure to co-chair this conference. The theme of the conference is very much relevant to the present day challenges faced by various industries. It's heartening to see the overwhelming response from both Academia and the Industry for the conference. I hope the delegates from across the nation and abroad will get immensely benefited by this conference.

Thanks & Regards

Dr. N. VENKAIAH
Assoc. Professor of Mechanical Engineering
Indian Institute of Technology Tirupati
Yerpedu – Venkatagiri Road, Yerpedu Post,
Tirupati District, A.P - 517619

National Design and Research Forum
The Institution of Engineers (India)
3, Dr.B.R.Ambedkar Veedhi
BANGALORE-560001

Dr. P. Raghothama Rao
Chairman, Board of Governors

Date: ***20th, August 2023***

Message

Any system and every system is an assembly of a variety of components shaped using a wide variety of materials. The components are configured by carefully chosen processes to perform the intended functions be it critical or non critical. Materials configured as components as per the conceptualized design must have integrity in all the environments envisaged throughout their defined life. What is more interesting is that the search, for new materials which are lighter and stronger Materials and Processes which can miniaturize the system and perform faster, more effectively and efficiently, is a continuum. Nano-Composites, Shape Memory Materials, Lithium ion batteries, additive manufacturing, friction stir welding and embedded integrations are a few examples to cite as visible emerging frontiers. The new Materials and processes open new vistas to understand structure and properties correlations.

It is gratifying to note that the International Conference to deliberate on the happenings and findings in Processing and Fabrication of Advanced Materials, (PFAM) has been initiated by Emeritus Professor T S Srivatsan, a senior faculty from Akron University, USA, and this is the 29th congregation in the series. It is much more than a delight to see that the Indian Institute of Technology (IIT), Tirupati, a premier academic centre is hosting PFAM for three days (6th to 8th September 2023) in association with National Design and Research Forum (NDRF), a wing of institution of Engineers (India), perhaps the biggest professional body in the country and a century old icon, in serving the society in the engineering domain.

The deliberations of this conference are certain to pave way for a quantum jump in its outcome in line with the Atmanirbhar programs of the nation.

I wish the PFAM Conference a great success.,

Dr. P. Raghothama R

E-mail: ndrf85@gmail.com | ndrf@ieindia.org | www.ndrf.res.in | 9901903336

National Design and Research Forum
The Institution of Engineers (India)
3, Dr.B.R.Ambedkar Veedhi
BANGALORE-560001

NDRF

Dr.S.Seetharamu
Director

Message

I am very gratified and honoured to inform you that the International Conference on the topic of PROCESSING AND FABRICATION OF ADVANCED MATERIALS [PFAM 29] to be held during 6-8 Sept 2023, organized by the Department of Mechanical Engineering IIT Tirupati and National Design and Research Forum (NDRF), Bangalore, and ably steered by the eminent PFAM Guru Dr T.S.Srivatsan, Professor (Emeritus), The University of Akron, USA.

I am overwhelmed and immensely delighted to note that the conference proceedings are teemed with commendable plenary lectures, key note addresses, oral presentations and posters covering the processing, fabrication, characterization, and evaluation of traditional, advanced, and emerging materials for potential use in a wide spectrum of products. The domains of applications involve the performance- critical areas in heat, wear and corrosion resistance applications, emission de-intensifying areas, additive manufacturing, and thorough quality assurance.

Evolution of Traditional Techniques and the Rise of Additive Manufacturing (AM): What truly excites us is the constructive emergence of additive manufacturing, which is poised to revolutionize the industry. Further, as additive manufacturing gains traction, the airworthiness of AM components is gaining increased attention.

Quality Advancements: Quality has always been a paramount concern, and we are pleased to see that quality aspects are catching up with the rapid pace of technological advancements.

Materials Landscape - From Graphitic Cast Iron to Graphene and CNT: While graphitic cast iron remains a trusted material, it is impossible to ignore the game-changing influence of Graphene and Carbon Nanotubes (CNT) and nanotechnology.

PFAM 29 promises to be a thought-provoking exchange of ideas and a platform to collectively envision the future requirements of advanced processing of materials and technology development.
I wish the delegates fruitful gain of knowledge in PFAM 29

Dr S. Seetharamu
Director NDRF
16 August 2023

होमी भाभा राष्ट्रीय संस्थान
Homi Bhabha National Institute

प्रशिक्षण विद्यालय परिसर, अणुशक्तिनगर, मुंबई 400094, भारत Training School Complex, Anushaktinagar,
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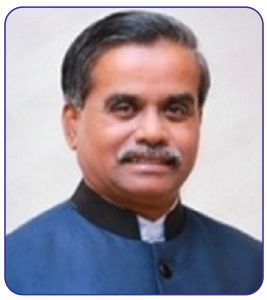
वसुधैव कुटुम्बकम्
ONE EARTH · ONE FAMILY · ONE FUTURE

Prof. U. Kamachi Mudali
FNAE, FNASc, FNACE, FASM, FAPAM, FIFHTSE
FICS, FIIM, HFECSI, FIIChE FIE,
FASch, HMIIM, HMUDCTAA
Vice Chancellor

प्रो. यू. कामाची मुदली
FNAE, FNASc, FNACE, FASM, FAPAM, FIFHTSE
FICS, FIIM, HFECSI, FIIChE FIE
FASch, HMIIM, HMUDCTAA
कुलपति



Message

August 9, 2023.

It's my great pleasure to learn that the Indian Institute of Technology Tirupati [IIT TP Campus], Tirupati, Andhra Pradesh, is joining hands with National Design and Research Forum, Bangalore, India (prime sponsors of this conference) and organizing the **29th International Conference on Processing and Fabrication of Advanced Materials (PFAM-XXIX) during 06 - 08 September 2023** at the **IIT Tirupati** (Tirupati, Andhra Pradesh, INDIA). I understand that the event aims to promote discussions and collaborations among professionals from academia, research centers, and industries and staying updated on the latest advancements in materials processing and fabrication.

The field of "**Processing and Fabrication of Advanced Materials**" involves the development and implementation of techniques and technologies for creating novel materials with enhanced properties and performance. This field is crucial for various industries, including electronics, aerospace, automotive, healthcare, energy, and more, as it enables the production of materials with tailored characteristics to meet specific needs. The conference spans three days and aims to bring together engineers, technologists, and researchers from various sectors, including industry, universities, and national/government laboratories. The conference would address the complex interplay between materials on various aspects related to the processing, fabrication, characterization, and evaluation of traditional, advanced, and emerging materials.

I would like to express my sincere appreciation to the dedicated organizing team for their tireless commitment and outstanding achievements in ensuring the success of this conference. **PFAM-XXIX** is set to challenge and inspire all participants, fostering enhanced knowledge, collaborations, and friendships among scholars and professionals.

Once again, I extend my best wishes for the success of **PFAM-XXIX**.

U Kamachi Mudali 09/8/2023

(U. Kamachi Mudali)

Message

I am delighted to learn that the Department of Mechanical Engineering, IIT Tirupati is organising an International Conference on **PROCESSING AND FABRICATION OF ADVANCED MATERIALS [PFAM 29]** at IIT Tirupati during 6-8 September, 2023.The topic of the conference is very relevant in modern times, with the emergence of newer and advanced materials every now and then. The proper utilisation of such materials will very much depend on their successful processing and fabrication.

I understand that you are having an overwhelming response to the conference. I sincerely wish that the proceedings will eminently serve the intended purpose and will be a grand success.

Yours sincerely,

Professor Ranjit Kumar Ray Ph.D. FNAE
Honorary Member, Indian Institute of Metals
Formerly, AICTE-INAE Distinguished Visiting Professor
SRMIST Chennai & CMRIT Bangalore, India
Formerly, Visiting Professor, IIEST Shibpur
Formerly, Visiting Scientist, Tata Steel R & D
Formerly, Professor of Materials & Metallurgical Engineering
IIT Kanpur, India

Pradeep Metals Limited

Manufacturers of Precision Closed Die Forgings

Message

I am extremely pleased that the Department of Mechanical Engineering, IIT Tirupati is organizing an International Conference, the twenty-ninth in a series, on the topic of PROCESSING AND FABRICATION OF ADVANCED MATERIALS [PFAM 29] at IIT Tirupati.

Materials science technologies make up our world -- the metals, semiconductors, plastics, composites that we use, to make all our devices, and products.

India as a nation is leapfrogging into the high technology areas such as Defence, Space, Energy and Transportation. All these sectors require reproducible processes and materials that are stronger, with more accurate properties.

This fervor is now evident in the way the industry has taken up the developments in space, railway, defense, agriculture, infrastructure, renewable energy, and other sectors. New developments in materials, processes and products are paving the way for a robust economy. Our own consumption in the country is fueling this growth.

This is a wonderful platform to cross pollinate ideas and knowledge for the common good of industry and the country at large.

This conference is an attempt to remind all stakeholders that India was and continues to be the fountainhead of knowledge.

I encourage all stakeholders to collaborate, share and put knowledge at the forefront so that we may all cross oceans together and become Atma Nirbhar.

Pradeep Goyal

Chairman & Managing Director

डॉ. नागहनुमय्या
DR. NAGAHANUMAIAH
निदेशक / Director
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Phone (D) : +91-80-22188263
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ಕೇಂದ್ರೀಯ ಉತ್ಪಾದನಾ ತಂತ್ರಜ್ಞಾನ ಸಂಸ್ಥೆ
केन्द्रीय विनिर्माणकारी प्रौद्योगिकी संस्थान
CENTRAL MANUFACTURING TECHNOLOGY INSTITUTE
(An autonomous R&D Institute
Under Ministry of Heavy Industries, Govt. of India)

Message

I wanted to express my sincere appreciation for organizing the Twenty-Ninth International Conference on Processing and Fabrication of Advanced Materials (PFAM-XXIX). It's evident that this event is a pivotal opportunity in today's competitive business landscape. Product innovation is the driving force behind sustainable growth, and material and process technology innovations are the bedrock for achieving greater efficiency, sustainability, and technological excellence.

I am sure PFAM-XXIX serves as an exceptional platform for fostering insightful discussions on these transformative technologies. The collaborative spirit, where researchers, businesses, and policymakers converge, is truly commendable. Embracing these technological advancements, particularly in the exciting realm of digital manufacturing, empowers industries to not just adapt but to lead and shape the future of manufacturing.

I'm genuinely excited to be part of this journey towards innovation and progress. I eagerly anticipate the opportunity to engage with like-minded individuals and contribute to the future of manufacturing.

Thank you once again for your efforts in making this event possible. I look forward to the valuable insights and connections that PFAM-XXIX will undoubtedly provide.

Best Regards,

[Nagahanumaiah]

Dr Raj Kumar Prasad Singh
Sr Director – KCTI
Bharat Forge

Kalyani Centre for Technology & Innovation
R&D – Bharat Forge Ltd
Survey # 15, Keshavnagar, Ahead Renuka Mata Temple, Pune – 411 036. INDIA

Message

Advance Materials are big hopes in the development of society as a whole. Its applications in various fields like Aerospace, Defence, Space Technology and Medical may not only give enormous advantages economically but can make life much easier and exciting in future. The field of their processing is full of challenges due to their different forming behaviour, corrosion resistance, heat transfer characteristic and narrow processing zones. Their fabrication too requires difference technologies and existing fabrication methods may not be competent to make components and assemblies out of them.

I am happy to note that IIT Tirupati has selected a very apt and challenging topic for International Conference and proceeding during conference will be able to solve lot of challenges being faced today. The interaction with experts will definitely be quite fruitful and technology from other parts of the world will be easily accessed by Indian Technologists during this Conference.

I wish grand success for this Conference.

Dr Raj Kumar Prasad Singh

Programme

29PFAM 2023 - Program Schedule Venue - Lecture Hall Complex, IIT Tirupati	
06-09-2023 - Day-1 (Wednesday) - Hall - A	
07:30-09:00	Registration
09:00-10:30	Inauguration
09:00-09:05	Welcome Address by Conference Chair - Dr. M. Ravi Sankar, IIT Tirupati, India
09:05-09:10	Theme Address by Conference Convenor - Dr. Ajay Kumar, IIT Tirupati, India
09:10-09:15	Address by Prof. K. N. Satyanarayana, Director, IIT Tirupati, India
09:15-09:30	Inaugural Address by Chief Guest 29PFAM 2023 - Shri APVS Prasad, Chief Executive (A), CEMILAC, DRDO, Bangalore, India
09:30-09:40	Special Address by Guest of Honor 29PFAM 2023 - Dr. U. Kamachi Mudali, VC, Homi Bhabha National Institute, Department of Atomic Energy, Mumbai, India
09:40-09:50	Special Address by Guest of Honor & Confrence Co Chair & Founder of PFAM - Prof. T. S. Srivatsan, USA
09:50-10:00	Special Address by Guest of Honor 29PFAM 2023 - Prof. Dr. R K Ray, Former Professor, IIT Kanpur, India
10:00-10:10	Address by Dr. P. Raghothama Rao, Chairman, NDRF, India
10:10-10:20	Vote of Thanks - Dr. Ajay Kumar, IIT Tirupati, India & Dr. S. Seetharamu, Director, NDRF, India
10:20-10:30	Conference Group Photo
Inaugural Tea Break | 10:30-11:00	

Parllel Session-1 Manufacturing Technologies Hall-A					Parllel Session-2 Materials and Processing Hall-B					Parllel Session-3 Modelling and Simulations Hall-C					Parllel Session-4 Semi Conductor Materials Manufecturing Hall-D				
Session Chair - Shri GAS Murthy & Dr. R Santhanam DRDL Hyderabad					Session Chair- Dr. Shirish S Kale, CEMILAC, DRDO					Session Chair- Dr. M. Sujata CSIR-NAL-Bangalore					Session Chair- Prof. Mohan S, IISc Bangalore				
Time	**MOP**	**ABS ID**	**ABS Title**	**Presenter Name**	**Time**	**MOP**	**ABS ID**	**ABS Title**	**Presenter Name**	**Time**	**MOP**	**ABS ID**	**ABS Title**	**Presenter Name**	**Time**	**MOP**	**ABS ID**	**ABS Title**	**Presenter Name**
11:00-11:30	KN-1	373	Hot deformation behaviour of exotic alloys: nickel and titanium based alloys	Dr. Raj Kumar P. Singh	11:00-11:30	KN-1	335	Green Technologies Using Microwaves	Shri Pradeep Goyal	11:00-11:20	IL-1	TBC	Computational approaches to development of Engineering Components (Opportunities and Challenges)	Dr. A Venugopal Rao	11:00-11:20	IL-1	399	Semiconductor Materials Manufacturing and Chip Design: Enabling the Digital Revolution	Dr. Balakrishna I
11:30-12:00	KN-2	411	Additive Manufacturing Technologies and Applications for Industrial and Strategic Contexts	Dr. U Chandrasekhar	11:30-12:00	KN-2	337	AI/ML for the Quantification of Process-Induced Uncertainty in Additively Manufactured Composites	Prof. Kishore Pochiraju	11:20-11:30	OP-4	310	Simulation of 4D printing of a Thermally Sensitive memory material	Harsha Ramachandra Murthy	11:20-11:40	IL-2	410	TBC	Dr. Harsha S
12:00-12:10	OP-1	1	Optimization of WEDM process parameters while machining Inconel 718 using Particle Swarm Optimization	Namadi Vinod Kumar	12:00-12:10	OP-1	3	Corrosion behavior of Nickel modified Zn-27Al alloy	Anusha Raj Kota	11:30-11:40	OP-1	371	Future is Vacuum	Amit Jawade	11:40-12:00	IL-3	387	Growing the Semiconductor manufacturing eco system in India- Imminent Opportunities for Semiconductor grade materials.	Mr. Krishna Moorthy K

12:10-12:20	OP-2	41	Comparison of Mechanical Properties and Effect of Process Parameters on CoCrMo Coupons Sintered by DMLS process and Simulated with ANSYS	Kedar Mallik Mantrala	12:10-12:20	OP-2	5	Synthesis and Characterization of Lanthanum Cerium Oxide for Thermal Barrier Coating Applications	Anant Kumar Gupta	11:40-11:50	OP-2	26	Finite Element Method for Free Vibration Analysis of Rectangular FGM Plate Based on First Order Shear Deformation Theory	Debarupam Gogoi	12:00-12:20	IL-4	379	Nanoscale Devices for Emerging Technologies	Dr. K.L. Ganapathi
12:20-12:30	OP-3	47	Laser-assisted machining of nickel-based super alloys and optimization of cutting force using ANN	Rangilal Bhukya	12:20-12:30	OP-3	8	Physico-chemical and Weibull distribution characterization of Myriostachia Wightiana (MW) stem fiber	Pramod Kumar Parida	11:50-12:00	OP-4	122	Insights into the Tension-Compression Asymmetry in Additively Manufactured Alloys: A Combined Phase Field-Strain Gradient Plasticity Study	Namit Pai	12:20-12:40	IL-5	TBC	TBC	TBC
12:30-12:40	OP-4	380	Negative Poisson Ratio Metamaterial Structure for Wing Morphing	Rajnish Mallick	12:30-12:40	OP-4	13	Numerical modelling and experimental analysis of uniaxial tensile test of fused deposition modelling printed acrylonitrile-butadiene-styrene	Mallikarjuna B										

Plenary Session-5-Hall-A

12:50-13:30	Session Chair - Prof. Satish V. Kailas, IISc-Bangalore
12:50-13:30	Light weighting of metal structures by metallurgical means; the avenue of severe plastic deformation- **Prof. Laszlo S. Toth**

Lunch Break - 13:30-14:30

Parellel Session-6 Manufacturing Technologies Hall-A					Parellel Session-7 – Materials and Processing Hall-B					Parellel Session-8 Manufacturing Technologies Hall-C					Parellel Session-9 Materials and Processing Hall-D				
Session Chair - Prof. Suhas S. Joshi, IIT Indore					Session Chair - Prof. Satyam Suwas, IISc, Bangalore					Session Chair - Prof. Kishore Pochiraju, SIT, USA					Session Chair - Prof. T.S. Srivatsan, University of Akron, USA				
Time	**MOP**	**ABS ID**	**ABS Title**	**Presenter Name**	**Time**	**MOP**	**ABS ID**	**ABS Title**	**Presenter Name**	**Time**	**MOP**	**ABS ID**	**ABS Title**	**Presenter Name**	**Time**	**MOP**	**ABS ID**	**ABS Title**	**Presenter Name**
14:30-15:00	KN-1	TBC	Manufacturing Challenges for Structural Materials in Nuclear Applications	Dr. Raghvendra Tewari	14:30-15:00	KN-1	374	Development and Characterization of Gradient Microstructures	Prof. David P. Field (Rec.)	14:30-15:00	KN-1	TBC	TBC	TBC	14:30-15:00	KN-1	388	What is all the fuss about Additive Manufacturing (AM) and Hybrid Manufacturing? Challenges and Opportunities for the 21 st Century	Prof. Guha Manogharan (Rec.)
15:00-15:30	KN-2	386	Driving Product Innovation: The Transformative Role of 4Ps - Product, Process, People, and Production Challenges	Dr. Naga Hanumaiah	15:00-15:30	KN-2	382	The Good, Bad, and Ugly: Smart Additive Manufacturing Part Qualification with Modeling, Materials Science, Monitoring and Machine Learning	Prof. Prahalada Rao (Rec.)	15:00-15:30	KN-2	TBC	TBC	TBC	15:00-15:30	KN-2	327	An exploration into invigorating role of cryogenic treatment on thermal and mechanical response of magnesium based materials	Prof. Manoj Gupta

15:30-15:40	OP-1	53	Study gas film formation through the current signal in Electrochemical discharge machining (ECDM) with and without a magnetic field.	Monika Singh	15:30-15:40	OP-1	9	Free vibration response of doubly curved FGM shell based on higher-order shear deformation theory	MD Irquam Alam	15:30-15:40	OP-1	73	Influence of welding process parameters on the quality of narrow gap welds	Sudheer Kumar Polamuri	15:30-15:40	OP-1	15	Influence of texture patterns and cryogenic coolant during machining of precipitation-hardened SS	Aniket Roushan
15:40-15:50	OP-2	70	Numerical modelling of machining of titanium alloys under phosphonium-based halogen-free ionic liquid as lubricant additives	Prameet Vats	15:40-15:50	OP-2	12	Investigation into the Shock Attenuation Response of a Hybrid Closed Cell Aluminium Metallic Foam under Shock Loading	Amit Kumar	15:40-15:50	OP-2	84	Fabrication of superhydrophobic aluminum surfaces using sink electrical discharge machining	Kishor Kumar Gajrani	15:40-15:50	OP-2	17	Microstructure Classification of Ultra High Carbon Steel Using Deep Learning Approach	Chandra Mohan Bhuma
15:50-16:00	OP-3	72	Excimer Laser Micro-texturing on Silicon Wafer using Mask Projection Technique	Raj Kumar	15:50-16:00	OP-3	14	X-ray Photoelectron Spectroscopy: An insight into surface analysis	Pragati Chaturvedi	15:50-16:00	OP-3	85	Creep behaviour of optimised heat treated Inconel 939 fabricated by Laser Powder Bed Fusion	Sarath Chandra Reddy Karumudi	15:50-16:00	OP-3	18	Fabrication and characterisation of polymer composites with the help of an enhanced vacuum moulding technique	Bhishm Dewangan

Parellel Session-10 Manufacturing Technologies Hall-A					Parellel Session-11 Materials and Processing Hall-B					Parellel Session-12 Modelling and Simulations Hall-C					Parellel Session-13 Materials and Processing Hall-D				
Session Chair- Prof. V R Ganesan, IIT Tirupati					Session Chair- Dr. Ajay M Sidpara, IIT-Kharagpur					Session Chair- Dr. Sheela Siddappa, Kyndryl					Session Chair- Prof. I. A. Palani, IIT-Indore				
Time	MOP	ABS ID	ABS Title	Presenter Name	Time	MOP	ABS ID	ABS Title	Presenter Name	Time	MOP	ABS ID	ABS Title	Presenter Name	Time	MOP	ABS ID	ABS Title	Presenter Name
16:00-16:20	IL-1	TBC	Industrial Automation to Industrial Autonomy (Ia2ia)-Prognosis for MRO Value Proposition	Lt. Gen. Anil Kapoor	16:00-16:20	IL-1	TBC	Constitutively informed particle dynamics: A new paradigm for discrete particle models	Prof. Srikanth Vedantam	16:00-16:10	OP-1	127	Design, Development and Analysis of Additively Manufactuctured and Assembled XY Compliant Precision Scanning System	Zeba Khan	16:00-16:20	IL-1	340	Common causes of failure in gas turbine engine blades	Dr. M. Sujata
16:20-16:40	IL-2	393	Environmentally Sustainable and CO2 Reduction Products- A Case Study	Prof. Kunigal Shivakumar	16:20-16:30	OP-1	39	Magnetorheological characterization assessment of developed composite magnetic abrasive towards surface finishing	Yogendra Kumar Dwivedi	16:10-16:20	OP-2	133	Crystal Plasticity Model for Cyclic Softening of a Polycrystalline Ni-based Superalloy	Suketa Amrutbhai Chaudhary	16:20-16:40	IL-2	378	Structure and Properties of Squeeze Cast Aluminum Metal Matrix Composites	Dr. T.P.D. Rajan
16:40-16:50	OP-1	95	Effect of deposition rate and deposition speed during the fabrication of iron aluminides with 10 wt. % of Al using GMAW-based TWAAM process	Tirupataiah Kasani	16:30-16:40	OP-2	50	Tribo-Corrosion and Mechanical Properties of Electro-deposited Hybrid Nano-Composite Coating for Under Water Applications	M. Ahmed Nazir Shaikh	16:20-16:30	OP-3	159	Simulation of Incremental Sheet Metal Forming of Titanium Alloy for Producing Complex shapes	Bharat Bhushan	16:40-16:50	OP-1	59	Development of a large shear-induced severe plastic deformation process	Govind Kumar
16:50-17:00	OP-2	98	Experimental Investigation on Metallurgical and Mechanical Properties of ND:YAG Laser Welded Inconel-825 Superalloy	Jaya Kishore S	16:40-16:50	OP-3	52	Experimental investigation to study the effect of cryo-rolling on the Johnson-Cook model parameter of Al6061	Girish Chandra Verma	16:30-16:40	OP-4	166	Development and Evaluation of a Hybrid Agricultural Drone for Precision Farming	Vivekananda N	16:50-17:00	OP-2	60	Influence of acrylate on mechanical and viscoelastic behavior of gel electrolyte	Vishal Agrawal

17:00-17:10	OP-3	112	Design and simulation of additively built acoustic metamaterial for the improvement of acoustic behavior and performance	Prasenjit Sharma	16:50-17:00	OP_4	309	Development of Single Source Precursor Derived ZrB2-SiC-B4C Ultra-High Temperature Ceramics	Vipin Vijay	16:40-16:50	OP-5	167	Optimizing Design of a Vertical Take-Off and Landing (VTOL) Blended Wing Body Aircraft through Modeling and Simulation	Amit S Herkal	17:00-17:10	OP-3	67	Experimental Investigation on MRR in Wire-Edm Machining S31803 Profile Surface with Different Currents	G Narendranath
										16:50-17:00	OP-6	193	Characterization of a 3D printed architected composite for enhanced properties	Prince Shukla					
										17:00-17:10	OP-7	201	Numerical analysis on friction stir processed Nickel 200 alloy plate with Al2O3 reinforcement	Rajnish Mishra					
Tea Break - 17:10-18:00																		
Gala Dinner & Cultural Program (Sitar Symphony & Classical Dance) - 18:30 Onwards at OAT (South Campus, IIT - Tirupati)																		

07-09-2023 - Day-2 (Thursday)	
08:30-09:00	**Registration**
Plenary Session-14-Hall-A	
09:00-09:40	Session Chair - Prof. Mohan S, IISc Bangalore
09:00-09:40	Biological strategies from natural structures for resilience in manufacturing - **Prof. Ajay Malshe (Rec.)**
Tea Break | 09:40-10:00	

Parellel Session-15 Prof. R K Ray Symposium Hall-A					Parellel Session-16 Materials and Processing Hall-B					Parllel Session-17 Manufacturing Technologies Hall-C					Parellel Session-18 Semi-Conductor Materials Manufecturing Hall-D				
Session Chair- Prof. R K Ray, IIT-Kanpur					Session Chair- Prof. Laszlo S. Toth, Lorraine University France					Session Chair- Dr. D P Mondal, AcSIR-AMPRI, Bhopal					Session Chair- Dr. Naga Hanumaiah, CMTI-Bangalore				
Time	**MOP**	**ABS ID**	**ABS Title**	**Presenter Name**	**Time**	**MOP**	**ABS ID**	**ABS Title**	**Presenter Name**	**Time**	**MOP**	**ABS ID**	**ABS Title**	**Presenter Name**	**Time**	**MOP**	**ABS ID**	**ABS Title**	**Presenter Name**
10:00-10:30	KN-1	356	Microstructural features of Additively Manufactured Metallic Materials: Origin and Consequences	Prof. Satyam Suwas	10:00-10:30	KN-1	404	Influence of ceramic particle reinforcenent on Mechanical response and fracture behavior of an aluminum alloy composite for use in performance-driven brake drums	Prof. T.S. Srivatsan	10:00-10:30	KN-1	376	Multiscale Functional Surfaces for Antibiofouling and Bactericidal Properties	Prof. Suhas S. Joshi	10:00-10:30	KN-1	365	Advanced Materials & Processes for Semiconductor & Adjacencies	Dr. Gopi Chandran
10:30-11:00	KN-2	375	Structure Integrity and in-Service Material Degradation based Life Cycle Management (LCM) of Aerospace & Defence Platforms-An Integrated Perspective	Dr. Vikas Kumar Saxena	10:30-11:00	KN-2	385	Processing and Fabrication of Advanced Polymer Derived Ceramic Composites using Severe Plastic Deformation Processes	Prof. Satish V. Kailas	10:30-11:00	KN-2	125	Mechanical Behaviour of Additive Manufactured Maraging Steel	Prof. (Mrs.) Santhi Srinivas N C	10:30-10:50	IL-01	339	Clean room for semiconductor manufacturing	Mr. Jayadev. K

11:00-11:30	KN-3	413	TBC	Dr. Debashish Bhattacharjee	11:00-11:10	OP-1	80	Pitting Corrosion Behavior of Nickel Base Superalloy- A Comparative Study in Na2SO4 and Na2SO4: xxNaCl Fluxing Salts.	Nandha K. E.	11:00-11:10	OP-1	116	Design & Modification of Cavity Plate for Injection Mold of Nail Polish Bottle Caps	Anagha Francis V.	10:50-11:10	IL-02	347	Semiconductor nanostructured based gas sensor for affordable healthcare	Dr. Mrinal Pal
11:30-11:50	IL-1	406	Development of MAX-phase Coated Zircaloy fuel tubes as Accident Tolerant Fuel Cladding	Dr. Bikas C Maji	11:10-11:20	OP-2	81	Comparing the effect of texture on strength and ductility of shear deformed and rolled magnesium	Sanika Paranjape	11:10-11:20	OP-2	120	Plasma Electrolytic Polishing Process: Mechanism and Characteristics	Sushil Kumar	11:10-11:30	IL-03	TBC	TBC	TBC
					11:20-11:30	OP-3	83	Investigations on the effect of loading rate on the formability of AA 6082	Irfan Khan	11:20-11:30	OP-3	94	Effect of heat treatment on microstructure evolution of laser powder bed fusion processed XH-67 nickel-based superalloy	Nithin Baler	11:30-11:50	IL-04	408	Through-Glass Vias-based 3D Interconnects for Microsystems Packaging	Prof. Pradeep Dixit
					11:30-11:40	OP-4	101	Understanding the texture evolution and deformation behavior under bending and uniaxial tensile creep loading	Naimish Sanjay kumar Shah	11:30-11:40	OP-4	394	Microstructure and Mechanical Behaviour of Ti6Al4V Specimens Fabricated Using Laser Powder Bed Fusion	Jagatheesh kumar S	11:50-12:10	IL-05	409	TBC	Prof. Siva Rama Krishna Vanjari

Parllel Session-19 Manufacturing Technologies Hall-A					Parellel Session-20 Materials and Processing Hall-B					Parellel Session-21 Make in India Hall-C					Parellel Session-22 Materials and Processing Hall-D				
Session Chair- Dr. Amit Arora, IIT-Gandhinagar					Session Chair- Dr. T.P.D. Rajan CSIR-NIIST, Trivendrum					Session Chairs- Prof. Mohan S, IISc Bangalore & Dr. Nagahanumaiah, CMTI Bengaluru					Session Chair- Prof. Srikanth Vedantam, IIT-Madras				
Time	MOP	ABS ID	ABS Title	Presenter Name	Time	MOP	ABS ID	ABS Title	Presenter Name	Time	MOP	ABS ID	ABS Title	Presenter Name	Time	MOP	ABS ID	ABS Title	Presenter Name
12:10-12:40	KN-1	35	High Throughput Determination of Creep Behavior of Additively Manufactured Alloys: DIC-Augmented-Bending Creep of LPBF Al Alloys	Prof. Praveen Kumar	12:10-12:30	IL-1	330	Laser Decal Transfer Based Laser μ-3D Printing for Multi-layer Structure	Dr. I. A. Palani	12:10-12:40	IL-1	400	A glimpse into the MEMS Fabrication Facilities at STARC	Dr. Meduri Ravi	12:10-12:30	IL-2	320	Engineering micro-strain localizations in dual phase steels to improve their hole expansion behaviour	Prof. Nagamani Jaya Balila
12:40-13:10	KN-2	401	Role of AI in Manufacturing Industry Over Time	Dr. Sheela Siddappa	12:30-12:50	IL-2	366	Flash sintering of ceramics: From sintering to material development	Dr. Devinder Yadav	12:40-13:10	IL-2	TBC	TBC	Shri Sakaram Srinivasulu	12:30-12:40	OP-1	142	Hydrothermally synthesized TiO2 nanostructures for LPG sensing applications	Shanmukha Rao Mutcha
13:10-13:20	OP-1	132	Effect of Process Parameters on Track Geometry and Porosity in Laser Direct Energy Deposition of High Strength Aluminium Alloy	Sai Kumar Balla	12:50-13:00	OP-1	104	Processing effect on the tensile properties of the coir fibre for sustainable composite development	Darshan Dange	13:10-13:40	IL-3	TBC	TBC	CMTI Bangalore	12:40-12:50	OP-2	150	Surface modification of Titanium Alloys with Nanopores to Enhance the Osteoconduction and incorporate antimicrobial properties	Jayashree Sathiyanarayanan
13:20-13:30	OP-2	134	Wire Arc Additive Manufacturing of Pelton wheel bucket	Srihari Chitral	13:00-13:10	OP-2	108	Loha Bhasma for Urinary Disorders: A Comprehensive Review of Material Science and Processing Techniques for Enhanced Therapeutic Efficacy of Nano-based Iron Medicine	Anantha Krishna						12:50-13:00	OP-3	151	Surface Modification of Agrowaste Coconut Fibers: Latex Coating	Sumanta Prasad Dewri

13:30-13:40	OP-3	147	Experimental investigation into depositing low melting point alloy utilising fused deposition (FDM) modelling technique	Rishi Parvanda	13:10-13:20	OP-3	109	Impact of chloroform treatment on the mechanical characteristics of PETG, ABS, and PLA materials fabricated via the Fused Deposition Modeling (FDM) Technique	Surjeet Singh Bedi						13:00-13:10	OP-4	155	Mechanical Properties and Characterization of Hybrid Composite Reinforced with Natural Fibers	Arunkumar Bheemanalli
13:40-13:50	OP-4	153	Geometrical inspection of fabricated micro-hole attributes using MagLev micro-EDM	Anand Kumar	13:20-13:30	OP-4	110	Effect of cell wall thickness and heat treatment on overall compressive strength of honeycomb structure made of PETG, PLA and ABS fabricated by FDM technique	Vasu M						13:10-13:20	OP-5	164	Study on rheological behavior of alumina ceramic slurry for Direct Ink Writing process	Gaurav Prakash
13:50-14:00	OP-5	160	Geometric Form Errors in Hollow Cylindrical Parts Manufactured by Powder Bed Fusion	Vamshi Veeraiahgari	13:30-13:40	OP-5	118	Fracture Properties of Additively Manufactured Mar-M 509 Cobalt-based Superalloy	Rohit Kumar Yadav						13:20-13:30	OP-6	183	Tribological and Corrosion Characteristics of a Novel Al-Fe-Cr-Ti alloy processed by Laser Powder Bed Fusion	Vedanth Bhatnagar
14:00-14:10	OP-6	161	Integrating System Engineering into the Design and Development of an Amphibious Surveillance UAV for Aerial and Underwater Missions	Amaranath Shantappa Siddaraddi	13:40-13:50	OP-6	119	Wear and Corrosion Analysis of MoS2/Epoxy Nanocomposite Coating	Pravesh Ravi						13:30-13:40	OP-7	185	Processing and Fracture Resistance of ABS-TPU Multi-Material 3D Printed Parts	Manonmani D
					13:50-14:00	OP-7	121	Effect of Build Orientation and Test temperature on Bending Creep of Additively Manufactured A205 Aluminium Alloy	Anup Shrikrishna Kulkarni						13:40-13:50	OP-8	289	Mechanical and Tribological Property Evaluation of Friction Stir Deposited and Hydroxyapatite Reinforced Surface layers on Ti6Al4V	Jibin Thazhethil Philip

					14:00-14:10	OP-8	354	Finite Element Analysis of Stress Distribution in Artificial Bone plate and Fractured Femur Bone	Shivani Gupta						13:50-14:00	OP-9	55	Interfacial damage detection in fiber metal laminates (FMLs)	Vinay Kumar

Lunch Break-14:00 - 14:30

Parllel Session-23 Manufacturing Technologies Hall-A					Parellel Session-24 Materials and Processing Hall-B					Parllel Session-25 Manufacturing Technologies Hall-C					Parellel Session-26 Materials and Processing Hall-D				
Session Chair - Dr. Mrinal Pal CSIR-CGCRI, Kolkata					Session Chair - Dr. A Venugopal Rao, DMRL, DRDO					Session Chair - Prof. Praveen Kumar, IISc, Bangalore					Session Chair - Dr. Mamilla Ravi Sankar, IIT Tirupati				
Time	MOP	ABS ID	ABS Title	Presenter Name	Time	MOP	ABS ID	ABS Title	Presenter Name	Time	MOP	ABS ID	ABS Title	Presenter Name	Time	MOP	ABS ID	ABS Title	Presenter Name
14:30-14:50	IL-01	405	AM in Aerospace and Defense	Mr Yathiraj Kasal	14:30-14:50	IL-01	37	Advances in Cellular Materials: Its processing and Multifunctional Applications	Dr. D P Mondal	14:30-14:50	IL-01	363	Controlled Directionality in 3D Printing of Reinforced Polymer Composites- A DEM Analysis	Dr. Amit Arora	14:30-14:50	IL-01	412	Fabrication of microneedles for biomedical applications	Dr Ajay M Sidpara
14:50-15:00	OP-1	189	Parametric Optimization and Performance analysis of adhesive bonding of automotive steel	Vishwajeet Kumar	14:50-15:10	IL-02	TBC	TBC	Prof. B. V Manoj Kumar	14:50-15:00	OP-1	249	Analysis and Optimization of Material Removal Rate, Recast Layer Thickness and Radial Overcut in Electrical Discharge Machining of Magnesium Alloy-ZE41 with Different Electrodes	Shrinivas Balraj Uyala	14:50-15:00	OP-1	325	Effect of Plasma sprayed TiO2-15wt% Inconel 718 coatings on salt spray corrosion of on SS304 steel	G. Giridhara

15:00-15:10	OP-2	198	Tool based electrochemical polishing of additively manufactured metallic components	Sri Satya Omkar Dadi	15:10-15:20	OP-1	186	Solution Precursor Plasma Sprayed (SPSS) HAp/Titania Coating for Biomedical Applications-Fretting Damage Analysis	Samiksha Moharana	15:00-15:10	OP-2	290	Maglev Electric Discharge machine (MEDM): Design and development	Vivek Bajpai	15:00-15:10	OP-2	223	Tribological study of surface charactertization of basalt fiber with and without surface modification with Silane	Baskara Sethupathi P
15:10-15:20	OP-3	203	Fatigue Performance of Wire Arc Additive Manufactured Aluminum alloy 5356	Senthilvelan Veerasamy	15:20-15:30	OP-2	192	High speed drilling of woven GFRP composites : Optimization of Machining Parametrs	Ashish kumar Chaudhari	15:10-15:20	OP-3	255	Effect of Build Orientation on Mechanical Strengths of Additive Manufactured AlSi10Mg Alloy	Vigneshwaran S	15:10-15:20	OP-3	233	Analysis of Fibre Length, Dispersion, and Orientation during Injection Moulding of Short Natural Fibre-Reinforced Biocomposites	Surya Rao Gorrepotu
15:20-15:30	OP-4	214	FDM Parametric Analysis for Determining Compressive and Impact Strength of PEEK using Multicriteria Decision Making	Chinmaya Prasad Padhy	15:30-15:40	OP-3	212	Influence of friction stir processing on microstructure and mechanical properties of as-cast magnesium alloy nanocomposites.	C. A. Niranjan	15:20-15:30	OP-4	259	Evaluation of Conventional Drilling and Helical Milling for Hole Machining in Ti6Al4V Titanium Alloy	Gururaj Bolar	15:20-15:30	OP-4	234	Hydroxyapatite Synthesis From Cuttlefish Bone For Biomedical Application	Mallikarjun B Jalageri
15:30-15:40	OP-5	239	Prediction and Validation of Peak Temperature during FSSW of AA 6063-T6 Aluminium alloy and CRCA/IS-513 Steel alloy using a Consumable Sheet	Sukanta Das	15:40-15:50	OP-4	213	Performance Evaluation of Multi-Cylinder Diesel Engine Fuelled with blends of Methyl Ester of used Vegetable Oil	C. Solaimuthu	15:30-15:40	OP-5	261	Investigations on the laser ablation of sintered silicon carbide ceramic for precision optics applications	Tayaaramma D P V Jalluri	15:30-15:40	OP-5	235	Influence of Processing Conditions on Thermal Insulation Characteristics 0f 3D-Printed Thermoplastic Polyurethane	Matcharla Devi Sri Prasad

15:40-15:50	OP-6	93	Optimization of Surface Roughness using Grey Relational Analysis and Response Surface Methodology in Abrasive Waterjet Machining of Stainless Steel 304	Karthik K	15:50-16:00	OP-5	221	Investigation of mechanical properties and tribological performance of Al-B4C Metal Matrix Composites	Balasubramanya H S	15:40-15:50	OP_6	316	Optimization of Selective laser melting process Parameters and corrosion resistance properties of Inconel 625 alloy by using Pareto Anova Technique	Rohith S	15:40-15:50	OP-6	245	Mechanical Properties of Bidirectional Silk Fibre Fabric and Bidirectional Glass Fibre Fabric Reinforced Nanoclay HDPE Hybrid Composites	Shridhar Deshpande
Tea Break and Poster Sessions 16:00-17:30																		
Banquet Dinner & Musical Fusion Performance- 19:00 Onwards at Hotel Marasa Sarovar Premiere, Tirupati- Assembling point for Banquet dinner is PFAM 2023 Lecture Hall Complex (Assembling Time: 18:00)																		

08-09-2023 - Day-3 (Friday)

Plenary Session-27-Hall-A

09:00-09:40	Session Chair - Lt. Gen. Anil Kapoor, IIT Tirupati
09:00-09:40	Digitalization of Manufacturing Enterprise System: Smart Manufacturing Innovation - **Prof. Sudarsan Rachuri (Rec.)**

Parllel Session-28 Manufacturing Technologies Hall-A

Session Chair- Dr. T Ram Prabhu, RCMA (F&F), CEMILAC, DRDO

Time	MOP	ABS ID	ABS Title	Presenter Name
09:40-10:00	IL-1	383	Artificial Intelligence & Machine Learning – Introduction & Applications in PFAM	Dr. Sri Vallabha Deevi

Parellel Session-29 Materials and Processing Hall-B

Session Chair- Dr. D V Kiran, IIT-Tirupati

Time	MOP	ABS ID	ABS Title	Presenter Name
09:40-10:00	IL-2	361	Hybrid Metal Additive Manufacturing	Prof. N Venkata Reddy (Rec.)

Parellel Session-30 Modelling and Simulations Hall-C

Session Chair - Prof. (Mrs) Santhi Srinivas N C, IIT (BHU)

Time	MOP	ABS ID	ABS Title	Presenter Name
09:40-09:50	OP-1	238	Architected polymer insulation coating design for traction motor bearings- Numerical simulations	Balakrishna G V

Parellel Session-31 Materials and Processing Hall-D

Session Chair- Dr. N. Venkaiah, IIT-Tirupati

Time	MOP	ABS ID	ABS Title	Presenter Name
09:40-09:50	OP-1	277	Improvement of Mechanical Properties in Al7075 Metal Matrix Composites with SiC Nano-Particle Inclusions	Mahesh G S

10:00-10:10	OP-1	265	Selective Laser Melting of Al2O3-EIP Composite: Single Track Study	Sumitkumar Rathor	10:00-10:10	OP-1	263	Investigation of Microstructural Influence and Synergistic effect of Zinc and Magnisium Nanoparticles on Mechanical Propeties of Al6303-T6	Podugu Naga B. Ravi Kumar	09:50-10:00	OP-2	244	Artificial Womb Technology: Addressing Philosophical Challenges and Ethical Implications through Machine Learning Analysis	Peddabuddi Uma Devi	09:50-10:00	OP-2	279	SmartEx QD-100 based SLS-mediated Immediate release tablet: Sintering, Characterization and Novel material finding for selective laser sintering	Tukaram Ram Karanwad
10:10-10:20	OP-2	266	Hybrid machining of nanoparticle-reinforced fused silica-based composites	Rajat Jain	10:10-10:20	OP-2	270	Nature Inspired Shape Shifting Soft Magnetic Materials: Inspiration, Fabrication, mechanism, and Application	Dharmi Chand	10:00-10:10	OP-3	250	Investigational Study on Mechanical Behaviour of Mathematical model on Atomic scale of Aluminum and Magnesium alloys	Sudhakar Choudary Pamidimukkala	10:00-10:10	OP-3	282	Impact of ageing treatment on microstructural evolution and tensile behavior of alloy 625	Sonika Chahar
10:20-10:30	OP-3	271	Effect of Interlayer Copper Micropowder Addition On the Mechanical As Well As Metallurgical Properties Of Wire Arc Additively Manufactured Ferritic Steel	Adarsh Prakash	10:20-10:30	OP-3	275	Experimental and numerical investigation of laser wire-directed energy deposition of SS 308L	Sanasam Sunderlal Singh	10:10-10:20	OP-4	274	Thermomechanical finite element based simulation of micro-EDM	Rajiv Kumar	10:10-10:20	OP-4	292	Direct Ink Writing-based 3D Printing of Graphene Electrodes	Poonam Sundriyal
10:30-10:40	OP-4	414	ZEISS Solutions for Electronics and Electronics component manufacturing	Manoj K Sundaram	10:30-10:40	OP-4	16	Influence of tool rotational speed on the mechanical properties of friction stir spot welded AA5052-H32/PU-foam/AA5052-H32 sandwich sheets	Divya Sachan	10:20-10:30	OP-5	66	Probing the influence of waveforms on the submerged arc weld characteristics and residual stress distribution	Adapa Mahanth Kumar	10:20-10:30	OP-5	299	Underwater Laser Bending of Stainless Steel sheet	Ramsingh Yadav

10:40-10:50	OP-5	415	Confront challenges of materials research with state-of-the-art in situ microscopy solution from Zeiss	Aloysius Daniel	10:40-10:50	OP-5	36	Effect of PTFE on the Mechanical and Tribological Properties of ABS and HDPE-Based Hybrid Nano Composite	Padmini B V	10:30-10:40	OP-6	115	Microstructure and Non-Destructive Evaluation of Aluminium 6009 Alloy Sheets Joined by Friction Stir Welding	Subhrajyoti Saroj	10:30-10:40	OP-6	312	Investigation on Tribo-Mechanical Behavior of Areca fiber reinforced Alumina filled Epoxy composites	N. Mohan
										10:40-10:50	OP-6	124	Estimation of Heat Affected Zone in the Laser Surface Modification of Single-Crystal Nickel based Superalloy by using a 3D Transient Heat Transfer Modelling	Srinivasa Rao Nandam	10:40-10:50	OP-7	107	Investigation of Residual Stress and Elastic Parameters Affected due to Variations in Manganese Content and Cast Section Size in Wear Resistant High Chromium Irons	T Pramod
Tea Break 10:50-11:10																		

Parllel Session-32 Manufacturing Technologies Hall-A					Parllel Session-33 Manufacturing Technologies Hall-B					Parellel Session-34 Manufacturing Technologies Hall-C					Parellel Session-35 Materials and Processing Hall-D				
Session Chair- Dr. Nagendra Singh, Eagle Robot Lab, Bangalore					Session Chair- Lt. Gen. Anil Kapoor, IIT-Tirupati					Session Chair- Dr. S. Seetharamu, NDRF Bangalore					Session Chair - Prof. Manoj Gupta, NUS, Singapore				
Time	MOP	ABS ID	ABS Title	Presenter Name	Time	MOP	ABS ID	ABS Title	Presenter Name	Time	MOP	ABS ID	ABS Title	Presenter Name	Time	MOP	ABS ID	ABS Title	Presenter Name
11:10-11:20	OP-1	272	Controlled texturing on Silicon carbide dispersed Aluminium matrix composite using ultrashort pulse laser irradiation for tribological enhancement	Shalini Singh	11:10-11:30	IL-1	377	Challenges & opportunities in Missiles & Aerospace business	Shri Laxmesh Hasanabadi	11:10-11:30	IL-1	TBC	TBC	Dr. T Ram Prabhu	11:10-11:20	OP-1	351	Key-hole Plasma Arc Welding of high thickness Titanium using modified Single V Groove Joint	Uday Parmar
11:20-11:30	OP-2	276	A comprehensive study of high quality film cooling holes, machined on IN718 by using a femtosecond laser trepan drilling techique	Sunil Kumar	11:30-11:50	IL-2	TBC	TBC	TBC	11:30-11:40	OP-1	353	Dynamics and Load Analysis of Micro Hydraulic Actuator Controlled through Multiple Micro Pumps	Thiruppathi Rengasamy	11:20-11:30	OP-2	137	Processing and Characteristion of Medical implant by Surfacemodification	Harish Ramanathan Babu
11:30-11:40	OP-3	283	Analysis of hole quality of Copper oxide nanostructured CFRP composite	Abhipsa Kar	11:50-12:00	OP-1	172	Spark plasma sintered SiC-ZrN composites for high temperature sliding wear resistance applications	Surya Prakasarao Chodisetti	11:40-11:50	OP-2	369	Temperature and Fluid Velocity Field Estimation in Melt-Pool using Multiphysics Based Numerical Simulation for Multi-track elective Laser Melting Process	Rakesh Kumar	11:30-11:40	OP-3	359	Anti-fungal Activity of Redox Metal-Organic Frameworks (R-MOFs) through synergistic release of Sodium Lignosulphonate	Chinmaya Mahapatra
11:40-12:00	OP-4	285	State of the art on additive manufacturing of moulding dies with conformal cooling channels	Nisar Ahamad Khan	12:00-12:10	OP-2	175	Characterisation of Functionally Graded Ni Based EWAC-TiB2 Cladding on Maraging Steel Using Microwaves	Nikita Rai	11:50-12:00	OP-3	179	Effect of Process Parameters on Mechanical Performances of 3D Printed ABS Parts	Dipayan Chakrabort y	11:40-12:00	OP-4	360	Transient stealth coating of liver scavenger sinusoidal wall enables retargeting of nanomedicines	Anjaneyulu Dirisala

12:00-12:10	OP-5	287	Analysis of Plasma Channel and its Effects	Kishalay Roy	12:10-12:20	OP-3	176	Investigation on multi-tool machining of Ag using Î¼-EDM process	Aruna Kotlapati	12:00-12:10	OP-4	180	Additively Manufactured Ceramic Lattice Structures: Fabrication, Challenges, and Applications	Shikher Verma	12:00-12:10	OP-5	362	Solidification behavior and microstructure evolution of Al-12.5wt%Si-(TiB2+Al2O3) hybrid composite	Pradeep Kumar Jha
12:10-12:20	OP-6	288	Machinability of Ti6Al4V in High Speed Micro Turning Under Dry Condition	Prince Anand	12:20-12:30	OP-4	177	Analysis of machining characteristics using silica mixed dielectric in MagLev EDM	Rajesh Sahoo	12:10-12:20	OP-5	256	Investigation on Machining Performance During Ultrasonic Vibration Assisted Turning of Magnesium AZ31B Alloy	Neeraj Deswal	12:10-12:20	OP-6	367	Design & static analysis of Connecting Rod of a petrol engine using FEA	Anand Raj Singh
12:20-12:30	OP-7	296	Performance Evaluation on Electrical Discharge Machining of Commercially Pure Titanium Using two Different Dielectrics	Dhanush Karthik Manogaran	12:30-12:40	OP-5	178	Evaluation of machining performances of Inconel X-750 in the electrical discharge machining process using CoCoSo method	Sameer Kumar Anand	12:20-12:30	OP-9	300	Laser Transmission Welding of Polycarbonate Sheets Using Dry Graphite Absorber	Dhruva Kumar Goyal	12:20-12:30	OP-7	370	In-situ dispersion of electrospun nanofibers in PDMS for fabrication of high strength, transparent nanocomposites	Prasoon Kumar
12:30-12:40	OP-8	298	Microstructure and Mechanical P roperties of Non equiatomic CoCrNi alloy F abricated by Wire Arc Additive Manufacturing	G. Dan Sathiaraj											12:30-12:40	OP-8	194	Fabrication of Delonix Regia based Natural Fiber Reinforced Polymer Composites	Arulprasanna Adiseshan
12:40-12:50	OP-9	131	Micro channel fabrication by additive and subtractive methods	Bhavani Tharra											12:40-12:50	OP-9	211	Influence of Hybrid reinforcement on Microstructure and Mechanical properties of Magnesium alloy Nanocomposites: A Study	Siddaraju C
Lunch-13:00-14:00																			

Parllel Session-36 Modelling and Simulations Hall-A					Parellel Session-37 ASM International Materials and Processing Hall-B					Parellel Session-38 Materials and Processing Hall-C					TIFAC- Panel Discussion on advanced Material and Manufacturing Technologies for Application in Defence Sector Hall-A
Session Chair- Dr. Anup Basak IIT Tirupati					Session Chair- Shri Babu Sathian V, ASM Bangalore					Session Chair- Dr. Mamilla Ravi Sankar, IIT Tirupati					15:00-16:30-Panelists
Time	MOP	ABS ID	ABS Title	Presenter Name	Time	MOP	ABS ID	ABS Title	Presenter Name	Time	MOP	ABS ID	ABS Title	Presenter Name	
14:00-14:10	OP-1	202	Numerical and experimental study on the effect of tool pin profile of friction stir additive manufactured AA6061/AA7075 joints.	Kishor Kumar Jha	14:00-14:10	OP-1	318	Surface Analysis of Inconel Alloy Machined by µ-EDM with Nano Powder Blended Dielectric	Bhargab Madhab Barua	14:00-14:10	OP-1	333	Microstructure and Mechanical Properties of Ni-Al-Co-Cr-Fe-Ti-Ta-Mo-W based high entropy Superalloy	Piyush Kumar	
14:10-14:20	OP-2	218	Stress and Vibration behaviour of 4 bladed composite marine Propeller	D. Harsha Vardhan	14:10-14:20	OP-2	321	Optimization of machining variables during nano powder mixed µ-EDM of NiTi Shape Memory Alloy	Souradeep Dutta	14:10-14:20	OP-2	341	Micromachining of NiTi SMA composite bimorph for smart actuators using a CO2 laser	Kaushal Gangwar	
14:20-14:30	OP-3	224	Forming Analysis of Metal-Polymer-Metal Sandwich Sheets	P. Praveen Kumar Reddy	14:20-14:30	OP-3	322	Study of Various Flank Surface Textured Coated Carbide and Ceramic Tools and their effect on the Performance Parameters during Machining of hardened H13 Steel	Arunabh Choudhury	14:20-14:30	OP-3	344	Does the atomic order hinder the diffusion in multicomponent intermetallics?	Mohan Muralikrishna Garlapati	
14:30-14:40	OP-4	48	A Novel Antenna Material for High-Performance 5G Wireless Networks	M. Amina Begum	14:30-14:40	OP-4	326	A Novel approach to weld flow analysis of electric resistance welded (ERW) Tubes: Significance and implications	Aravind P	14:30-14:40	OP-4	348	Lubricant Wetting Transitions And Scuffing In Nano-Micro Topographies	Vimal Edachery	

14:40-14:50	OP_5	280	Multiphase phase-field study of grain boundary-induced martensitic phase transformations for cubic to orthorhombic transformations	Newton	14:40-14:50	OP-5	328	The Effect of Heat Treatment and Squeeze Casting on the Microstructure and Creep Behavior of Die cast AZ91 Magnesium Alloy	Hitesh D. Patil	14:40-14:50	OP-5	43	Effect of Severe Plastic Deformation Involving ECAP of Aluminum 2024 alloy Beryl Composites on the Mechanical Properties	SagarK G	
16:30 to 18:00- Valedictory, Award Ceremony & Cultural Program followed by High Tea at Hall- A														

Plenary Talk

Lite Weighting of Metal Structures by Metallurgical Means; The Avenue of Severe Plastic Deformation

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Abstract

One way of reducing the mass of a metallic structure is to use stronger metal. A metal with higher yield limit permits to reduce the thickness of a structural element while bearing the same load. Strengthening of metals can be achieved by producing fine microstructures which can be obtained by alloying or by nano-structuring. Severe plastic deformation (SPD) has been used since long time for reducing the grain size thus, increase the strength via the Hall-Petch effect, without alloying the metal. The research in SPD has been very intensive since about 25 years. New SPD processes were established which permit to approach the theoretical yield limit of metals that are ultra-fine grained or even nano-structured. Such structures are obtained by a grain fragmentation process due to large plastic strains. This lecture will first overview the most well-known SPD processes, then present the latest ones that are able to bring the metal into its limiting stage of grain fragmentation in a single deformation step, thus candidates for industrial applications. Insight will be given on the grain fragmentation process and on the mechanical/thermal stability of the UFG/nano-grained microstructures.

Keynote Talks

Green Technologies Using Microwaves

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Abstract

Many nonconventional processing methods are in use to reduce production costs, processing times, and to enhance properties of manufactured products. Microwave processing is one such novel processing technology emerging as an alternative for a variety of areas. Realizing the importance of microwave technology and its capabilities, Pradeep Metals Limited established Industrial Microwave Research Center (IMRC), an in-house R&D center, almost 15 years back.This is dedicated for carrying out applied research in the field of microwave processing of materials. The centre's aim is to convert potential applications to commercially viable, energyefficient, green processes. Disinfestation of food grains technology was developed, wherein, byexposing grains for a few seconds to microwaves, the shelf-life of the commodity can be enhanced to more than a year. Another high temperature technology has been developed wherepowdery iron ore is converted, with or without coal, into better quality pig iron. In this processuse of coke is eliminated. This makes the process environment friendly. This paper presents some such different novel technologies developed by IMRC.

Hot Deformation Behavior of Exotic Alloys: Nickel and Titanium Based Alloys

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Abstract

The continuous development of exotic alloys used in specialized sectors (like aerospace, oil & gas etc.) has resulted in design of complex material compositions with substantial amount of alloying elements. These alloying elements are added to improve high temperature strength, toughness and resistance to degradation in corrosive and oxidizing environment. Higher alloying makes these alloys more difficult to deform and process as it requires high temperature for heating and shaping the parts. Low thermal conductivity poses another problem in both hot deformation and machining. Hot forging of these alloys is very sensitive to its process parameters like temperature, strain rate and strain. Forging strategy of these alloys is defined based on the microstructural factors such as recrystallization, grain growth, precipitation, cracking tendency and forging load. Improper selection of forging process parameters may result into forgings with inhomogeneous deformation, grain growth, micro & macro cracks, flow localization and shear bands. All these factors restrict the forging process window and hence, make control of process parameters extremely critical. Thus, in order to get a sound forged product, determination of optimized process parameters for these alloys becomes extremely important, which otherwise require trial and error method which would in turn be time consuming and costly affair. In such scenario, physical simulator like Gleeble comes to the rescue, which can be used to simulate the thermomechanical conditions experienced by materials in actual conditions through well characterized predetermined heating & cooling cycles, load, strain rates to replicate real world environments.

This presentation gives an insight into the deformation behavior of exotic alloys like Nickel Based and Titanium based alloys. The different strengthening mechanisms (solid solution precipitates etc.), physical/thermal properties and their interaction with the deformation parameters will be demonstrated through examples and case studies.

Driving Product Innovation: The Transformative Role of 4ps - Product, Process, People and Production Challenges

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Abstract

In the realm of modern business, product innovation stands as a crucial pillar for sustained growth and competitive advantage. This presentation sheds light on the transformative role of the 4Ps - Product, Process, People, and Production - in fostering innovation across industries. Drawing from research experience and case studies, the interplay between these four dimensions and their collective impact on driving product innovation will be discussed. Firstly, the focus is on the pivotal role of product design and development, exploring how cutting-edge technology and creative ideation lead to revolutionary products that resonate with customers. Secondly, it delves into process optimization, elucidating how streamlining production methods and embracing agile practices accelerate the innovation cycle, fostering a culture of continuous improvement, taking additive manufacturing as a case to explain. Thirdly, this presentation highlights the paramount significance of people in the innovation ecosystem, emphasizing the value of diverse and empowered teams, supportive leadership, and a culture that encourages open communication and inclusiveness. Lastly, it addresses the challenges faced in integrating the 4Ps effectively, ranging from resource constraints to resistance to change. Understanding and overcoming these obstacles are crucial for unleashing the full potential of product innovation. The synthesis of these factors culminates in a comprehensive framework for driving product innovation, which organizations can leverage to navigate the dynamic landscape of markets and achieve sustainable growth. By embracing the power of the 4Ps, industries can proactively tackle challenges, capitalize on opportunities, and lead the way in shaping the future of product innovation.

Development and characterization of gradient microstructures

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Abstract

Development of gradient microstructures in metals and alloys can result in improved strength with retained ductility. These structures can be achieved through various approaches, including severe plastic deformation or strategic additive manufacturing. Gradients in grain size, crystallographic texture, and defect content are all of interest in designing microstructures for optimum mechanical performance. Electron backscatter diffraction can be used to obtain information on the spatial dependence of each of these structural features. This discussion focuses on various strategies to develop gradient structures as well as characterization tools to quantify the observed microstructures.

Structure Integrity and in-Service Material Degradation Based Life Cycle Management (Lcm) of Aerospace & Defence Platforms - an Integrated Perspective

Vikas Kumar Saxena

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Visiting Professor -IIT-Roorkee, IIT-Bombay, UPES-Dehradun
Chairman - Steering Aeronautical Research & Development Board (AR&DB), DRDO
Chairman- Bureau of Indian Standards (BIS- MTD3)
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Abstract

Safety of a structure for the intended life cycle is of prime concern for a designer, especially for critical applications such as defence, nuclear, and aerospace. The conventional strength based design approaches may not ensure integrity of structure during its design life span. In critical applications, there is a continuous in-service degradation of material, and hence, unexpected catastrophic failures may occur during its service life. In that case, fracture and damage mechanics based approaches coupled with conventional design approaches are more appropriate, which take into account all possible in-service material degradation mechanisms. In this presentation, an integrated approach towards material-design-performance under service simulated environment has been attempted for Structural Integrity (SI) & Life Cycle Management (LCM) of Aerospace & Defence platforms.

The latest Damage Prognostic based SI & LCM technologies are being researched through Academia-Industry-R&D Labs partnership under Aatmnirbhar Bharat Initiative of Govt. of India for sustainability of legacy Defence platforms. Based on more than two decades of experience, DRDO-IAF developed systematically various technologies involving several agencies. The various strategies have been envisaged depending on the cost-benefit analysis, time and criticality of mission operations. Latest Digital Twin and AI driven FMECA based on damage prognostics technologies are also being considered to develop strategies for LCM of legacy Aerospace & Defence Platforms. The NextGen strategies based on Multiscale-Multiphysics-Multidisciplinary technologies will have capabilities to exploit 'Failure Assessment Diagrams (FADs)' based dashboards as safety alerts available to operators with part-by-part 'Reserve Factors (RFs)' against any potential catastrophic failure. These could be very powerful tools based on AIML technologies exploiting data and physics based driven models using advanced sensor technologies. The author will share few Academia-Industry-R&D Labs consortium initiatives and also present few successful case studies which yielded a lot benefits to Defence Services in terms of safety, cost, time and expertise development.

AI/ML for the Quantification of Process-Induced Uncertainty in Additively Manufacture Composites

Kishore Pochiraju

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Abstract

Heterogeneity and uncertainty in a composite microstructure lead to either computational bottlenecks if modeled rigorously or to solution inaccuracies in the stress field and failure predictions if approximated. This presentation explores applications of Artificial Intelligence/Machine Learning (AI/ML) methods for characterizing the part defects induced by the Additive Manufacturing (AM) machinery and quantifying microstructure and property heterogeneity and uncertainty in AM composite parts. Variability in properties of heterogeneouscomposites arises from manufacturing processes, service loads, or environmental factors, significantly impacting macroscopic structural performance.

Uncertainty Quantification (UQ) offers a framework for measuring these uncertainties and evaluating their effects, enhancing confidence in simulation outcomes. Comprehensive UQ can facilitate certification by simulation for composite materials, manufacturing processes, and aerostructures, where substantial experimental efforts are needed. We investigated UQ methods for computational efficiency and material variability assessment. It explores innovative artificialintelligence and machine learning approaches for a more versatile and efficient microstructure homogenization framework during UQ.

The presentation will discuss the ongoing efforts in our lab to develop methods for reducing the computational load for uncertainty propagation by adopting the Quasi-Monte Carlo (QMC) method with various low-discrepancy sampling approaches. Additionally, convolutional neural networks are shown to infer parameters describing random fields modeling a material's spatial property variability from a limited number of experimental tests with full-field strain measurement. Defining random fields for highly anisotropic materials requires extensive experimental characterization or computationally intensive multi-scale simulations. Surrogate models utilizing neural networks are often developed for stochastic heterogeneous materials to decrease computational costs. However, these models are microstructure-specific, and calibrated models are non-transferable. The research demonstrates that the transformer neural network architecture can generate knowledge about various microstructures and constituents, allowing thetransformer to serve as a computationally efficient homogenization surrogate model applicable tomultiple microstructures. The transformer network uses a learned and adaptive microstructure encoding to predict the composite's nonlinear and history-dependent response accurately. Also, these predictions can be made considerably faster than finite element method-based approaches, saving orders of magnitude in computational time.

An Exploration into Invigorating Role of Cryogenic Treatment on Thermal and Mechanical Response of Magnesium Based Materials

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Abstract

High performance materials are increasing required for modern applications due to increasing service demands from engineering systems. This translates to, depending on the nature of application, a holistic enhancement in thermal, mechanical and electrochemical response. Among the metal based materials, magnesium based materials are the lightest and have significant potential in engineering and biomedical applications. As magnesium based materials provide almost 33% weight saving over aluminum based materials, their use particularly in transportation sector can minimize carbon dioxide emission, fuel consumption and global warming significantly. As magnesium is a nutrient element to living organisms, it is useful as temporary implant in the human body and accordingly has no recycling issues even if it is dumped illegally. Further, magnesium is one of the most abundant material in planet earth and the universe, so sustainability is not an issue. However, as magnesium based materials are recently revived, the property spectrum they exhibit is limited when compared to its near rival, the neurotoxic aluminum. Accordingly, much efforts are placed to improve the properties of magnesium based materials and cryogenic treatment is one of them which is least explored and explained. Present talk will hence focus on the microstructural, thermal, mechanical and electrochemical response of magnesium based materials including nanocomposites following cryogenic treatment at different levels.

Keywords: Magnesium, Sustainable, non-toxic, cryogenic, light weighting, composites.

Microstructural Features of Additively Manufactured Metallic Materials: Origin and Consequences

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Abstract

In recent times, additive manufacturing-based processes have rapidly gained considerable interest owing advantages such as ability to produce intricate components, minimisation of large number of steps during production, elimination of tooling requirements, site-specific deposition and repair of parts, etc. The physical phenomenon associated with additive manufacturing process can be compared with high energy welding processes and solidification. A clearer understanding of these interrelated processes requires a thorough investigation of microstructure, especially micro-texture. The knowledge of micro-texture as well as bulk crystallographic texture not only provides the underling mechanism of the process, it also helps in the assessment of mechanical properties of the additively manufactured material and hence related performance. The present work unravels the above-mentioned aspects for additively manufactured stainless steel 316L, IN718 and Cu-Ni-Sn systems.

Keywords: Additive manufacturing; 316L; IN 718; Cu-Ni-Sn; EBSD; Texture.

Processing and Fabrication of Advanced Polymer Derived Ceramic Composites Using Severe Plastic Deformation Processes

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Abstract

Control of the stress strain curve of the material is the primary requirement for its optimal use. This control enables tailoring the use of these materials for specific applications. The control of Young's modulus, yield strength and ductility being the primary challenge. However, for a given metal/alloy, if the strength is increased it generally leads to a drop in the ductility. Metal matrix composites is one such material where the strength can be increased substantially by mixing a hard phase in the metal matrix. However a significant drop in the ductility is observed. In this work we present a new way to make composites; Polymer Derived Ceramic Metal Matrix Composites. The material is prepared by dispersing a brittle polymer in the aluminum matrix by severe plastic deformation. The severe plastic deformation, which is is solid-state process, enables distribution and fracture of the brittle polymer in the metal matrix. The fracture will also lead to formation of nano particles with sizes as small as a few nano meters. The metal is then heated to a particular temperature below the melting point of the matrix when the polymer converts to a ceramic. Controlling the amount, sizes and distribution of the particles that range from 100s of nanometers to a few nanometers enables control of the strength, and ductility of the metal matrix. The nano-size particles will allow for Oorowan strengthening by dislocation bowing and multiplication. The larger size particles act as dislocation barriers that increases the yield point of the material. The high ductility is also attributed to the very good interfacial bonding between the aluminum matrix and the particle. The polymer derived aluminum metal matrix ceramic compositeis is also seen to exhibit exceptional grain boundary stability even at 550^0C.

Acknowledgments

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Manufacturing: Vision for Future

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Abstract

The talk deals with advanced micromachining and nano-finishing technologies being developed across the globe. It emphasizes on the two major issues of futuristic manufacturing, namely, miniaturization and sustainable manufacturing or green manufacturing. Many of the processes being practice in high tech industries do not fulfill the later requirement that is “Green manufacturing”. To meet micro / nano-manufacturing demands of the industries, single step or two step processes are being developed in place of multi-step processes being used. These processes are being discussed along with the working principle and some interesting examples for which they have been implemented.

To name some of the above discussed processes include, Advanced Mechanical Processes, Advanced Thermal Processes, Advanced Electrochemical Processes and Hybrid Processes. The presentation also has some discussion on nano-finishing processes namely, abrasive and non-abrasive based finishing processes and magnetic field assisted processes. It also gives some indirect direction for further research to enhance the performance of these processes.

Multiscale functional surfaces for antibiofouling and bactericidal properties

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Abstract

Antibiotic resistance poses a significant global health risk, making it increasingly challenging to treat bacterial infections using conventional methods. The problem is further aggravated by the formation of biofilms by bacterial pathogens on the surfaces of medical and dental devices, which enhances their tolerance to antibiotics. The advancements in antibacterial nanostructured surfaces have a great potential for their utilization as next-generation biomaterials in the field of medicine, food packaging and marine applications. These textured surfaces offer excellent prospects in preventing bacterial attachment, killing bacteria, and inhibiting the formation of biofilms through their physico-mechanical interactions with bacteria. As a result, they are promising in effectively circumventing bacterial infections.

Micro-/nano-structuring techniques invoke dual mechanisms for combating bacterial contamination on surfaces. Firstly, the sharp nano-tips generated in these techniques can efficiently rupture the bacterial cell-wall upon contacting the surface, known as bactericidal mechanism. Secondly, the high contact angle resulting from micro-/nano-structuring can effectively repel bacterial attachment to the surface, known as antibiofouling mechanism [1]. The characteristics of surface micro-/nano-patterns can help determine overall antibacterial efficiency. It is defined by a set of important geometric parameters, namely width of the feature cap, base width, periodicity (spacing), and height. As the average size of most of the bacteria is in the range of 1–2 µm, surfaces with nano topographies are found to be of antibacterial nature [2]. However, the adhesion property is extremely low for the feature size less than 30 nm and is extremely high for the features greater than 1-2 µm of surface micro roughness [3]. Furthermore, the surface structure or roughness directly influences the macroscopic hydrophobic or hydrophilic properties of the surface, consequently impacting bacterial adhesion. Superhydrophobic surfaces, with contact angle of more than 150^{o}, enable easy rolling of droplets, thereby facilitating the removal of surface microbes.

Another technique for achieving surface functionalization is to impregnate surfaces with lubricants, referred as slippery liquid infused surfaces (LIS), inspired by pitcher plant Nepenthes, that enhances antibiofouling properties by slipping bacteria over liquid infused layers [4]. LIS rely heavily on the lubricants for their performance [5]. The lubricant can experience depletion based on the application and external environment. The choice of external liquid, lubricant (viscosity ratio) and textured geometry (shape and size) defines the interaction of the liquid-lubricant interface [6]. Oleophobic re-entrant geometries assist lubricant retention as they enforce the lubricants to re-circulate within the cavities rather than deplete out of them.

This work aims to explore design and fabrication approaches that can help advance the area of research of functional surfaces for antibiofouling and bactericidal properties. In our work, antibiofouling surfaces are obtained by creating femtosecond laser induced sub-micron topographies on biomedical elastomer surfaces [7]. Two topographies, first, a highly regular and single-scale submicron laser-induced periodic surface structures (LIPSS), and the second, multiscale structures (MSs) containing both submicron- and micron-scale features, were fabricated. Both surfaces have

nano-features of 200 nm height and 800-900 nm spacing. They show substantial reduction in bacterial adhesion (>89%).

The work also aims to analyse bacterial behaviour in contact with a sharp tip using nanoindentation. Gram negative Escherichia coli bacteria were investigated at different loading rates and applied load for quantifying their visco-elasto-plastic behaviour. The rupture force was found to be 34.38±5.15 nN, irrespective of the loading rate, making it a failure criterion for bacteria rupture.

In designing the efficient topography for bactericidal surfaces using finite element (FE) simulations, we found that rupture force of the bacteria increases with the sharpness of the pillar confirming the piercing mechanism [8]. For pillar spacing, the rupture force exhibits an increase within the range of 25 nm to 100 nm, while it remains constant for larger spacing values. We also discuss the design of a robust LIS system that can retain the lubricant independent of the viscosity ratio using dynamic numerical simulation [9]. The dovetail-shaped re-entrant cavity showed better lubricant retention as the vortex formation inside the cavity was minimised.

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High Throughput Determination of Creep Behavior of Additively Manufactured Alloys: DIC-Augmented-Bending Creep of LPBF Al Alloys

Praveen Kumar

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Abstract

If the flexibility of rapidly changing the processing parameters that additive manufacturing allows is combined with a high throughput test methodology, the process-structure-property-performance optimization can be revolutionized. In this context, we will discuss the utility of the DIC-augmented-bending creep test methodology in measuring the power-law creep response of a couple of additively manufactured Al alloys, namely A205 and AlSiMg. DIC-augmented-bending creep works on the simple principle of tracking the 2D strain field on one of the faces of a cantilever using digital image correlation (DIC) and correlating the obtained strain and strain rate fields to prevalent graded stress field at various locations in the cantilever [1,2]. Therefore, it provides multiple stress-strain-strain rate triplets using one sample tested under one condition [3]. Often, the DIC-augmented-bending creep test methodology can provide ten times more creep data as compared to the traditional uniaxial creep tests. Hence, herein, it was effectively used to evaluate the effect of heat treatment, composition, and build orientation of additively manufactured Al alloys in a much shorter time. The relevant test setup [4] and the structure-property relationship will be discussed.

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Heat Treatment Optimization of Additively Manufactured Cobalt and Nickel Alloys Towards Thermally Stable Mechanical Properties

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Abstract

Additive manufacturing (AM) offers immense potential for accelerated alloy development, with opportunities for enhanced product development. Owing to the rapid solidification process in metal AM, a variety of non-equilibrium microstructures and phase equilibria are possible. This provides an opportunity to tailor the heat treatments to enable stability of structure towards optimized mechanical properties. Nickel (IN939/IN718) and Cobalt (MarM509) alloys used in hot section turbine components are being studied for their potential via the laser powder bed fusion technique (LPBF). The study will showcase how heat treatment optimization plays an important aspect of metal additive manufacturing qualifications of new and improved alloys. In the case of IN939, the effect of direct aging on the mechanical properties, without having to solution heat treat, was studied. The evolution of strengthening γ' precipitates were systematically studied towards the observed strength and ductility. The high temperature creep-rupture notch sensitivity of LPBF IN718 was characterized by varying the heat treatments to tailor the optimum formation of δ-Ni_3Nb precipitates. In LPBF MarM509, short cycle heat treatments were designed and tailored to obtain optimum mechanical behavior and fracture characteristics were studied. Overall, the importance of heat treatment and advanced characterization in bringing out the optimum mechanical behavior in LPBF alloys is presented.

Keywords: Additive manufacturing, Heat treatment, Cobalt alloys, Nickel alloys, Mechanical properties

The Good, Bad and Ugly: Smart Additive Manufacturing Part Qualification with Modeling, Materials Science, Monitoring and Machine Learning

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Abstract

What's this talk about: Using physical modeling, in-situ data, machine learning, and materials science for rapid qualification in metal additive manufacturing (AM).

Who cares?: Qualification of AM part quality for mission critical aerospace and defense applications requires over 5 years, and costs over $1 million per year, per machine.

To facilitate rapid qualification of metal AM parts my research integrates the following four aspects of AM (the 4 Ms of AM):

(1) Modeling the thermal history of the process to predict and avoid flaw formation via novel rapid computational heat transfer simulations;

(2) Materials science to understand the link between process physics and flaw formation;

(3) Monitoring (tracking) the process using in-situ sensor arrays; and

(4) Machine learning to detect and prevent flaw formation combining insights from physical models and sensor data (physics-based machine learning).

In my talk I will discuss results from industry-based projects exemplifying the advantage of integrating fundamental heat transfer modeling with in-situ data for flaw mitigation in AM.

Additive Manufacturing Technologies and Applications for Industrial and Strategic Contexts

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Abstract

The presentation delineates the laser powder bed fusion based technology and its application for various facets of product design and development in industrial and strategic contexts. The initial part of the presentation highlights various process parameters that influence ensuing part quality, integrity and dimensional fidelity in individual and combined modes. Concept of classical format of volumetric energy density and its adapted version accounting for material properties such conductivity, reflectivity, density etc., are presented with a view point of arriving at the optimised process window. Various zones of process window related to keyhole regime, non-fusion of powder particles and balling are presented with focus on materials of functional interest to aerospace sector such as titanium and aluminium alloys are presented with concomitant connectivity to the development of aeronautical gas turbine engines. The presentation is concluded through an explanation of process-structure-property corelation in the context of laser powder bed fusion and its pertinence to the contemporary metal additive manufacturing activities that have innate proclivity to transitioning the technological practice from that of a prototyping tool to a digital manufacturing solution that can potentially fulfil service conditions.

Invited Talks

Hybrid Metal Additive Manufacturing

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Abstract

Hybrid Manufacturing (HM) broadly is a combination of two or more different processes to overcome their individual limitations and take advantage of their combined strengths to produce components resource efficiently and eco-friendly than existing processes without compromising on the quality. Hybrid technologies (metal Additive Manufacturing (AM) combined with other established processes with appropriate modifications) are gaining importance as they widen the scope of geometries, enhance process capabilities in terms of quality of component and eco-friendliness due to integration of two or more different process capabilities sequentially and/or concurrently to overcome limitations. Initial attempts on hybridization are by combining the metal deposition and removal intermittently to enhance the quality and geometric complexity by avoiding accessibility issues to removal after completely depositing the component and these systems are commercially available now. Combination of deformation processes with metal AM is gaining importance in recent years and their emphasis was on enhancing the surface quality and mechanical properties by locally deforming deposited layers and deformation of the deposited or deposition on the deformed components. This presentation is intended to emphasize details related to Hybrid concepts developed by combining Deformation and Additive Manufacturing (HyDAM) of metals either sequentially and/or concurrently including the ones being attempted at IIT Hyderabad.

Common Causes of Failure in Gas Turbine Engine Blades

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Abstract

Nickel-base superalloy blades are extensively used in aero-engine applications for operation at service temperatures above 800^0C. To ensure structural integrity in terms of strength retention at high temperatures, the blades are cooled by regulated air flow within the cooling passages using suitable metallic deflectors. The blades are protected with diffusion aluminide coatings or zirconia-base thermal barrier coatings for high temperature oxidation resistance during operation. In spite of these measures to ensure safe operation of the blades at the prevailing temperature and oxidizing environment, premature failures do occur in aero-engine blades.

The service induced damage in gas turbine blade materials generally occurs by mechanisms that are operative at high temperatures, namely, creep and stress rupture. However, since the blades are subjected to cyclic loads as well as sustained vibration during operation, irrespective of the primary operative mechanism for damage initiation, the failures in the blades eventually take place by fatigue mechanism. Fatigue failure in turbine blades is also known to occur because of a number of other reasons wherein the crack initiation is purely driven by stress concentrators originating from either material defects or fabrication deficiencies or damages during service. Abnormal engine operating conditions are other common factors that lead to premature fatigue failure of turbine blades. In this talk, the common causes of failures in gas turbine engine blades will be discussed with examples drawn from the investigations carried out in the author's laboratory.

Engineering Micro-Strain Localizations in Dual Phase Steels to Improve Their Hole Expansion Behavior

Nagamani Jaya Balila

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Abstract

Ferrite-martensite dual phase (DP) steels are widely employed in the automobile industry to make different components of the chassis of automobiles due to their impressive mechanical properties at par with other advanced high strength steels. Nonetheless, DP steels exhibit poor hole expansion ratio (HER), which is a measure of its stretch formability, due to early crack initiation from the hole periphery. Strain measurement at the microstructure length in these heterophase microstructures during uniaxial tensile loading has shown that failure in DP is primarily controlled by high strain/stress localizations at the ferrite/martensite interfaces, leading to damage nucleation at these "hotspots" and eventual catastrophic failure. Our own measurements of strain localizations using microscopic digital image correlation (DIC) during uniaxial tensile tests have shown that tempered DP microstructures exhibit less severe strain localizations and higher post uniform ductility. In the present work, we use a novel miniature HER setup coupled with µDIC to measure the strain partitioning behavior of DP in the virgin and tempered conditions. Further, we also measure the micro-HER values of these conditions to show the effect of such strain partitioning on the HER values. Our findings show that similar to the uniaxial stress state, DP steels exhibit large strain localizations at the ferrite/martensite interface under the triaxial stress state of the HER tests. Further, tempering the DP allowed us to engineer less severe strain localizations at these interfaces and as a result obtain higher micro-HER values.

Keywords: Dual phase steels, Digital image correlation, Hole expansion ratio, Strain partitioning

Laser Decal Transfer Based Laser µ-3D Printing for Multi-layer Structure

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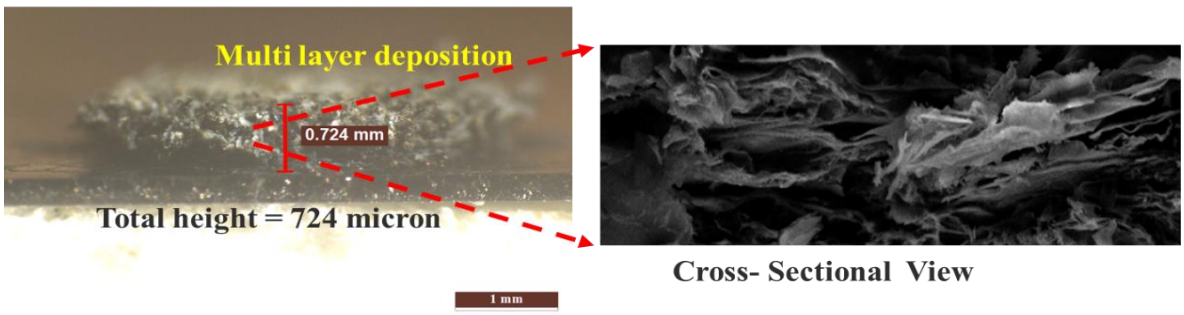
Abstract

In this work, Laser micro 3D printing is deployed to fabricated three-dimensional structure multilayer structure for the MEMS application. Micro 3D printing is a thin film based maskless manufacturing process which caters the limitation existing microfabrication techniques. It prints the material with 1 µm layer thickness for the fabrication of different sensors for electronic circuit. Here NiTi multi-layer material is printed using CO_2 laser (λ=10.6 µm) in form of the solid phase. The transparent silicon wafer (with laser wavelength) is used as the donor substrate and Polydimethylsiloxane (PDMS) as a sacrificial layer that absorbs the laser energy and induces a thrust force for the transfer mechanism. Over the sacrificial layer, NiTi thin film is deposited with DC sputtering technique at working pressure $2x10^{-3}$ mbar and standoff distance 5 cm. After the donor preparation, the micro-3D printing is deployed at laser fluences 1030 mJ/cm^2 for NiTi for the threshold fluence. It is observed that the bonding between the two materials is enact without any diffusion between the two materials. The deposited three-dimensional geometry morphology has been analyzed using a scanning electron microscope (SEM) and optical microscope. To confirm both the material, a cross-section EDX shows the NiTi composition with respect to height.

Fig. Micro printing of thin film based multilayered structure.

Keywords: Laser Micro-3D printing, Microfabrication, multi-layered deposition, Laser induced forward transfer, 1 Micron layer thickness



Flash Sintering of Ceramics: From Sintering to Material Development

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Abstract

Flash sintering is a recent development in the area of electric field assisted sintering processes. During flash sintering a ceramic green body is densified in few seconds and at remarkably low furnace temperature. This is achieved by applying electric field across the green sample with a pair of electrodes. The main characteristic feature of the process is the non-linear rise in the electrical conductivity of the ceramic at the onset of flash. The short sintering times and low furnace temperatures has the potential of unleashing a new way for the manufacturing of ceramics.

Flash sintering experiments were carried out on 3 mol.% yttria stabilized zirconia at different electrical parameters (electric field and current density). It was found that the applied electric field controls the furnace temperature at which sintering occurs and the current density controls the extent of densification. The sample temperature rises considerably above the furnace temperature during flash sintering. The sample temperature was measured by different methods. Though the temperatures were different however, they are still far less than that required to sinter the samples conventionally in few seconds. This indicates that thermal runway of Joule heating may not be the only mechanism for the ultra-rapid densification. Pair distribution function analysis of the total scattering was carried out to study the mean square atomic displacement in rutile TiO_2. In the state of flash, atomic displacement of the oxygen atoms, from their ideal lattice positions, was much higher than that of titanium atoms. In addition, the atomic displacement parameter was higher than that predicted by the thermal expansion (in the absence of electric field). The hardness and indentation fracture toughness of the flash sintered samples were close to that of the conventionally sintered samples.

Flash sintering technique was also used for phase reaction in ceramic systems where phase reaction and sintering occurred together. Flash phenomena experiments on the TiO_2 single crystals changed the electronic properties, making the single crystals electrically conducting at room temperature after flash. The results shows the potential of the flash sintering technique as a one-step method for materials development.

Challenges & Opportunities in Missiles & Aerospace Business

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Abstract

For the domestic manufacturers, the opportunities in the defense and aerospace sector have grown over the past few years. Achieving indigenization of critical platforms and spares have been one of the main drivers in this growth. Although significant strides have been made towards establishing self-reliance in processing and fabrication processes like additive manufacturing of metallic materials, composite production and precision assembly processes, the availability of quality materials exhibiting high strength, high temperature, and low density, as is essential for missile and aerospace sectors, is still challenging due to supply chain constraints. Hence, realization of the systems with advanced materials invariably expands project timelines.

Due to non-availability and high cost of critical raw materials, independent research on advanced processing techniques and fabrication methodology for high-end materials are limited to commissioned projects. For larger structures used in the aerospace and defense, the cost of procuring & establishing suitably-sized processing equipment are substantial. Furthermore, the procurement of such equipment from foreign nations for defence end-use are often restricted or mired in export control protocols. All these challenges compounded with lower assured order volumes, directly impact the viability of establishing such infrastructure.

This speech outlines some of the key challenges faced in processing & fabrication of aerospace materials, and presents how those challenges were mitigated through innovation and business resolve. The speech also expands on the opportunities unlocked with this concerted effort to meet user requirements and expectations.

Semiconductor Nanostructured Based Gas Sensor for Affordable Healthcare

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Abstract

Sensors are now omnipresent and became an indispensible part of our society. Besides conventional use, gas sensor based breath analyzer has attracted increasing interest among the scientist, technocrats and clinical communities. This is a non-invasive technique which can provide information of diseases and monitoring of therapy just analyzing exhale breath. There exists a huge market for gas sensors which is ever increasing due to new application possibilities including non-invasive breath analysis for monitoring diseases.

Various oxides such as SnO_2, ZnO, TiO_2, WO_2, MoO_3 etc. are being explore for gas sensing application. However, due to limitations like high operating temperature, low selectivity and stability of oxide based sensors, now a day's researcher are also trying to replace the metal oxide with much stable materials. Other than metal oxide, metal chalcogenides and some novel complex oxide composites are now being well considered due to low cost, easy fabrication and good stability. Also, use of nanomaterials has been shown to allow gas sensors to work at lower temperature, with better sensitivity, selectivity and long term stability than sensors based on bulk materials.

Human breath is composed of several gasses and hundreds of volatile organic compounds (VOCs). An accurate detection of specific gas /VOCs in exhaled breath, known as biomarkers, can provide essential information for the diagnosis of related diseases. The compounds of interest (VOCs) are generally found at ppt /ppb /sub-ppm level in healthy human breath which can increase several times in the breath of patients. However, the ability to prepare novel nanomaterial having high sensitivity, good resolution at sub-ppm /ppb level and insensitive toward moisture is required for development of breath analyzer, is currently not achievable. This presentation will cover all the aspects starting from preparation of novel nanocomposites to fabrication and performance of prototype device in detail.

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Structure and Properties of Squeeze Cast Aluminum Metal Matrix Composites

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Abstract

Metal matrix composites (MMC) are one of the advanced materials widely used for aerospace, automotive, defence and general engineering applications. MMC can be tailored to have superior properties such as enhanced high temperature performance, high specific strength and stiffness, increased wear resistance, better thermal and mechanical fatigue and creep resistance than those of unreinforced alloys. To fabricate such composites with ideal properties, the processing technique has to ensure high volume fraction of reinforcement incorporation, uniform distribution of the reinforcement and acceptable adhesion between the matrix and the reinforcing phase without unwanted interfacial reactions which degrades the mechanical properties. A number of processing techniques such as stir casting/vortex method, powder metallurgy, infiltration, casting etc. have been developed to synthesize MMC employing a variety of alloy and the reinforcement's combinations. Among these squeeze infiltration process is widely used for making MMC with high volume fraction of reinforcements and offers many more advantages compared to other conventional manufacturing processes. The present paper describes various squeeze casting and infiltration techniques used for making the Al MMC and the evolution of microstructure and mechanical, physical, thermal and tribological properties attained.

Indigenous Development of Silicon Carbide Bulk Single Crystal Growth (4"Dia., 4H-Polytype) and Wafer Fabrication Technology

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Abstract

Owing to the superior properties of the wide band gap, high carrier mobility, high thermal conductivity and high stability, 4H silicon carbide (4H-SiC) holds great promise for applications in electric vehicles, 5G communications and new energy systems. Also, Silicon carbide has become front runner for a new generation of high performance, high efficiency RF and power devices. Dramatic growth for SiC based devices and systems are being witnessed by increasing market demand. The success story behind this revolution is availability of improved materials quality after several years of technology and process development efforts.

The 4H-SiC single crystals can be grown by top seeded solution growth (TSSG), high temperature chemical vapor deposition (HTCVD), and physical vapor transport (PVT) approaches, among which the well-developed PVT technology prevails over other growth technologies because of its high maturity, sensitive temperature tunability, and low cost of the solid raw materials. The most used method of growing SiC bulk single crystal is Physical Vapor Transport (PVT) technique usually performed at temperature > 2000^{o}C; this process involves many physical phenomena such as electromagnetic induction, mass and heat transfer, chemical reactions and so on.

Simulation of PVT growth process is a useful tool for optimizing the thermal design and improving the crystal growth process. Growth process is simulated for PVT reactor using Virtual Reactor (VR) software.

Present study focuses on the optimization of process parameters such as temperature, coil position, pressure, source to seed distance and initial SiC source powder grain size. The 4"diameter SiC single crystal were grown using optimized process parameters. Experimental observations such as boule shape, thickness, graphitization degree, porosity, mass flow in the source powder confirms the predictions of numerical simulation study performed by VR software.

As SiC being third hardest materials, wafer fabrication and polishing poses great difficulties compared to traditional semiconductor materials. Processed wafers were characterized by Optical/DIC microscopy, HRXRD and Raman spectroscopy for their structural properties. The analysis confirmed the formation of single crystal with 4H polytype and FWHM value showed good crystalline quality. Types of defects such as micropipes and dislocations were studied by KOH etching. Electrical resistivity of the obtained wafers showed the resistivity > 10^{6}ohm-cm confirming semi-insulating nature.

Challenges involved in SiC single crystal growth and wafer fabrication process shall be presented in detail.

Advances in Cellular Materials: Its Processing and Multifunctional Applications

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Abstract

Cellular materials are one kind of porous materials where porosity is significantly high (>50%). These materials are ultra light and exhibited very high surface areas and deforms at constant plateau stress after yielding upto significantly higher densification strain. These led to some special characteristics within the materials such as very high surface areas, impact energy absorption without increasing stress level greater than plateau stress, sound and vibration attenuation, heat and mass transfer for insulator as well as for heat exchanger, mine blast and other blast mitigation, catalyst substrate, energy storage (battery and capacitor), hydrogen storage, light weight panels for ship building, raiways, automobiles and aerospace etc. Different methods used for making different kind of such cellular materials for specific application will be presented. Emphasis will also be given the process developed in India for making different kinds of cellular materials and the product made for specific applications. The awareness developed in India on these kind of materials will also be highlighted with special emphasis on CSIR-AMPRI's activities. The quasistatic deformation behaviour as well as dynamic behaviour will be discussed.

Mechanical Behaviour of Additive Manufactured Maraging Steel

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Abstract

Additive manufacturing (AM) utilises 3D model data to build near-net shape components layer by layer. AM technologies via 3D printing are already revolutionizing many sectors by reducing time required for component processing, cost of production, wastage of material, consumption of energy and emission of hazardous pollutants. Though AM has gained importance in biomedical and functional applications, the potential of manufacturing AM structural parts has not yet fully explored. The main challenge is uncertainty in mechanical properties due to microstructural inhomogeneities and non-uniform distribution of defects. Process parameters such as scan speed, laser power, layer thickness, hatch spacing and thermal history in AM also affect microstructural details and consequent mechanical behaviour. Maraging steels have a wide range of aerospace applications such as landing gears of aircrafts, missile casings, aircraft forgings, bearings, high power transmission shafts, fan shafts in commercial jet engines in addition to tooling and dies. In many of these applications, the steels are subjected to various kinds of stresses such as uniaxial, cyclic and/or thermal stresses. Investigations on mechanical behaviour of metallic AM parts subjected to uniaxial and cyclic loading are very limited. As mechanical properties of AM steels are significantly different from those of conventional steels, clear establishment of process-structure–property correlations is essential before such AM components are placed in service to prevent failures. The present work deals with the investigation of the mechanical behaviour of 18Ni300 maraging steel processed by additive manufacturing through Selective Laser Melting (SLM) using indigenous steel powders. The tensile and low cycle fatigue behavior of the steel were studied in different orientations, namely 0°, 45°, and 90° in as-built (AB) and optimized heat treated (HT) conditions. Highest values of 0.2% yield strength and ultimate tensile strength were noticed in 90^{o} oriented as-built specimen tested at RT. Reasonable strength values with good ductility were obtained in as built specimens in 0^{o} and 45^{o}orientations. After heat treatment, specimen in 0^{o} orientation showed better strength parameters followed by those built in 45^{o} and 90^{o}. With increase in test temperature, the strength parameters decreased and ductility parameters increased. Low cycle fatigue behavior of maraging steel was also found to be dependent on build orientation.

Controlled Directionality in 3D Printing of Reinforced Polymer Composites - A DEM Analysis

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Abstract

Composites have been key from the early age of human civilization to date. Composites have many advantages over other materials such as high specific strength and stiffness, design flexibility, durability, and corrosion resistance. These properties are due to the combined effects of reinforcements and the matrix. Additive manufacturing is gaining high popularity to fabricate composites with the controlled alignment of the reinforcement (alignment as a function of loading direction). The objective of this study was to analyze the correlation between 3D printing conditions and the structural characteristics of a composite material, to determine the optimal nozzle diameter and flow rate for particle alignment, evaluate the mechanical properties of additive manufactured structures compared to film cast samples. A 15% (w/v) PVA solution was taken as a matrix with different wt.% (1, 5, and 10%) of graphite. The ink was passed through a circular cross-section needle/nozzle having different diameters (0.7, 1, and 1.4 mm) with different volume flow rates. This was done to examine the effect of controlled variables on the output variables, such as the orientation of the particles, particle distributions, average particle distance, and porosity. The experimental results were compared with the simulation software to visualize and validate the process during additive manufacturing. The lowest diameter nozzle, 0.7 mm, has proved to be the relatively optimum diameter for the alignment of particles along flow direction than 1-mm and 1.4-mm diameter nozzles. A higher flow rate has a better alignment of particles along the flow direction. In conclusion, the experimental and theoretical analysis establishes a strong correlation between 3D printing conditions and the composite's structure (orientation, graphite dispersion, porosity).

Keywords: 3D printing, Polymer matrix composites, Discrete element modelling, Computational fluid dynamics

Nanoscale Devices for Emerging Technologies

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Abstract

Current century is marking the beginning of 4th industrial revolution with the rapid development of information and communication technologies such as artificial Intelligence (AI) and Internet of Things (IoT). Successful adoption of these technologies necessitates the development of supporting hardware at the same time in order to process massive amounts of data at a faster rate while using the least amount of power. Given that Silicon (Si) transistor technology has reached sub 10 nm for logic and around 14 nm for memory applications, future device scaling using traditional materials appears to be at a stumbling block due to a number of material and technological hurdles. Fundamental physical limits are among the major roadblocks towards realizing energy-efficient devices. Therefore, to meet the emerging hardware requirements, the semiconductor industry is eagerly looking for novel multifunctional materials and device/circuit architectures to develop the energy efficient electronics. This talk will discuss one of the fundamental physical limits in silicon transistors that must be overcome in order to achieve low-power devices. The specifics of the problem, as well as various approaches to solving it, will be discussed, including an understanding of device physics and the incorporation of ultrathin semiconducting materials known as 2D materials. The development of ferroelectric nonvolatile memory and broadband detectors using 2D semiconductors will also be covered in detail. In addition, some of the research on the quantum properties of 2D materials will be discussed, such as tuning exciton dynamics for low power technology.

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Fabrication of Microneedles for Biomedical Applications

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Abstract

Microneedle (MN) arrays have many applications in biomedical fields to deliver drugs trans dermally or extract biomarkers from the interstitial fluid from the human skin. Several methods have been used to fabricate MNS of the required shape and size with materials such as polymers, ceramics and metals. In the present talk, a new way of fabricating an MN array with wire cut EDM (WEDM) process will be discussed. A systematic experimental plan is carried out to study different parameters of MN array (microneedle height, base width and tip width). The MN arrays of different densities from 0.52 / mm2 to 0.61 / mm2 are successfully fabricated on SS316 material.

Artificial Intelligence & Machine Learning – Introduction & Applications in PFAM

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Abstract

Artificial Intelligence & Machine Learning (AIML) have revolutionized industries with large human interactions like Banking, Insurance, Retail and CPG. Domains like Science and Engineering are starting to explore the use of AIML in their research. Google's AlphaFold that accurately predicts 3D models of protein structures is one such example. This talk focuses on introducing AIML to researchers in Science and Engineering and discusses some applications in manufacturing and characterization of materials. The usage of Large Language Models (LLMs) like ChatGPT to mine/query internal knowledge, Graph Neural Networks to predict molecular/material properties, predictive models for product quality, anomaly detection methods for machine maintenance are discussed.

Environmentally Sustainable and CO2 Reduction Products - A Case Study

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Abstract

With the advancement of knowledge and understanding of problems, one can develop /evolve several durable products that are needed in our daily life. Coal ash has been a subject of interest due to its potential environmental impact, particularly when not managed properly. However, it also has beneficial reuse applications. One such case study is demonstrated in this presentation. The case used is manufacturing of bricks using coal burned residual from power plants. Also addressed is how fine aggregate of river sand can be substituted by other minerals that are considered to waste or not suitable.

Oral Presentations

Optimization of WEDM Process Parameters While Machining Inconel 718 Using Particle Swarm Optimization

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Abstract

The objective of this paper is to find the optimal wire electric discharge machining process parameters to obtain minimum surface roughness. Nickel-based superalloy Inconel 718 has been chosen as the workpiece material because of its superior mechanical and thermal properties used in high-temperature material processing industries. The experimental work is carried out on the basis of Taguchi's L27 Orthogonal array design. A heuristic based Particle Swarm Optimization algorithm is applied to predict the optimal solution of surface roughness based on the training set of conditions. Surface topography at various machining conditions was compared by a non-contact 3D profilometer and surface irregularities are compared. FE-SEM and EDS analysis will also be performed to inspect micro globules, voids, and cracks at different machining conditions. A check for elemental contamination by wire electrode material at various machining conditions will also be studied. The efficiency of the PSO algorithm is verified using the predicted and experimental values obtained thereby enhancing the machining performance.

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Corrosion Behavior of Nickel Modified Zn-27Al Alloy

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Abstract

The alloy ZA27, which is based on zinc and contains 27% aluminum, can be used to produce casting materials with high wear resistance, low density, and low costs. It can be cast readily using sand, shells, and permanent molds and competes with other cast metals such high-strength aluminum alloys, aluminum bronzes, grey iron, and brass. Common applications include those in machine tools, presses, internal combustion engines, general engineering, and the transportation sector. However, ZA27 alloy's mechanical characteristics degrade over 100 °C as a result of its low melting point and copper content. Changes in the microstructure of the alloy, which have been achieved by adding some chemical elements, employing various heat treatments, or thermomechanical treatments, can improve the mechanical properties of the ZA27 alloy. An effective technique was found to be the addition of an alloying element. The mechanical characteristics of the ZA alloy are improved by the addition of an alloying element, however this also changes the alloy's corrosion resistance. The influence of nickel modification on the corrosion behavior of the zinc-27 weight percent aluminum alloy was investigated in the present work. Castings of the zinc-27 aluminum alloy with varying weight percentages of nickel (0-3%) were produced by gravity die casting. Hank's solution and 3.5 wt% NaCl solution were used to study the corrosion behavior of alloys using the immersion method. Additionally, the accelerated corrosion investigation was conducted at 3V. The results showed that the accelerated corrosion test was a better choice than immersion testing for evaluating the corrosion behaviors of the ZA27 alloy, and that the addition of nickel had a substantial impact on corrosion behaviors.

Keywords: ZA27 alloy, Hank's solution, NaCl solution, Corrosion, Alloying element

Synthesis and Characterization of Lanthanum Cerium Oxide for Thermal Barrier Coating Applications

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Abstract

Lanthanum cerate ($La_2Ce_2O_7$) is a potential candidate for thermal barrier coating (TBC) applications due to its long-term phase stability at operating conditions, in contrast to yttria-stabilized zirconia. In addition, it possesses low thermal conductivity and large coefficient of thermal expansion (CTE) at high temperatures, and its magnitude is closely similar to CTE of underlying bond-coat in a TBC system. However, limited literature exists with regards to the large-scale synthesis of lanthanum cerate using commercially available precursors, which is crucial for its utilization in next-generation aero-turbines. In this work, La_2O_3-CeO_2 mixed oxide and $La_2Ce_2O_7$ compound were developed using indigenously available precursors of lanthanum and cerium, through facile synthesis in a cost-effective manner. Firstly, thermal decomposition and phase evolution behavior of as-received lanthanum and cerium precursors were studied using thermo-gravimetric analysis, FT-IR and X-ray diffraction, respectively. Subsequently, Lanthanum cerium oxide was prepared through combined sol-gel and ball milling technique and its thermo-physical properties were evaluated.

Furthermore, dip-coating technique was explored for the coating deposition of La_2O_3-CeO_2 mixed oxide and lanthanum cerate, onto commercially available alumina substrates. Suspension solution containing optimal contents of lanthanum and cerium precursors, were prepared for this purpose. Upon dip-coating, the as-coated alumina substrates were calcined at 800^o C to obtain lanthanum cerium oxide coatings. The as-coated samples were then examined using scanning electron microscopy and the processing parameters were optimized to obtain defect-free adherent coatings.

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Physico-chemical and Weibull distribution characterization of Myriostachia Wightiana (MW) stem fiber

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Abstracts

Environmental concerns and costly conventional fibers have prompted researchers all over the world to concentrate their efforts on the use of cellulosic fibre as reinforcement in polymer matrices. Lignocellulosic fibres are a cheap and easily renewable resource that is abundantly available in all countries. Cellulosic plant fibres have potential applications in the paper/packaging industry, biomedical, and structural components, etc. In the current study, Myriostachia Wightiana Stem fibers (MWSFs) extracted from Myriostachia Wightiana (MW) plants have been investigated for physico-chemical properties. The extracted fibre was tested using the Universal testing equipment at a loading rate of 1 mm/min in accordance with the ASTM D3822 standard. Weibull distribution analysis has been carried out to ascertain the variability and predict the properties of the fiber at a gauge length of 20-60 mm. Tests show the potential applicability of the MWSF for lightweight bio-products owing to its low density (1375-1510 kg/m^3) and high cellulose content (70%), thereby leading to higher strength (46.554 MPa). The predicted average diameter, tensile strength and Young's modulus are in good agreement with the experimental results.

Keywords: Natural fiber; Single MW fiber; Weibull distribution analysis; Physico-chemical analysis

Free Vibration Response of Doubly Curved FGM Shell Based on Higher-Order Shear Deformation Theory

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Abstract

Functionally graded materials (FGMs) are advanced composite materials having gradual variations in properties along the thickness direction. This work deals with finite element analysis for finding free vibration response of a doubly curved FGM shell based on Reddy's higher-order theory (HSDT). The variation of the in-plane displacement field is considered to be cubic, while the transverse displacement field remains constant with respect to shell thickness coordinate z. This model also meets the zero transverse shear stress criteria at the shell's top and bottom surfaces. The analysis was carried out on relatively thin cylindrical/spherical FGM shells with varying power law indices (n) at different boundary conditions with nine-noded isoparametric shell elements. The findings are in good agreement with the existing literature. After validating the present model, parametric studies were carried out to show the effect of curvature ratio, aspect ratio, and thickness ratio on the first five natural frequencies. The mode shapes for a few of the cases have also been presented.

Keywords: FGM; FEM; HSDT; Shell; Free vibration response

Numerical Modelling and Experimental Analysis of Uniaxial Tensile Test of Fused Deposition Modelling Printed Acrylonitrile-Butadiene-Styrene

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Abstract

Acrylonitrile-Butadiene-Styrene (ABS) has good mechanical properties and a wide variety of applications, including household appliances, automotive, aerospace, etc. Testing the mechanical properties of Fused Deposition Modelling (FDM) ABS samples is expensive and time-consuming. So, predicting FDM printed sample mechanical properties can give designers and researchers vital information. This paper reported uniaxial tensile test numerical modelling and experimental investigation of FDM-printed ABS. The nonlinear structural analysis was employed to simulate the uniaxial tensile test. The stress, strain, and deformation were predicted. The FDM-printed ABS samples were carried out the uniaxial tensile test. Stress-strain data was determined from experimental investigation. The ultimate tensile strength of 31 MPa was predicted via numerical analysis. FDM printed samples yield and ultimate tensile strength were 26.5 MPa and 30 MPa, respectively. The brittle fracture in the tensile sample for both numerical and experimental analysis was observed at the same location. It can be concluded that the developed non-linear numerical model could be helpful for the ABS objects which are expected to withstand tensile stress.

Keywords: Acrylonitrile-Butadiene-Styrene; Fused Deposition Modelling; Numerical Modelling, Tensile Test

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X-Ray Photoelectron Spectroscopy: An Insight into Surface Analysis

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Abstract

X-ray Photoelectron Spectroscopy (XPS) is an extensively used technique to understand the qualitative, quantitative, and chemical state information about surfaces and interfaces. Over the last few decades, the improvement in the reliability of instruments and automation have led to the wide use of X-ray Photoelectron Spectroscopy (XPS), changing from a specialist technique only performed by dedicated practitioners to a routine analysis tool widespread throughout academia and industry. In this talk, we address students, researchers, engineers, scientists, faculty, analyst, and technologists who would like insight into the fundamentals and latest technological advances. It aims to introduce the applications in the latest research topics like battery, memory, polymers, biomaterials, coatings, nanomaterials, catalysis, and corrosion, and methods where XPS can be used to unravel material challenges. It covers the concept of multi-technique integration to get a more comprehensive understanding of the sample under investigation.

Instrumentation for Surface Analysis

Influence of Texture Patterns and Cryogenic Coolant During Machining of Precipitation-Hardened SS.

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Abstract

During machining, severe difficulties can arise as a consequence of friction and adhesion at the tool-chip interface. These problems shorten the life of the tool and lower the quality of the surface. Surface texturing of the tools and coolant application at the tool-chip interface could be a better alternative with the aim of enhancing the tribological characteristics and decreasing the tool-chip adhesion. Therefore, the main focus of the present work is to study the effectiveness of cutting with textured carbide tools when turning PH 13-8 Mo SS alloy under dry and cryogenic coolant (liquid nitrogen) conditions. ND: YAG Laser was used to generate sinewave and hexagonal patterns on the rake face of tungsten carbide tools. The cutting performance of textured tools is compared to that of plain carbide tools in terms of cutting forces and tool wear. In order to gain a deeper comprehension of the surface properties of the tool wear, SEM and EDS tests were carried out. According to the findings, the texture reduced the adherence of chips on the rake face in comparison to the conventional tool. This results in a reduction in the cutting forces of up to 15%. In addition, the performance of the machining process is strongly impacted by the utilization of liquid nitrogen as the coolant in the machining zone.

Keywords: Textured tool, tungsten carbide, PH 13-8 Mo SS, cryogenic machining.

Influence of Tool Rotational Speed on the Mechanical Properties of Friction Stir Spot Welded AA5052-H32/PU-Foam/AA5052-H32 Sandwich Sheets

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Abstract

This article presents the results of investigation on fabrication of PU foam core AA5052-H32 face sheet sandwich structure by Friction stir spot welding (FSSW). Depending on the core material the sandwich structures are seen as alternative to several functional materials including honeycomb structures [1]. The sandwich sheets have wide range of applications as vibration and sound isolators in automobile, marine, rapid transport system, i.e., high speed train nose, and in the constructions as prefabricated products/building panels etc. [2]. The polymer core sandwiches are traditionally made by adhesive bonding which has typical limitations associated with the stiffness and brittleness. In this context, in the current work AA5052-H32 face sheet of 2 mm thickness and PU foam core of 20 mm thickness were FSSW from both sides by using pinless tool. Tool rotational speed was varied systematically at five levels from 710 rpm to 1800 rpm using a specially designed fixture. The effect of tool rotational speed on the mechanical properties of the sandwich sheet structure are reported. From the preliminary investigation, intimate interlocking between the Aluminium sheet and PU foam is observed. An increase in the rotational speed resulted significant change in fracture resistance, i.e., lap shear strength and peel strength of the sandwich structure. It is observed that the interfacial joint strength of FSSW sandwich sheet structure is comparable to that of PU foam core. Bonding area, hardness, temperature distribution, and optimized rotational speed are also evaluated from systematic experiments.

Key words: Friction stir spot welding; sandwich structure; pinless tool; tool rotational speed; Lap shear test

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Microstructure Classification of Ultra High Carbon Steel Using Deep Learning Approach

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Abstract

One way of understanding the material characteristics is using the information obtained from the micrographs of the materials. Classification and evaluation of microstructures is done by human experts leading to errors. Computer vision approaches are superior in this scenario. In this work, a deep learning approach is presented for classifying the Ultra High Carbon Steel (UHCS) micrographs [1] obtained from SEM (Scanning Electron Microscope) images captured under varieties of heat treatments. There are seven classes and 961 images in the UHCS dataset and are shown in Fig. 1. In [2], the images were classified using texture features.. In this proposed work, several (600+) pre trained Convolutional Neural Networks (CNN) are used for extracting the features from the micrographs. Selected features from the CNNs are concatenated and are given to a classifier. Since the dataset is an imbalanced one, oversampling strategy is employed for the under-represented classes like Martensite, and Pearlite+Widmanstatten categories. A balanced accuracy of 95.2% and F1 score of 97% is obtained for a 10 fold cross validation using a Passive Aggressive Classifier. Further, the proposed approach is also tested with another dataset using Ti-6Al-4V alloy micrographs [3]. There are three classes (Acicular(186), Bimodal(350) and Lamellar(689) and 1225 images in this dataset. A classification accuracy of 98% is obtained on this dataset.

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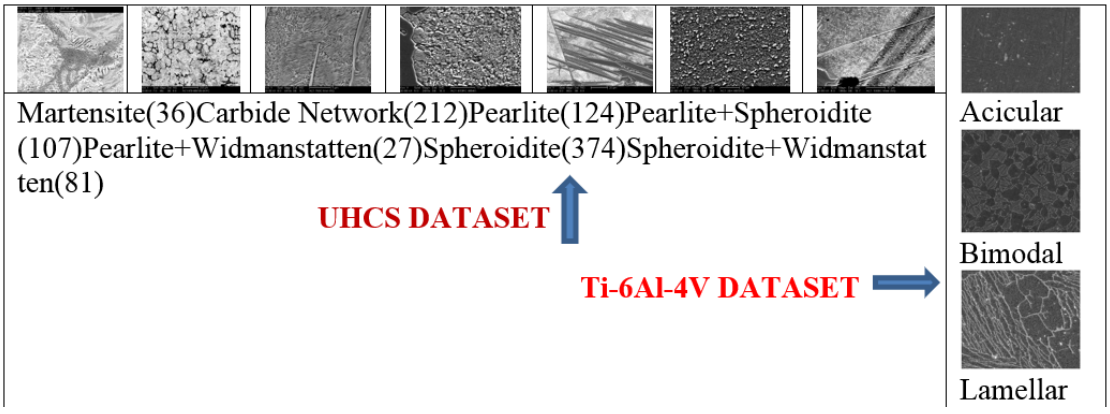

Fig. 1: Seven Classes of Ultra High Carbon Steel Dataset and Ti-6Al-4V Dataset

Fabrication and Characterisation of Polymer Composites with the Help of an Enhanced Vacuum Moulding Technique

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Abstract

Composite fabrication with the help of vacuum bagging is widely undertaken by VARTM approach with an aim to enhance productivity. However, the pace of resin front, proper degassing of the resin-hardener mix decides the quantity of trapped gases and bubbles in the resin flow which eventually lead to degraded characteristics of the cured composite. This study has proposed an improvement in the traditional vacuum bagging process such that there is a significant improvement in the tensile and flexural strength up to 20%. Entrapped bubbles in resin being one of the many reasons behind Porosity defect, the current study has attempted to overcome this challenge. Degassing time and vacuum pump condition were found to be crucial factors during the vacuum bagging process. Five experiments were performed with three degassing times (i.e., 0 min, 5 min, and 10 min) and two vacuum pump conditions (on and off) while infusing of the resin. Flexural characterization was performed to get the optimized time of the degassing and infusing condition during the vacuum bagging process of composite manufacturing. ASTM D7264 was used to conduct the 3-point bend test on the composite samples made of Epoxy 1564 and Aradur 22962 and 400 gsm plain glass weave fabric. It was concluded that a degassing time of 5 mins with vacuum pump Off condition during resin infusion produced the best results.

Keywords: Vacuum bagging, Degassing time, Flexural test

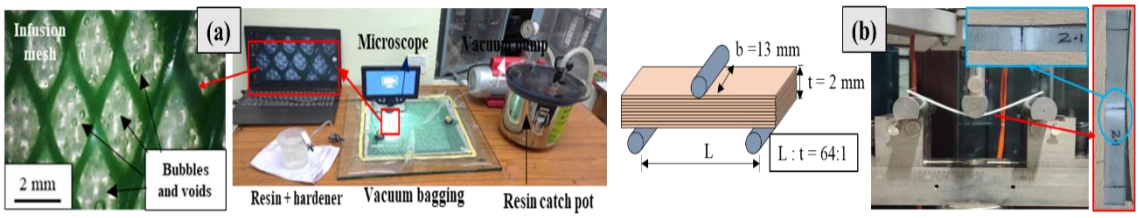

Fig. 1: (a) vacuum bagging setup, (b) flexural test layout, and tested sample

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Finite Element Method for Free Vibration Analysis of Rectangular FGM Plate Based on First Order Shear Deformation Theory

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Abstract

Functionally graded materials (FGMs) are advanced composites having two constituents (metal and ceramic) whose mechanical properties vary gradually along the thickness of the structure with an assumed mathematical model. The present study deals with free vibration analysis of rectangular FGM plates based on first-order shear deformation theory (FSDT). The variation of the in-plane displacement field is considered to be constant and hence suitable shear correction factor is selected in terms of Poisson's ratio. The analysis was carried out on both relatively thick and thin FGM plates with varying power law indices (n) and at different boundary conditions. Two isoparametric quadrilateral elements were selected for mesh generation and to compare the obtained results. The governing equation was formed using Hamilton's principle and solutions were done with finite element method. The findings are in good agreement with the existing literature. After validating the present model, parametric studies were carried out to show the effect of length to thickness ratio, aspect ratio, and volume fraction 'n' on the fundamental frequencies. The results showed that when the boundary conditions changes from 'ssss', 'scsc' to 'cccc', the frequency increases. The same also increases with increase length to thickness ratio and decreases with increase in 'n'.

Effect of PTFE on the Mechanical and Tribological Properties of ABS and HDPE-Based Hybrid Nano Composites

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Abstract

The objective of the present investigation, is to evaluate the mechanical and tribological properties of polymer composites, prepared with Acrylonitrile butadiene styrene (ABS) and High-density polyethylene (HDPE) as matrix, along with Kevlar short fiber as reinforcement. Multiwalled carbon nanotubes (MWCNT) in fixed proportion by weight, is added as a filler and Polytetrafluoroethylene (PTFE) in the levels of 10%,15% and 20%, were added to the resultant composite to make it a hybrid. The polymer composite was prepared by melt mixing method, using a Brabender machine, followed by compression molding process. Mechanical and tribological properties were evaluated using an extensometer and pin-on-disc machine. The effect of different levels of PTFE and reinforcement materials, are investigated. The results indicate that the mechanical properties viz., tensile strength, percentage elongation and flexural strength, increased with the addition of PTFE. The wear resistance was also enhanced due to the addition of PTFE to the matrices.

Keywords: PTFE, ABS, PMC, Hybrid composites, Tribology

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Comparison of Mechanical Properties and Effect of Process Parameters on CoCrMo Coupons Sintered by DMLS process and Simulated with ANSYS

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Abstract

Additive Manufacturing is one of the advanced manufacturing technique in which the fabrication takes place in layer by layer manner until the final product is prepared. There are different additive manufacturing techniques used now a days for various applications in engineering and medical fields. One such process is Direct Metal Laser Sintering, which uses powder as raw material for fabrication.
The present study deals with the fabrication and testing of porous structured CoCrMo alloy coupons using Direct Metal Laser Sintering technique. The parameters selected for the fabrication of the samples are laser power, scan speed and porosity. L9 orthogonal array is used for design of experiments. Tensile and Compression strength Analysis is performed using ANSYS software and it is observed that the maximum ultimate tensile strength is observed as 1098.25MPa and the maximum compression strength is observed as 898.7MPa. The results obtained from ANSYS software are compared with the physical tensile and compression test results. The results states that the high yield strength of 511.95±10 is obtained for the coupon sintered with medium laser power, low scan speed and medium porosity and the high ultimate tensile strength of 1051.5±17 for the coupon sintered with high laser power, medium scan speed and low porosity. In the similar way the low compression of 953.83±19MPa is obtained for the coupon sintered with low laser power, high scan speed and high porosity. The high compression strength of 1395.39±12MPa for the coupon sintered with high laser power, high scan speed and moderate porosity. The reasons are discussed in detail.

Keywords: DMLS; additive manufacturing; Co-Cr-Mo; tensile strength; hardness; laser power; scan speed; porosity; ANSYS

Effect of Severe Plastic Deformation Involving ECAP of Aluminum 2024 Alloy Beryl Composites on the Mechanical Properties

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Abstract

The Aluminum Metal Matrix composites have gained popularity and widespread application in view of their light weight and superior mechanical strength compared to the un-reinforced alloy system. Further improvement in the properties have been derived based on the adoption of secondary processes such as rolling, forming, drawing and plastic deformation. In this context, the preparation of Al2024 alloy, containing Beryl particles as reinforcement, is envisaged for getting better properties in terms of strength and hardness for structural use in aerospace industry. Further enhancement in properties may be possible by subjecting the alloy to severe plastic deformation, especially Equal Channel Angular Pressing (ECAP) process.

The present work focuses on developing Al 2024 alloy composites containing Beryl particles at 6 wt.%, through stir cast method. This is followed by ECAP in the annealed condition with the ECAP facility designed and developed in house. Following this, the mechanical properties, involving tensile strength, % elongation & hardness have been evaluated for the ECAP processed Al2024 Beryl samples and the values thus obtained are compared with those derived on samples without Beryl additions. The microstructures of the samples, for key stages of the work, have been recorded. Further, the fracture morphology of ECAP processed samples have been examined and analyzed using SEM/EDAX and correlated with the tensile strength data. The ECAP with pass II processed samples have shown higher tensile strength and hardness as well as good grain refinement in the matrix compared to annealed Al alloy sample.

Keywords: Severe Plastic deformation, Equal Channel Angular Pressing, Tensile Strength, Hardness, Microstructure, SEM, % Elongation, Grain Size.

Laser-Assisted Machining of Nickel-Based Super Alloys and Optimization of Cutting Force Using ANN

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Abstract

In recent years, laser-assisted machining (LAM) has shown to be a cost-effective method for cutting high-temperature materials such as nickel based super alloys that are prominent in the aerospace industry. The main aim of LAM is in maintaining the material's metallurgical and mechanical qualities while achieving optimal cutting force through control of the machining process's parameters such as feed rate, depth of cut, laser power, and cutting velocity. Therefore, this research's primary objective is to create an AI model for predicting the cutting force in laser aided machining. The artificial neural network (ANN) model was created after careful consideration of network structure, method, and neuron count. When creating an ANN model, the Levenberg-Marquardt algorithm is taken into account, and the root-mean-square approach is used to reduce the error. Both the experimental and ANN models agree with one another more closely. The proposed model accurately predicts the cutting force needed during LAM of nickel-based super alloys with a 95.94 percent confidence level.The total content should not exceed one page, including supporting figures.

Keywords: LAM, Ni super alloy, ANN, Cutting force, Optimization.

A Novel Antenna Material for High-Performance 5G Wireless Networks

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Abstract

Antenna materials are a crucial component of 5G wireless networks. The 5G technology requires high frequency bands that operate at millimeter-wave frequencies, which in turn require antenna materials with specific characteristics such as high conductivity, low loss, and high bandwidth. Traditional antenna materials such as copper and aluminum are not sufficient for 5G networks, and new materials are being developed to meet the requirements of 5G technology. One of the most promising antenna materials for 5G networks is graphene, a two-dimensional material with high conductivity and low loss. Graphene-based antennas can operate at frequencies up to 1 THz, making them ideal for 5G networks. Other promising materials for 5G antennas include carbon nanotubes, metal-dielectric composites, and metamaterials. The ever-increasing demand for high-speed and high-bandwidth wireless communications has led to the development of 5G networks. To support the massive data traffic and provide reliable communication services, high-performance antennas with enhanced radiation efficiency and bandwidth are essential.

In addition to material properties, the design of 5G antennas is also critical for their performance. Antennas must be designed to have high gain and directivity, as well as low sidelobes and cross-polarization. With the right materials and design, 5G antennas can provide the high data rates and low latency required for applications such as autonomous vehicles, smart cities, and virtual reality. The graphene-TiO2 nanocomposite material is designed and optimized using numerical simulations and experimental measurements. The results show that the proposed material can achieve a radiation efficiency of over 90% and a bandwidth of more than 10 GHz in the 5G frequency range. The proposed antenna material also exhibits a low loss tangent, which results in low signal attenuation and improved signal-to-noise ratio. Moreover, the graphene-TiO2 nanocomposite material can be fabricated using a simple and scalable process, making it cost-effective and compatible with current manufacturing technologies. This novel antenna material can provide a significant boost to the performance of 5G wireless networks, enabling faster data transmission, better connectivity, and improved user experience.

Tribo-Corrosion and Mechanical Properties of Electro-deposited Hybrid Nano-Composite Coating for Under Water Applications

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Abstract

Corrosion is a natural process that may severely destroy metal structures and equipment, posing safety and economic concerns. Corrosion prevention and control necessitate a complete understanding of its mechanics and influencing elements and the deployment of appropriate corrosion protection technologies. This study focuses on characterising electro-deposited nanocomposite hybrid coatings, and it was prepared by incorporating hBN and Talcum nanoparticles into the nickel matrix. The optimised parameters were used to develop a new anti-corrosion and anti-wear coating. Further, the coating surface was characterised through XRay diffraction analysis (XRD), Fourier transforms infrared (FTIR), Water contact angle test, and Crosshatch adhesion test. While their corrosion resistance and wear resistance were evaluated using electrochemical impedance spectroscopy and a pin-on-disc tribometer, respectively. The results show that incorporating nanoparticles in composite coating improves the mechanical, tribological and corrosion properties. Further, the hybrid nanocomposite coating significantly enhances the mechanical, tribological and corrosion properties. Therefore, it can be used as a coating to protect underwater structures.

Keywords: Corrosion, Coating, Nanocomposite, Electrodeposition, Additives, Tribology

Experimental Investigation to Study the Effect of Cryo-Rolling on the Johnson-Cook Model Parameter of Al6061.

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Abstract

Cryo-rolling is a sophisticated rolling technique performed at very low temperatures (in the range of -110 to -230 ℃) to improve the mechanical properties of metals and alloys. In the present study, the effect of cryo-rolling on the mechanical properties of Aluminum alloy, Al 6061 has been evaluated. Before rolling the Al 6061 sheets were treated with liquid nitrogen to achieve the desired temperature of -160 ℃. Further, the uniaxial tensile samples were obtained from the rolled sheets for experimentation. The stress-strain relations, obtained from the experimentation were further used to extract the Johnson-Cook (J-C) plasticity model parameter for the cryo-rolled Al 6061. The effect of cry-rolling on J-C model parameters was evaluated by comparing the results with the stress-strain response of the Al6061 sheets rolled at room temperature. Samples with different reduction percentages namely 30%, 50%, and 70% were also tested to evaluate the effect of strain during cryo-rolling. From the experimental study, it was found that the cryo-rolled sample of Al6061 had greater mechanical strength than samples rolled at room temperature. However, a reduction in ductility was also observed in cryo-rolling as compared to room temperature rolling. It was also found that the effect of strain hardening was more severe in the cryo-rolling method. Further, the microstructures of samples rolled in different conditions were also studied to understand the reason behind the change in mechanical properties. Apart from mechanical properties wear behaviour of rolled Al6061 samples was investigated with the help of a tribometer.

Keywords: Cryo-rolling, Johnson-Cook parameters, Mechanical properties, Al 6061 Aluminum alloy, Wear.

Study gas film formation through the current signal in Electrochemical discharge machining (ECDM) with and without a magnetic field.

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Abstract

Electrochemical discharge machining (ECDM) is a hybrid advanced micromachining process known for nonconductive materials. In this process, material removal mainly occurs through the melting of the workpiece due to the electrochemical discharge at the tool electrode and high-temperature chemical etching through OH radicals in the electrolyte. The behavior of electrochemical discharge directly impacts the material removal rate (MRR) and surface quality of a machined surface. The presence of stable gas film around the tool electrode is an essential parameter for quality discharge. Gas film formation in the ECDM process has been studied many times through recorded voltage signals and recorded high-speed images during machining. However, the repeatability of the process still needs to be controlled. The effect of input parameters on spark discharges with and without a magnetic field was examined in the present study through current and voltage signals in different parametric conditions to explore the phenomenon of gas film formation and stability. It is deduced from the current signal output that the gas film formation time and stability vary with the input voltage, duty cycle, magnetic field, and electrolyte concentration. The effect of gas film stability and spark discharge consistency on surface quality is also discussed in this article.

Keywords: Magnetic field, Gas film formation time, gas film stability, Heat affected zone (HAZ), Consistence discharge.

Interfacial Damage Detection in Fiber Metal Laminates (FMLs)

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Abstract

Delamination at fiber-metal interface is the most common failure mode observed in fiber metal laminates (FMLs) during service life. It is attributed to the property mismatch at interface and causes catastrophic failure in fiber metal laminates. Early detection of the induced interlaminar damage is an important aspect to take preventive measures and avoid complete failure of FMLs. While the existing non-destructive methods such thermography, X-rays and ultrasonic testing methods work efficiently for monolithic materials, they are not well suited in FMLs due to the existence of the interfaces and anisotropic and inhomogeneous properties of FMLs. In this work, a simple electrical resistance measurement-based technique is developed to detect the damage in FMLs modified with carbon nanotubes (CNTs). The Glass reinforced aluminium laminates (GLARE) are fabricated for experimental testing in this work. CNTs improve the interfacial electrical conductivity in FMLs. The applicability of present approach is investigated using mode-I and mode-II testing of modified FMLs. The change in electrical resistance across the fiber/metal interface is recorded to predict the damage during crack growth in FMLs. It is shown that the modification of FMLs with CNTs, efficiently captures the interlaminar damage in FMLs. Moreover, it is recorded that the CNTs modified FMLs has improved interlaminar toughness in comparison to conventional GLARE laminates. The improved mode-I, mode-II toughness for modified FMLs is attributed to the mechanical interlocking provided by the CNTs at the fiber/metal interface.

Keywords: Fiber metal laminates (FMLs), Carbon nanotubes (CNTs), Glass reinforced aluminium laminates (GLARE), Resistance measurement, Damage detection

Development of A Large Shear-Induced Severe Plastic Deformation Process

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Abstract

Materials are processed for their application primarily by deformation. The choice of using a particular processing technology is driven by the mechanical properties of the processed material. Imparting large strains into metal is known to improve the mechanical properties, especially the strength of the material. The strength of metal, in general, is governed by grain size. In this work, a new SPD process has been developed to impart a large shear strain along with compressive strain into the material, in a single step operation. Commercially Pure (CP) aluminum sheets were subjected to 75% reduction in thickness. The processing was carried out by varying the operating parameters for the same thickness reduction, for several samples, to tailor the mechanical properties of the materials. From the obtained results, the effect of the variation in processing parameters on the properties of the material can be easily examined. The mechanics of the process is established and the Von mises equivalent strain has been calculated. Microstructural investigations show enormous stretching of the grains and the formation of sub-grains. The frequent change of strain path with the deformation leads to the fragmentation of the grains heavily to reach the steady state regime of grain size, ~1 micron. A threefold increase in the strength of the material has been observed.

Keywords: Severe plastic deformation (SPD) process; mechanical properties; von mises equivalent strain; processing-controlled properties (PCP); commercially pure aluminum.

Influence of Acrylate on Mechanical and Viscoelastic Behavior of Gel Electrolyte

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Abstract

Now days, electrochemical cells (sensors, batteries, electrochromic devices (ECD) etc) are increasing attention in the application of flexible, wearable and stretchable power electronics. Their cutting edge applications find in the field of health management, motion monitoring etc. In general, electrochemical cells are the layered devices and their conductivity depends on the conductive substrates and gel electrolyte (GE). GE layer sandwiches between the conductive substrates to provide the ions as well as adhesion. Due to the increase in wearable and stretchable applications, investigation of its mechanical and viscoelastic properties are also required among with ionic conductivity. GE comprises of salt, solvent and polymer. Salt provides the ions while solvent gives the path for movement of ions. Addition of polymer solidifies the electrolyte and are responsible for introducing the mechanical properties. Poly methyl methacrylate (PMMA) is one of the most explored polymer in the polymer electrolytes. The focus of this study is to investigate the mechanical and viscoelastic properties of gel electrolyte by varying the weight percent of PMMA. Rheology is performed by sweeping the strain amplitude, frequency and temperature. Linear viscoelastic region (LVER) is found to be decrease with the increase in PMMA. While elastic modulus (G') increases with PMMA. Tan δ is found less than 1 for all the samples and also shows reverse trends in lower and higher frequencies. Further, glass transition temperature (Tg) is measured to understand the effect of PMMA structure on GE. Effect of PMMA network on the ionic conductivity (σ) is also investigated. Further constitutive model is fitted to validate the experimental evidences. Later on, a thorough analysis is carried out to optimized the weight percent of PMMA in GE.

Acknowledgments

Authors acknowledge the Fluid Mechanics Research Lab, IIT Ropar to provide the rheometer facility.

Probing The Influence of Waveforms on the Submerged arc Weld Characteristics and Residual Stress Distribution

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Abstract

High deposition rates and penetrations in submerged arc welding are possible with negative and positive polarities, respectively. Whereas optimum weld penetration and deposition can be achieved using an alternating current power source. Balance and offset significantly affect the weld bead profile and residual stresses in the submerged arc welding with an alternating current power source. In this paper, a thorough experimental investigation of the effects of the balance and offset on the weld bead profile, microhardness, and the distribution of residual stress in bead-on-plate submerged arc welding of low-carbon steel is presented. An X-ray Diffractometer is used to quantify the surface residual stresses in the welds. Results revealed that the offset has the greatest impact on weld bead penetration, although weld bead width and reinforcement heights are sensitive to balance. Higher current with constant balance in negative polarity resulted in enhanced residual stresses due to an increment in deposition rate. Likewise, constant current at a higher balance led to increased residual stresses due to large shrinkage forces. The hardness of welds decreased with an increase in balance or offset. It is also observed that flux consumption per unit length raises with an increase in balance and negative offset.

Keywords: Alternating current, Balance, Offset, X-ray Diffraction, residual stress

Experimental Investigation on MRR in Wire-Edm Machining S31803 Profile Surface with Different Currents

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Abstract

A wire-EDM process is a sophisticated procedure for cutting complex profiles. The machined surface of high strength alloys should be highly polished in order to increase the removal rate. The current work focuses on MRR with surface finish by varying pulse on/off times on different thickness profiles while maintaining a constant distance at the nozzle. The output response of Taguchi is optimized using an L16 orthogonal array. Designed for combining with water immersed work pieces that have three varying parameters and four levels. MRR changed with the increase of thickness and pulse off time. The experiment was designed to investigate the effects of different combinations of pulse on/off times and thickness profiles on the material removal rate (MRR) and surface finish of the work piece. The Taguchi orthogonal array was used to optimize the output response of the experiment and the results showed that the MRR increased with increased thickness and pulse off time. Pulse on time also varied in 4 steps: 4, 6, 8 and 10 seconds to check the MRR increment. Among all the experiments, the best results were obtained with 10mm thickness material with an 8 second on time and 2 second off time.

Keywords: Wire-EDM, MRR, Pulse On/Off, Surface finish, Taguchi

Numerical Modelling of Machining of Titanium Alloys Under Phosphonium-Based Halogen-Free Ionic Liquid as Lubricant Additives

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Abstract

In general, dry machining is not recommended as the surface finish of the machined product is poor. Also, the tool life is low specifically when machining difficult-to-cut materials such as titanium alloys. Therefore, lubricants are used, however, traditional lubrication with flood cooling has various detrimental environmental effects as well as it costs approximately 17% of the total cost of the product. As a result of the aforementioned factors, it is essential to employ bio-based lubricants with minimum quantity lubrication (MQL) in the machining process to make the process environmentally friendly and economical. However, bio-based lubricants such as vegetable oils have low pour points and are susceptible to oxidation as well as degradation. To improve the properties of vegetable oils, ionic liquids (ILs) have emerged as desirable additives for metalworking fluids owing to their unique qualities such as low or minimal volatility, strong polarity, and excellent thermal stability. However, most of the ILs being used as lubricant additives are halogen-based. Halogen-based ILs are sensitive to moisture and have the potential to produce dangerous halogen acids, which can corrode metal surfaces. In this work, numerical analysis using ABAQUS™ was performed to investigate the effect of mineral oil and canola oil blended with halogen-free ILs under MQL environment on cutting temperature and cutting forces. For comparison, simulations were also carried out under dry machining. Simulations were performed at two different cutting speeds (80 m/min and 120 m/min) at a constant feed of 0.1 mm. Results show that the cutting temperature was reduced by 13.75% and 9.98% under canola oil blended with halogen-free ILs at 80 m/min and 120 m/min, respectively as compared to dry conditions. Also, cutting forces were reduced by 14-15% under canola oil blended with halogen-free ILs under the same conditions. Whereas, mineral oil used with MQL shows the total reduction of cutting temperature by 8.8% and 4.4% and cutting forces by 8.77% and 8.69% at 80 m/min and 120 m/min, respectively as compared to dry machining. This is attributed to the adsorption of ILs on the metal surface, which formed the lubrication film and reduces the friction resulting in lower cutting temperature and cutting force.

Keywords: Additives; cutting forces; cutting temperature; halogen-free ionic liquids; ionic liquids; minimum quantity lubrication.

Excimer Laser Micro-texturing on Silicon Wafer using Mask Projection Technique

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Abstract

Micro-Texturing is a novel way of offering material surface properties and has been extensively explored by researchers over the last few decades. Silicon has been used in the plethora of application such as micro-electro-mechanical systems (MEMS), electronics, optical devices, and biomedical applications as a result of the growing need for new biomaterials. In the aforementioned application, silicon is textured using an appropriate etching process. Out of various etching processes reported for the machining of silicon, laser machining is of particular interest since it is a single-step process for achieving the desired patterns on the silicon surface. In the current study, an attempt has been made to study the use of KrF excimer laser to fabricate micro-pillars (50µm × 50µm) over a large area on a silicon wafer surface.
A parametric study has been performed to optimize the processing parameters such as pulse energy (400 mJ – 600 mJ) and the number of pulses (260 - 300) for obtaining desired machined feature. The ablation performance was reported better at pulse energy 600 mJ with 300 pulses at a predetermined frequency 30Hz.

A numerical study using COMSOL Multiphysics software was also performed to understand the ablation process of silicon with a nanosecond laser, and the obtained result were compared with the experimental result, which was found to be in agreement with each other. Furthermore, a thorough study on mask profile was carried out to achieve the final feature on Si wafer in minimum machining time.

Keywords: Excimer laser, Mask, Silicon, COMSOL, Micro-texturing

Influence of Welding Process Parameters on the Quality of Narrow Gap Welds

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Abstract

Narrow gap welding (NGW) was performed on 12 mm thick steel plates with a 5 mm gap square butt joint. The influence of gas metal arc welding (GMAW) variants like a cold metal transfer (CMT) and pulsed DC was addressed in the narrow gap first. Followed by the narrow gap, arc oscillation amplitude, number of passes/travel speed, and welding voltage effect were studied sequentially. Based on the stability of the welding arc, molten pool, and the quality of the welding joint, the welding process parameters were finalized. A high-speed camera is used to capture the welding arc inside the narrow gap joints. Recorded welding current and voltage helped in understanding the real-time arc behavior. Lower heat input in CMT results in a lack of fusion and is minimized while using pulsed DC, a higher narrow gap results in a much more stable arc. It is observed that for a 5 mm narrow gap, 1 mm arc oscillation amplitude results in a stable welding arc with minimum weld defects. For a fixed wire feed speed (WFS), lowering the number of passes required to complete the weld joint or lowering the travel speed results in an overflow of the molten pool. The combination of pulsed DC, 5 mm narrow gap, 1 mm arc oscillation amplitude, 9 mm/s travel speed, and 25 V results in a stable welding arc with a sound weld joint.

Keywords : Narrow Gap Welding; CMT; GMAW; Multipass welding

Pitting Corrosion Behavior of Nickel Base Superalloy- A Comparative Study in Na_2SO4 and Na_2SO_4:Xxnacl Fluxing Salts.

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Abstract

Hot section components in aero gas turbine engines encounter the adverse effects of hot corrosion due to the prevailing atmospheric conditions constituting high-temperature fuel emission gases and salts, ingested from the outside environment. Nickel-based superalloys used in turbine discs show debits to their fatigue behaviour after exposure to hot corrosion and which could potentially result in a significant reduction in their service life. In this study a detailed analysis of the pitting characteristics of two different corrosive salts (Na2SO4:2%; NaCl vs Na2So4: 25% NaCl) on the nickel based superalloy is studied. The process variables to achieve a uniform salt deposit, was first established in a systematic manner, by looking at the effect of, a. surface roughness, b. spray vs slurry, c. molar concentration (1M, 2M, 4M), d. geometry (flat vs cylinder) and e. exposure time (5 h up to 100 h), at 700°C. Pits up to a depth of 100 μm and a width of 200 μm were seen in the first 5 h. Detailed microstructural analysis indicated the formation of mixed oxides of Cr, Ni, Ti in the insides of the pit, with inter granular attack on the base metal, with sporadic remanence of reaction product with Sulphur rich regions, in the base metal. The role of pitting formation in the fatigue behaviour is brought out via these microstructural characteristics.

Keywords: Hot corrosion, Nickel based superalloy, Thermal cycling, Characterization, Oxide scales, Pitting.

Comparing the Effect of Texture on Strength and Ductility of Shear Deformed and Rolled Magnesium

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Abstract

Magnesium is the lightest structural material and is an attractive alternative in weight saving applications. However, due to the hexagonal packed structure of magnesium, it has limited slip systems. So, it is difficult to impose large strains without fracturing. However, a newly developed severe plastic deformation process was used to deform the magnesium sample. A large strain of 34 was imposed during the deformation process. After processing, a shear texture was developed and simultaneous increase in strength and ductility was observed in magnesium. To compare the properties with typical rolled texture, a sample was processed by accumulative roll bonding up to similar strain. The resulting texture, grain size and the corresponding properties in tension (yield strength and ductility) were compared.

Investigations on the Effect of Loading Rate on the Formability of AA 6082

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Abstract

High strain rate forming (HSRF) is a forming technique where strain rates are in the range of 102 /s – 104 /s and is achieved through high amount of energy applied for short period of time. These HSRF methods may be used to create big complex components out of most metals, including those that are often challenging to form using traditional techniques. Metals formed using this technique have attributes such as less spring back effect & good formability and they are adopted in variety of industries including aerospace, automotive and defense to produce components with tight tolerances. High strain rate forming such as electromagnetic forming, electrohydraulic forming and explosive forming are mostly used to produce components of complex geometries. Besides several advantages, the major limitations of these processes are higher capital cost, complexities in handling, less safer and requires skilled personnel & instrumentation. Pneumatic loading can be used to overcome many of these limitations. This method ensures uniform loading of the specimen and is also capable of generating a wide range of loading rates, depending on the rate of pressurization. A schematic of the pneumatic loading setup used for the current study is shown in Fig.1. The high pressure chamber is pressurized using a compressed air bottle till the point of rupture of the diaphragm. The intermediate chamber then gets pressurized subsequently resulting in rapid loading of the specimen, leading to plastic deformation. Aluminum discs of 1.5mm thickness are used as the diaphragm for experimentation and they are locally weakened by marking v-grooves, to facilitate clean rupture. The groove depth is to be varied to control the diaphragm rupture pressure and thereby the loading rate of the specimen In this paper, aluminium alloy, AA 6082 sheets of 1.5 mm thickness were sliced to the a diameter of 126 mm for experimental studies to observe the forming behavior of the material. Circular grids were marked over the surface of the work piece using a laser marking machine to analyse the strains after subjecting the same to rapid deformation. The formability of the workpiece in terms of maximum mid-point deflection will be studied. Thickness variation and deflection profile along the deformed plate will be measured . Major strain, minor strain, circumferential, radial, and thickness strains will be measured and the Von Mises strain will be reported for samples loaded at various rates. Experiments would also be carried out with quasi static loading and the results will be compared with those with dynamic loading and the deviation will be detailed. The experimental results will be compared with the numerical simulation performed using finite element analysis (LS-DYNA). The material model used will be a non-linear rate dependent plasticity model which is generally used for high velocity forming. Fully integrated Belytschko–Tsay shell element with five integration points will be used.

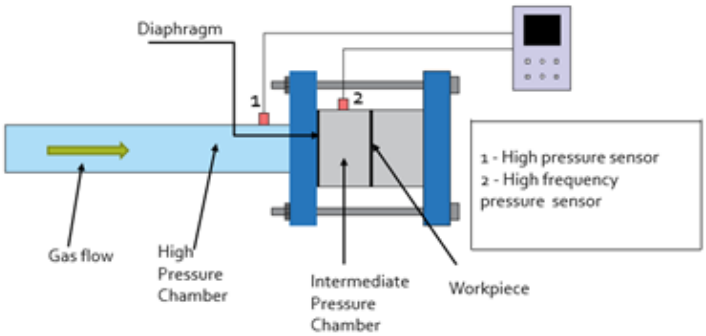

Fig.1 Schematic of experimental setup

Fabrication of Superhydrophobic Aluminum Surfaces Using Sink Electrical Discharge Machining

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Abstract

The evolution of surfaces with superhydrophobic properties has attracted significant attention due to their potential for self-cleaning, anti-icing, and anti-biofouling applications. The self-cleaning and anti-biofouling properties of the fabricated aluminum surface have the potential for usage in hygiene-critical environments such as food packing industries, solar panel casing, and satellite dishes. While chemical etching and passivation with low surface energy octyltriethoxysilane (OTES) molecules have been used to fabricate such surfaces, they come with significant environmental and health risks. In this project, we explore the use of sink electrical discharge machining (EDM) as a single-step manufacturing process for the fabrication of durable metallic hydrophobic surfaces. Machining was performed by varying three parameters i.e., voltage (ranges from 30V to 80V), current (ranges from 20 A to 30 A) and pulse on time (ranges from 4ms to 6ms). Experiments were conducted at varying input parameters and we achieved a nearly superhydrophobic aluminium surface with contact angles ranging up to 150°. Using a hydrocarbon dielectric, we demonstrate that sink EDM can swiftly develop inherently water-repellent surfaces, which were formed by overlapping carters generated by electric sparks. Our approach offers a more sustainable and efficient alternative to traditional fabrication methods while providing a tunable superhydrophobic surface with self-cleaning, anti-icing, and anti-biofouling properties.

Keywords: Superhydrophobic; sink electric discharge machining; self-cleaning;

Creep Behaviour of Optimised Heat Treated Inconel 939 Fabricated by Laser Powder Bed Fusion

Sarath Chandra Reddy Karumudi

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Abstract

Medium to high gamma prime-strengthened Nickel-based superalloys are susceptible to cracking during Laser Powder Bed Fusion (LPBF), which demarcates the widespread application in aerospace components. In this study, as a prelude to understanding the creep performance of LPBF fabricated Inconel 939 (IN939), the as-printed samples were subjected to three different cooling modes (Water Quenching (WQ), Air Cooling (AC), and Furnace Cooling (FC) methods) after solutioninzing treatment at 1190°C for 4h. Amongst all cooling processes, the WQ sample showed higher hardness, fine gamma prime size, and superior room temperature tensile properties. Further, we evaluated the creep performance of the WQ samples at 816°C and 300MPa, 250MPa, and 200MPa. The creep rupture lives of the fully heat-treated samples showed a large debit in creep rupture life compared to the cast counterparts. The microstructural instability causing the low creep life of LPBF IN939 samples during the creep test corroborates with the microstructural evidence.

Keywords: Laser Powder Bed Fusion, Additive Manufacturing, Nickel Based Superalloy, Creep, Advanced Microstructural Characterization.

Effect Of Heat Treatment on Microstructure Evolution of Laser Powder Bed Fusion Processed XH-67 Nickel-Based Superalloy

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Abstract

Owing to better combination of high temperature corrosion and oxidation resistance, XH 67 precipitation strengthened Nickel-base superalloy is used mainly to fabricate the critical parts of turbine engines. Since composition of this alloy is prone to hot cracking during casting and repair welding, it presents a challenge to produce defect free additively manufactured (AM) parts made of XH 67 superalloy. In this study, Laser Powder Bed Fusion (LPBF) technique has been used to fabricate nearly dense (> 99.5%), crack free coupons of XH 67 alloy. Inhomogenity was observed in the as-built microstructure in both along and perpendicular to build direction. Room temperature mechanical properties were evaluated in As-Printed condition and structure property relationship of alloy XH 67 was reported. Based on thermodynamic predictions made using Thermo-Calc, heat treatment optimization was carried out and the effect of heat treatment on microstructural characteristic and mechanical properties was studied. Time-Temperature-Transformation (TTT) diagram was constructed based on the microstructural observations at different temperatures and time, and experimental results are correlated with phase predictions. Further, comparison between AM XH 67 and Cast XH 67 properties was reported.

Keywords: Additive Manufacturing, XH 67 alloy, Laser Powder Bed Fusion, Heat Treatment, TTT curves, Thermo-Calc

Effect of Deposition Rate and Deposition Speed During the Fabrication of Iron Aluminides with 10 Wt. % of Al Using GMAW-Based TWAAM Process

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Abstract

Iron aluminides are used in fossil fuel energy systems and rotors of turbochargers in the automobile industry due to their excellent oxidation and corrosion properties. The development of iron-iron aluminides is still a challenging task because of the large difference in various thermos physical properties of iron and aluminum. In the present work, iron aluminide thin walls are fabricated with a composition of 10 wt. % of Al (AA 4043) & 90 wt. % of Fe (ER 70S-6), using CMT technology by GMAW-based TWAAM process. To minimize the overall heat input in the process both electrodes are in CMT mode and the corresponding synergic lines are selected for the deposition process. Fe wire is selected as lead wire to form a stable melt pool and Al wire as trail wire to transfer the molten metal directly into the same melt pool. The deposition process is carried out at 0.66, 1, and 1.28 g/s deposition rates with 5 and 10 mm/s deposition speeds to fabricate five-layered iron aluminide thin wall structures. For each thin wall, the macro dimensional analysis, and microstructural studies are carried out. V-I waveforms are recorded for both electrodes and also thermal profiles are recorded by attaching thermocouples to the substrate during the deposition. The results reveal that as the deposition rate increases at a low deposition speed, the depth of penetration is more. The deposition rate and the deposition speed influence the bead dimensions. Cooling rates are estimated from thermal profiles and heat input in the process is calculated from V-I waveforms. Cooling rates affect the microstructural features and subsequently the various mechanical properties. XRD and microhardness tests are performed and results confirm that iron-rich intermetallic phases are predominant in the thin wall iron aluminide structures.

Keywords: TWAAM, Iron aluminide, Cold metal transfer, Thermal profile, V-I waveforms

Experimental Investigation on Metallurgical and Mechanical Properties of ND:YAG Laser Welded Inconel-825 Superalloy

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Abstract

Inconel-825 is Nickel based Super alloy which can hold its properties at high elevated temperature up to 1550°C. It is majorly used in applications like Rocket engines, Gas turbine blades and Nuclear reactors. In this research paper Inconel-825 pieces with 2mm thickness are welded by ND:YAG laser welding having laser power of 3kW by varying power (70%,65%,60%,55% and 50%) total 5 experiments are carried out. Quality of weld is investigated by mechanical tests such as computer assisted Universal testing machine, hardness number is identified by using Vickers hardness test on Fusion zone. Metallurgical investigation is carried out by Optical Microscopy test identified equiaxed grain growth in fusion zone. Grain orientation angle and grain size distribution was investigated by Electron Backscatter Diffraction Analysis. The results reveal that by utilizing laser power at 50% i.e, 1.5 kW mechanical and metallurgical properties are improved as UTS is 538 Mpa , % of elongation is 16.50%, hardness is 220.75BHN, Average grain size is 2.90µm. Fine grains are formed and ductility improved in Fusion zone. Still improving power to 65% i.e 1.95kW lave phases are formed such that brittleness is improved, and weld strength reduced.

Keywords: Inconel-825, Laser Welding, Mechanical Properties, Metallurgical Properties and EBSD.

Acknowledgments (if any)

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Understanding the Texture Evolution and Deformation Behavior Under Bending and Uniaxial Tensile Creep Loading

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Abstract

High specific strength makes aluminum and titanium alloys suitable for high performance aerospace components. High temperature properties like creep are critical for alloys in such application. Bending test with cantilever geometry coupled with digital image correlation (DIC) in a high throughput fashion has been reported to facilitate the creep study with a possibility of getting multiple data points for both tension and compression stress range from a single strain-stress graded specimen as compared to the conventional uniaxial creep testing which produces only one data point. The correlation is made for equivalent stress between conventional uniaxial creep sample and one of the stress invariant points in bending creep sample. Dislocation density plays an important role in the materials creep deformation behavior. Electron back scattered diffraction (EBSD) allows the geometrically necessary dislocation (GNDs) quantification based on the lattice orientation measurement with relatively simpler sample preparation. In the present study, the micro-texture, sub-grain structure and the dislocation density evolution has been analyzed in the crept specimens under bending and uniaxial tensile loading in the temperature range of 200-250oC using EBSD and transmission electron microscopy (TEM) for additively manufactured AlSi10Mg and A205 aluminum alloys, and unirolled Ti-6Al-4V. Additionally, the statistically stored dislocation density (SSDs) and geometrically necessary dislocation density (GNDs) was quantified. A systematic correlation was done between the creep properties and dislocation behavior to understand the deformation mechanisms.

Keywords: AlSi10Mg, A205, Ti-6Al-4V, dislocation density, bending, creep, EBSD, TEM

Processing Effect on the Tensile Properties of the Coir Fibre for Sustainable Composite Development

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Abstract

Sustainable materials based on agro-waste contribute to a sustainable world and circular economy. Natural materials in the form of fibres and particles have a complex architecture and chemical composition compared to synthetic materials and require special processing for use in engineering applications. Coconut fibre, called coir, is available in huge quantities and is reported to have superior mechanical properties. Various physical and chemical methods are adopted to modify the coir fibre surface to improve performance, wettability and bonding with the polymer matrix. This study aims to comprehend how climatic variability or chemical processes affect coir fibre strength and mechanical properties. The climatic variability can be achieved by keeping the fibres for water soaking and the oven drying. The alkaline treatment with 5% NaOH to modify the fibre's surface and enhance the fibre's wettability with the polymer matrix. To analyse the effect of these processes on the mechanical properties of the single fibre, a uniaxial tensile test was performed according to ASTM standard. An increase in the tensile strength is observed after alkaline treatment and water absorption due to exposure is found to affect the strength. In the alkaline treatment, after the lignin removal crystallinity of the fibre increases, the reorientation of the cellulose microfibrils strengthens the fibre. Oven-dried coir fibre shows an increase in strength due to the removal of volatile gases and moisture, which leads to the shrinkage, and entanglement of the microfibrils, hence a slight increase in the strength. The effect of water absorption on the tensile properties are reported and possible influence on the composite development are discussed.

Investigation of Residual Stress and Elastic Parameters Affected due to Variations in Manganese Content and Cast Section Size in Wear Resistant High Chromium Irons

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Abstract

The ferrous based system especially high chromium alloyed irons are known for superior wear behavior in view of possessing hard carbides in a martensitic phase, but prone to failure upon load application. The improvement to withstand load is possible through the addition of manganese element to chromium as it serves as an austenite stabilizing agent. These alloys are subjected to different processing conditions, such as designing of alloy systems, heat treatment cycles, cooling rates etc., before considered for actual field applications such as grinding media, liners, impellers in thermal power plants. These components are subjected to various manufacturing processes resulting in onset of residual stress in the form of plastic strain. During the processes such as casting, machining, welding and heat treatment, one region of a part gets constrained by the adjacent region resulting in expansion or contraction, releasing elastic strains, thus introducing residual stress. These stresses have impact on the mechanical performance involving elastic parameters such as Young's and Shear modulus as well as Poisson's ratio. Therefore, it is very much required to enlarge the scientific database of chromium manganese irons on the parameters relating to residual stress and elastic constants as they are significantly less explored.

In this study, chromium irons have been prepared in grey cast iron moulds by induction melting and subjected to hardness, residual stress, sonic tests and microstructure involving carbide morphology in the heat-treated conditions. The data gathered due to the change in cooling rate through the variation in cast section thickness from 12 to 40 through 24 mm in 5% and 10% Mn-added chromium irons, have resulted in better correlations among residual stress, elastic constant, hardness and metallurgical parameters.

Keywords: High Chromium Iron, Manganese, Residual Stress, Elastic Parameters, Surface Morphology

Loha Bhasma for Urinary Disorders: A Comprehensive Review of Material Science and Processing Techniques for Enhanced Therapeutic Efficacy of Nano-Based Iron Medicine

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Abstract

Loha Bhasma is a traditional Ayurvedic medicine prepared by processing iron in a specific way. It has been a metallic preparation used to treat urinary disorders, anemia, and other blood disorders for centuries. Loha Bhasma's therapeutic efficacy depends on the material science and indigenous processing techniques employed in its preparation. This comprehensive review examines the traditional and contemporary techniques for preparing and characterizing Loha Bhasma. It also investigates the scientific basis of Loha Bhasma's therapeutic effects, including its anti-inflammatory and diuretic properties. The challenges associated with standardizing Loha Bhasma and the need for additional research to optimize its therapeutic efficacy are discussed. This article explores the potential of Loha Bhasma as a safe and effective treatment for urinary disorders.

Impact of chloroform treatment on the mechanical characteristics of PETG, ABS, and PLA materials fabricated via the Fused Deposition Modeling (FDM) Technique

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Abstract

The advent of Additive Manufacturing (AM) technologies has brought about a paradigm shift in object fabrication. Among the various AM techniques, Fused Deposition Modeling (FDM) has gained immense popularity due to its cost-effectiveness, user-friendliness, and versatile applicability. However, despite the widespread use of FDM materials such as PETG, ABS, and PLA, these materials exhibit mechanical limitations such as low tensile strength, low impact resistance, low durability, and low heat resistance. In light of this, the present investigation delves into the efficacy of post-processing treatment with chloroform to enhance the mechanical properties of these materials. The study involves the printing of PETG, ABS, and PLA materials using an FDM printer, with a layer height of 0.2 mm and a raster angle of 45˚. Subsequently, chloroform treatment is administered by enclosing the printed specimens in a sealed container with chloroform for 60 minutes. The mechanical properties of the treated and untreated specimens are then compared using a universal testing machine. Moreover, the microstructure of the fractured specimens is analysed under a scanning electron microscope to discern the causes of failure. This study provides valuable insights into the post-processing treatment and its influence on the mechanical properties of thermoplastic materials.

Keywords: Fused deposition modelling (FDM), Polyethylene terephthalate glycol (PETG), Acrylonitrile Butadiene Styrene (ABS), Polylactic acid (PLA), Universal Testing Machine (UTM), Chloroform treatment, Post processing.

Acknowledgments

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Effect of Cell Wall Thickness and Heat Treatment on Overall Compressive Strength of Honeycomb Structure Made of PETG, PLA And ABS Fabricated By FDM Technique

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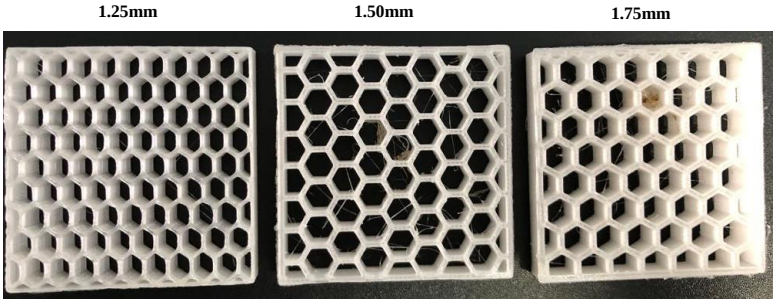
Abstract

Honeycomb structures are extensively used in various industrial applications due to their high strength-to-weight ratio. Honeycomb structures, which have exceptional crushing resistance and specific energy absorption capabilities, have found application in a variety of engineering fields, including automotive, aerospace, and sports. However, conventional manufacturing processes for such structures are often expensive and labour-intensive. In this context, additive manufacturing (AM) processes provide a potential solution to alleviate these challenges. This study investigates the effect of cell wall thickness and heat treatment on the overall compressive strength of honeycomb structures made of polyethylene terephthalate glycol (PETG), polylactic acid (PLA) and ABS (Acrylonitrile Butadiene Styrene) fabricated by fused deposition modeling (FDM). The experimental procedure includes the preparation of honeycomb structures with different cell wall thicknesses (1.25mm, 1.50mm and 1.75 mm) and heat treatment at two different temperatures (70 and 90 °C) for 2 hours. The compressive strength of the honeycomb structures was evaluated using a universal testing machine. The deformed honeycomb structures will also be analysed under a scanning electron microscope (SEM) to identify the cause of deformation. Therefore, this study offers valuable insights into the compressive properties of AM honeycomb structures and their potential applications in various real-world engineering fields.

Keywords: Fused Deposition Modelling (FDM), Polyethylene Terephthalate Glycol-modified (PETG), Additive manufacturing (AM), Honeycomb Structure, Scanning electron microscope (SEM), Universal Testing Machine (UTM).



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The authors extend their appreciation to the Department of Production Engineering NIT Trichy, for the research facilities and financial support given by seed grant.

Design and Simulation of Additively Built Acoustic Metamaterial for the Improvement of Acoustic Behavior and Performance

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Abstract

Comfort in the built environment is greatly influenced by acoustic design, which heavily relies on sound absorption to reduce noise. Acoustic design necessitates various specialized solutions depending on the characteristics of functions and environments. However, the constraints of today's sound absorbers prevent them from being customized to the unique acoustic requirements of space; these restrictions mostly pertain to geometry and materials and are primarily related to design and production issues. This paper focuses on absorbers based on the passive destructive interference (PDI) concept to discover options for highly tailored sound absorbers (PDI). The fractal design derived from the Helmholtz Resonator structure demonstrated 88% absorption for narrow-band noise reduction applications. This is due to frictional losses on acoustic wave energy induced by predetermined arrangements. The influence of extrinsic features, including sample thickness, gate opening, and sample divider, is studied and dimensionally tuned for maximum absorption. The unique design is confirmed numerically, analytically, and empirically before being 3D printed. The sound insulation peaks indicate that the physical properties of fractal designs can be tuned. The study concept outlines a hybrid lightweight, deep-subwavelength (14.5 mm) acoustic-metamaterial with nearly perfect sound absorption capabilities.

Keywords: Acoustic metamaterial, Additive Manufacturing, Sound Absorbers

Microstructure and Non-Destructive Evaluation of Aluminium 6009 Alloy Sheets Joined by Friction Stir Welding

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Abstract

Friction Stir Welding (FSW) is one of the advanced welding techniques in which the material joining occurs purely in the solid-state i.e. without any material melting. FSW has material joining through the combined effects of frictional heat and the plastic deformation of the materials. Aluminium 6009 alloy is important from automobile body panel point of view. In this present work, Aluminium 6009 alloy plates were friction stir welded at four different sets of process parameters using alloy steel FSW tool. After the welds were successfully obtained, they were subjected to Radiographic Testing (RT), a Non-Destructive Testing (NDT) technique, for analysis of weld defects formed during FSW of the plates. Furthermore, to analyse the microstructural changes at the Stir Zone(SZ), Thermo-mechanically Affected Zone (TMAZ), Heat Affected Zone (HAZ) and the Base Metal (BM), Optical Microscopy(OM) as well as Scanning Electron Microscopy (SEM) techniques were carried out on these welds. The RT-NDT results indicated the exit hole defects as well as ribbon flash defects in all the welds obtained from different process parameters. The microstructural analysis indicated presence of finer grains in the Stir Zone (SZ) of the welds.

Keywords: Friction Stir Welding; Friction; plastic deformation; automobile; Radiographic Testing; Optical Microscopy; Scanning Electron Microscopy; exit hole; ribbon flash

Design & Modification of Cavity Plate for Injection Mold of Nail Polish Bottle Caps

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Abstract

In a manufacturing company, it is found that a die in perfect condition was typecast as dead mold because the product was outmoded and that would be abolished due to space constraints, so the company had to discard such dies. After doing some research about the dies and analyzing the circumstances that led to discarding the die, the proposed system is an alternative to save the dead mold from being discarded completely. Instead, it could be designed and could create a new cavity plate which would fit in the existing die and also make a single cap which could be used for 2 types of bottle-necks by making some changes in the die and then after production simply inserting the desired inner . Resulting in saving the manufacturing and material cost of making a whole new die and hence avoiding a whole die to go waste. So the whole idea of this project is to design and modify the cavity plate and with necessary changes make it sustainable and yield more production. Also can preserve the old cavity plate so that if in future there is any requirement for the product of outmoded design we could simply put back the original cavity plate and obtain products making a single die take production of two different products in succession. Have a sustainable approach to the whole project ,so besides the modification of the cavity plate and reusing an old die have also managed to recycle the byproducts while production into the inners used for the same caps.

Keywords: Injection Mold, Cavity Plate design, Increased productivity. quality check parameters, sustainable design and manufacturing.

Acknowledgments

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Fracture Properties of Additively Manufactured Mar-M 509 Cobalt-based Superalloy

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Abstract

Mar-M 509 is a cobalt-based carbide strengthed superalloy exhibiting oxidation resistance and mechanical properties at high homologous temperatures. Its properties make it an excellent material for high-temperature applications like nozzle guide vanes and blades of aero engines and gas turbines. This application requires components of intricate geometry, and the high hardness of superalloys, increasing machining complexity and cost of production. Metal additive manufacturing provides a route of production and repair of these complex components at reduced cost and better performance compared to the traditional route of casting followed by machining. The effect of Laser Powder Bed Fusion (LPBF) on the mechanical properties of as-printed and short-cycle heat treatment at 1250C for 3hrs was studied by Sahu et al. [1]. The presence of carbides along intercellular boundaries prevented recrystallisation and grain growth to a large extent. However, there was change in carbide morphology and the formation of additional Cr23C6. In this study, we determine the fracture toughness and fracture micro-mechanism of additively manufactured Mar-M 509 in the above two conditions. The effect of heat treatment on fracture properties is studied along three different orientations using a novel clamped beam bend geometry, incorporating advanced tools such as digital image correlation and finite element analysis to quantify critical crack opening displacement and Jc at crack initiation. Crack trajectories are explained in the context of the differences in the microstructures of the crack planes.

Keywords: Mar-M 509 Cobalt-based superalloy, fracture, LPBF, digital image correlation.

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Wear and Corrosion Analysis of MoS2/Epoxy Nanocomposite Coating

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Abstract

This study focuses on the wear and corrosion analysis of MoS2/epoxy nanocomposite coating on a mild steel substrate. MoS2 is a good lubricant additive with significant potential to enhance wear resistance and reduce friction. On the other hand, epoxy is a well-known polymer with good mechanical properties and excellent adhesion to metal substrates. Therefore, in this work, MoS2 nanoparticles were dispersed in an epoxy matrix to form a nanocomposite coating on a mild steel substrate. The wear and corrosion properties of the nanocomposite coating were evaluated using pin-on-disc and electrochemical impedance spectroscopy techniques, respectively. The results show that the MoS2/epoxy nanocomposite coating exhibits superior wear and corrosion resistance compared to the neat epoxy coating. The nanocomposite coating exhibited a lower corrosion current density and higher charge transfer resistance than pure epoxy coatings, indicating enhanced corrosion resistance. Overall, the MoS2/epoxy nanocomposite coating demonstrated outstanding potential for mild steel use as a protective coating in harsh environments.

Keywords: Epoxy, Nanoparticle, Tribology, Mild Steel, Coating, Corrosion

Plasma Electrolytic Polishing Process: Mechanism and Characteristics

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Abstract

Parts made by most of the machining processes, conventional or unconventional, required post-processing steps to render them suitable for end-use. The most common method for removing of burrs and machining marks from the surface of parts is electrolytic polishing (EP). The key advantage of EP is in processing of freeform surfaces without the need for any tooling. However, this technique is not suitable for finishing of alloys as each component has its distinct dissolution rate. Another parameter limiting the application of EP is high processing time. In recent decades, the research and applications of plasma electrolytic polishing (PeP) has grown in leaps and bounds. PeP is ideal for the processing of alloys and is significantly faster than EP. In this work, we present an experimental study on Pep wherein, we investigate the influence of applied potential and processing time on surface roughness. For this, SS304 substrates having cross-sectional area as 15 mm × 15 mm and initial roughness (Ra) as 0.95 µm is finished using aqueous solution of 1M NaNO3. Experimental results suggests that with an increase in applied potential, Ra value decreases for a specific processing time. Also, for a specific value of applied potential, the value of Ra decreases and surface becomes glossy as the processing time increases. Finally, minimum Ra of 0.48 µm is achieved at an applied potential of 350 V and processing time of 150 sec.

Keywords: Discharge; vapor gas envelope; surface roughness; potential gradient; voltage.

Effect of Build Orientation and Test temperature on Bending Creep of Additively Manufactured A205 Aluminium Alloy

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Abstract

This paper showcases the effect of build orientation on the bending creep behaviour of additively manufactured A205 aluminum alloy at different test temperatures. A205 is an Al-Cu-Mg-Ag-TiB2 that has been known to exhibit excellent creep strength and thermal stability, making it attractive in applications such as heat exchangers. In a bending creep test, multiple creep curves (in tension and compression) can be obtained from a single test. Specimens of 2×2 mm2 cross-section are extracted from horizontally and vertically built cylinders via laser powder bed fusion (LPBF) and employed for bending creep tests at 200°C and 150°C in the effective stress range of 100-200 MPa. Steady state strain rates were determined via. 1. Strain evolution at points of invariant stress and 2. Deflection rates of indenter. The stress exponent was calculated using multiple steady state strain rate-stress pairs from a single test.

Acknowledgments (if any)

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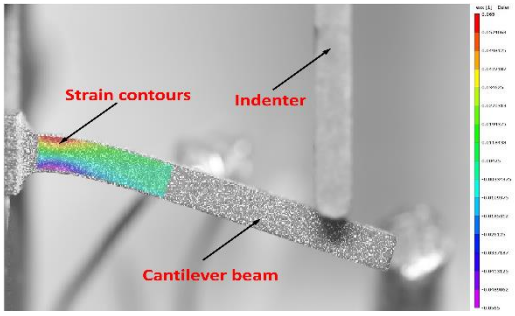

Figure 1: Representative Image of deformed bending creep sample and strain contours

Insights into the Tension-Compression Asymmetry in Additively Manufactured Alloys: A Combined Phase Field-Strain Gradient Plasticity Study

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Abstract

Rapid solidification in Additively Manufactured (AM) metallic systems leads to the development of significant microscale internal stresses. These stresses are attributed to the printing induced dislocation substructures arising in the microstructure. The resulting backstress due to the Geometrically Necessary Dislocations (GNDs), are responsible for the observed tension-compression (TC) asymmetry phenomenon. Here, we propose a combined phase field-strain gradient J2 plasticity framework to investigate the TC asymmetry in AM alloys. The proposed model is an extension of Kobayashi's dendritic growth framework, modified to account for the orientation based anisotropy and multi-grain interaction effects. Additionally, we have introduced an anisotropy parameter, equivalent to the maximum Schmid factor among all available slip systems, in our strain gradient J2 plasticity framework to account for intergranular heterogeneity. The model is implemented using a two-step scheme: firstly, a combined phase field-strain gradient J2 plasticity module is used for complete solidification of the liquid phase. Subsequently, only the strain gradient J2 plasticity framework is used for simulation of cooling to ambient temperature, followed by uniaxial loading deformations. This model is then used to predict the dislocation substructure evolution and ensuing TC asymmetry in AM SS 304L. It is observed that higher thermal gradients result in larger magnitudes of backstress, and a corresponding increase in the predicted TC asymmetry. The results presented in this study point to the microstructural factors, such as dislocation substructure and solute segregation induced residual stress development, which contribute to the development of TC asymmetry in rapidly solidified metallic systems.

Acknowledgments

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Estimation of Heat Affected Zone in the Laser Surface Modification of Single-Crystal Nickel Based Superalloy by Using a 3D Transient Heat Transfer Modelling

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Abstract

Single-crystal (SC) castings are highly desirable due to their superior properties, which include improved creep-rupture, fatigue, and oxidation when compared to equiaxed and columnar-grained castings. As a result, they are extensively used in advanced gas turbine engines in aerospace applications. Nonetheless, their physical and mechanical properties also make them challenging to machine. This research work investigates the use of laser surface modification (LSM) to enhance the machinability of SC nickel-based superalloys. The study was conducted by using a continuous wave fiber laser through a DOE-based robust design, L18 (orthogonal array) OA with different levels of laser power, focal position, and scan speed under the conductive mode of penetration. The experiments were conducted on the three specimens of superalloy with a replication of the full matrix. The LSM geometry was evaluated through the cross-sectional analysis with repeated measurements. A 3D transient laser heating model with a moving heat source including temperature-dependent thermomechanical properties was developed based on the finite element method using commercial software, Abaqus CAE. Part modelling was carried out with a hybrid elemental meshing technique. The governing equations of the standard gaussian beam, moving heat source and initial boundary conditions are called by subroutines of DFLUX. Based on the steady-state temperature profiles, the heat-affected zone (HAZ) of the LSM geometry was calculated to be the regions having temperatures above 1200 °C and the melting temperature of the alloy. The model was calibrated with the experimental values of the LSM depth using a correction factor. The model was further used to carry out a parametric study as per the L18, OA matrix. ANOVA analysis revealed that scan speed and laser power have a significant contribution to HAZ. On average, the estimated HAZ consists of around 30% of the LSM depth. The study provides insight into the optimization of LSM parameters for enhancing the machinability of SC nickel-based superalloys.

Keywords: Single-Crystal Nickel-based Superalloy, CW Fiber Laser, Laser Surface Modification, Design of Experiments, 3D Transient Heat Transfer.

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Design, Development and Analysis of Assembled XY Compliant Precision Scanning System

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Abstract

Precision Scanning stage is a need of current technology, accuracy of positioning is limited in rigid link scanning mechanisms is due to the friction, backlash etc. in joints. Flexural mechanisms (which provides motion based on flexibility of the members not like sliding or rolling motion between the rigid links) offers great advantage and provides micro-nano positioning accuracy. Various researchers attempted to design, develop a flexural mechanism having a monolithic structure [1,2,3,4]. Manufacturing of such mechanisms have disadvantage due to the limitations of manufacturing and it has complex structures. There is need of the methodology which provides greater flexibility and customized approach of assembled flexural mechanisms and few researchers attempted to develop such assembled flexural mechanisms. In this research article such methodology is applied, and XY precision scanning mechanisms is developed [5,6,7]. Components (rigid as well as flexible elements) of mechanism are 3D printed and later assembled. Typically, flexible elements of flexural mechanisms are categorized into two categories (1) planar flexible links and (2) hinge-based links. These flexible elements prone to fatigue failure due to repetitive dynamic loading and its complex shapes, if mechanisms are manufactured as monolithic structure, it becomes difficult to replace these flexible links and need to replace entire mechanisms. Hence, there is need of modular type mechanisms which can be assembled as well manufactured with ease. Proposed approach is to have a flexural mechanism using modular approach (manufacturing different links of mechanism and assemble) and further it offers greater flexibility in manufacturing, provides short time for manufacturing and assembly, failure of any link (deformation, crack etc.) will be taken into account and for this it is need not to be replace entire mechanism. Assembled mechanism is further interfaced with dSPACE DS1104 microcontroller, optical encoders are used for measurement of precise position of motion stage and voice motors (which provides frictionless actuation to motion stage) are used for close loop control of XY motion of the motion stage. System identification (static i.e. force deflection curve and dynamic i.e. frequency response curve) is carried out using standard test method and experimental model is estimated for development of close loop control algorithms. Various close loop control experiments (set point control and trajectory tracking control) are conducted and accuracy of less than 5 microns is achieved at the speed of 5 mm/s. Approach mentioned in this article is vary much useful for fast, customized development of XY flexural mechanisms and has numerous applications range from micromachining to biomedical imaging and organ manufacturing.

Acknowledgement

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Effect of Process Parameters on Track Geometry and Porosity in Laser Direct Energy Deposition of High Strength Aluminium Alloy

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Abstract

Laser Directed Energy Deposition (LDED) is a metal Additive Manufacturing (Metal AM) process that has attracted significant attention due to its ability to produce complex geometries with material properties comparable to cast and wrought parts. LDED has shown significant applications in repair of components and, adding features onto existing components. High strength aluminium alloys especially 2xxx, 6xxx, and 7xxx series are difficult to fabricate using LDED process since these alloys are prone to hot cracking due to rapid solidification during the LDED process. The focus of this work is to evaluate the effect of LDED process parameters on track geometry and porosity. Gas atomised Aluminium 7075 powder was used as feedstock material. The Chemical composition, particle size and morphology of the procured powder were analysed to gain insights on the characteristics of the feedstock used for deposition. The effects of process parameters such as laser power, scan speed, and powder flow rate on track geometry and porosity, were investigated using a Formalloy LDED machine via L27 orthogonal array of experiments. Increasing the laser power resulted in an increase in bead width, height, and wetting angle, whereas increasing the scan speed led to a decrease in bead height and wetting angle, and a minor increase in width. The results also showed a linear increase in wetting angle and bead height with increased powder flow rate, while the width of the bead remained relatively constant. Furthermore, it was also observed that increasing the laser power to 750 W resulted in a decrease in the cross-sectional porosity of the bead due to the availability of sufficient energy density thereby facilitating proper melting.

Keywords: Laser Directed Energy Deposition, Al7075 alloy, Process parameters, Single tracks, Porosity,

Crystal Plasticity Model for Cyclic Softening of a Polycrystalline Ni-based Superalloy

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Abstract

Failure of turbine disc components during low cycle fatigue is not fully understood, especially in terms of the physics of microstructure evolution during cyclic deformation, which leads to cyclic hardening followed by softening for polycrystalline Ni-based superalloys. In this study, cyclic deformation tests were performed at 1% strain amplitude and 2 % strain amplitude for the same alloy at room temperature. Microstructure characterization using Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) revealed the shearing of the secondary γ′ precipitates after deformation. A dislocation density-based, crystal plasticity model has been developed to simulate this observed phenomenon in polycrystalline Ni-based superalloy. The model accounts for solute solution strengthening due to the various constituent elements present in the matrix and the precipitate phase and Taylor hardening due to dislocation forests that evolve during deformation. A slip-system level backstress model is developed to account for the initial kinematic hardening. A model for microstructure evolution due to precipitate shearing is developed that accounts for the dislocation-precipitate interactions and the change in precipitate strengthening due to secondary and tertiary γ′ precipitates present in the matrix (γ) phase and contributes to cyclic softening. The developed model is used to simulate cyclic deformation for two strain amplitudes at room temperature. The model shows a qualitative comparison of the stress-strain response and the variation in peak stress as a function of the number of cycles with the corresponding experimental data.

Acknowledgments

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Wire Arc Additive Manufacturing of Pelton Wheel Bucket

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Abstract

Wire and arc additive manufacturing (WAAM) is used for building medium to large sized components without using any support structures and also have low buy-to-fly ratio compared to other additive manufacturing techniques. This study mainly focuses on the process planning in WAAM, which mainly requires CAD modelling software, Slicing software and a programming tool for tool path generation to build a complex components. Pelton wheel bucket is manufactured with the developed methodology which is used in the hydraulic turbines for power generation. The proposed methodology can be used for building complex components in WAAM without using any commercially available 3D printing software.

Keywords: Wire and arc additive manufacturing, Pelton wheel bucket, Process planning, Tool path generation

Processing and Characterization of Medical Implants/Devices by Surface Modification

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Abstract

Metal alloys like stainless steel and titanium alloys play a critical role in medical industry and are indispensable part of modern medicine. Numerous alloys of stainless steel and titanium have been developed advancement in metallurgy and allied sciences and some of them have been adopted for medical use. Among several stainless steel materials and titanium alloys AISI 316L, AISI 410 and Titanium grade 2 have been chosen because of its ample availability and copious use in the medical industry. The purpose of the study is to investigate the tribological, micro-biological properties of the a fore mentioned materials subjected to different controlled treatment including surface treatment of the alloys with thermal diffusion. Thermal diffusion treatment commercially termed as boronizing or boriding is the preferred approach for enhancing the wear resistance of bio-materials in this research. The use of nitriding by molten salt bath was investigated. Properties critical to medical application like metrological aspects, like dimensional and roughness changes were also assessed. Boriding and nitriding processes were conducted for a fixed duration of 2 hours. Both, Nitriding and boriding treatments displayed anti-bacterial properties, nitrided specimens displayed a larger zone of inhibition during bacterial sensitivity testing. While the boriding treatment provided a maximum surface hardness and least wear losses despite drastic increase in surface roughness. Bothnitriding and boronizing treatments enhanced the surface hardness and improved wear resistance of all the base materials concerned in this research. Boronizing produces highest resistance to wear and tear compared to other processes investigated in this research. Despite high friction coefficient, least wear losses were recorded in borided specimens. Both nitriding and boronizing processes produced antibacterial activity against subtilis bacillus bacterial.

Hydrothermally Synthesized TiO2 Nanostructures for LPG Sensing Applications

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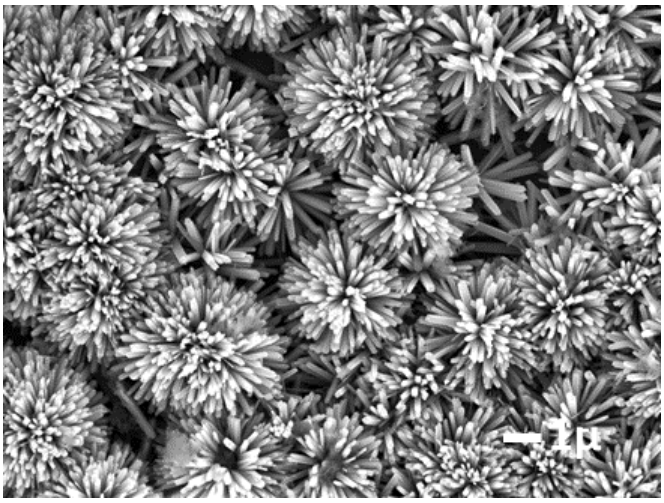
Abstract

Gas sensors have become increasingly significant because of the rapid development in electronic devices that are applied in detecting noxious gases. In this work, titanium dioxide (TiO2) nanostructures are hydrothermally synthesized by tailoring the growth parameters such as substrate orientation in the precursor solution, growth temperature and ageing time. Variation in the growth parameters significantly varies the morphology of TiO2 nanostructures. Interestingly, at 150°C with 24 h ageing time, a flower-like nanostructured TiO2 is obtained on silicon substrate oriented at immersed position against gravity in the hydrothermal reactor. The obtained nanostructures are characterized using several characterization tools to understand the morphology, crystalline quality and bonding characteristics of the material. The mechanism on the formation of nanostructures due to the growth parameters is discussed. Furthermore, the LPG gas sensing characteristics are investigated systematically. The gas sensors based on TiO2 nanostructures displayed the superior sensitivity, high response and recovery value, and good reproducibility to LPG. The outstanding gas sensing properties of TiO2 nanostructures can be ascribed to relatively narrow band gap and more oxygen vacancies of rutile phase, which showed a probable way for design LPG gas sensors based on metal oxide semiconductors.



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Experimental Investigation into Depositing Low Melting Point Alloy Utilising Fused Deposition (FDM) Modelling Technique

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Abstract

The 3D printing techniques are now effectively utilised for various applications, including medical, electronics, tooling, etc. One such application is the direct printing of electronic circuitry or machine tool using low melting point alloys like solder. The most common solder material is the alloy of tin and lead. However, lead, a hazardous material, is now being replaced with other elements like copper, silver, bismuth etc. The current study deals with the deposition of Sn-Bi, a low melting point alloy, using fused deposition modelling. The customised direct-type extruder head is fitted to an existing FDM printer to achieve the required deposition. The idea behind using direct type extruder assembly instead of bourdon type is to get the necessary force for pushing the metal out of the nozzle. The process window of temperatures is identified for extruding the material and suitable print speed for depositing the same. The discontinuity is observed at a certain range of parameters and filament types. The filament combinations of 1.75 and 2.85 mm were used with subsequent modifications in the extruder assembly. The nozzle diameter is varied with two filament combinations. The results for both filament types are compared in terms of continuity and uniformity in the deposition. The microstructure of the raw material and deposited beads are also analysed. The future scope of the current set-up can be its utilisation for printing electronic circuits or developing a tool for rapid tooling applications.

Keywords: Fused deposition modelling, Temperature, Low melting point alloy, Print speed

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Surface Modification of Titanium Alloys with Nanopores to Enhance the Osteoconduction and Incorporate Antimicrobial Properties

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Abstract

Infection is the second leading cause of failure for orthopedic implants followed by lack of osseointegration. Bacterial surgical site infection (SSI), which raises the risk of patient morbidity, numerous procedures, and possibly paralysis, is one of the most prevalent orthopedic implant complications. Titanium and its alloy are often used for orthopedic implants due to their superior mechanical and biocompatibility properties. The aim of the study is to investigate the gentamicin-coated titanium oxide nanotube arrays' potential antibacterial properties. Anodization is a promising technique to develop controlled nanotubes on the surface for localized drug delivery and effective drug reservoir to prevent bacterial colonization and implant infection, at the same time nanosurface will promote cell adhesion and proliferation. In this study, titanium implant material is made bioactive through a coating of niobium (Nb). Depending on the atomic weight percentage of the Nb, the coating contained varied weight percentages namely 5%, 10%, and 15% of Nb. Following this, the substrates are anodized using a graphite counter electrode and an ammonium fluoride electrolyte solution at different voltages between 60 and 80 volts for 60 minutes. The fabricated nanotubes were analyzed for microstructure using a scanning electron microscope (SEM). The nanotubes on the surface of the Ti substrates with Nb coating, had a diameter ranging from 80-140 nm and a coating thickness of 1-3.5 µm. In order to achieve drug delivery, co-precipitation coatings are used to load gentamicin into anodized Ti substrates. These drug-loaded anodized Ti samples are shown to obey first-order dissolution kinetics, exhibiting burst release followed by sustain release. The impact of Titanium nanotube diameter on the loading/release of gentamicin and on the resistance of Staphylococcus aureus and Escherichia coli was evaluated.

Keywords: Anodization, nanotubes, drug loading, antibacterial, sputter coating

Acknowledgments

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Surface Modification of Agrowaste Coconut Fibers: Latex Coating

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Abstract

Agricultural waste coir fiber, extracted from the coconut husk, has advantages over synthetic fiber by being eco-friendly, economically affordable, and abundantly available. Low density, moderate strength, good sound absorptivity, and lesser health hazards properties show the potential of coir to be used in interior applications of automobiles. However, the high water absorption property of coir tends to deteriorate the fibers. Coir fibers are used as woven and non-woven textiles and the friction properties of the fiber affect the performance. This study aimed to study the effect of surface modification of coir fiber with latex coating on surface morphology, water absorption, and frictional properties. Coir fibers were pretreated with alkali(NaOH) solution and then coated by dipping in latex solution. Alkali pretreatment improves the compatibility of the fiber with coating and latex coating improves the hydrophobic property. The investigations were carried out on two types of samples: untreated (UT) and latex-coated (LC) coir fibers. The friction coefficient estimated using a capstan friction test rig and damage in fiber under contact loading are reported.

Acknowledgments

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Geometrical Inspection of Fabricated Micro-Hole Attributes Using Maglev Micro-EDM

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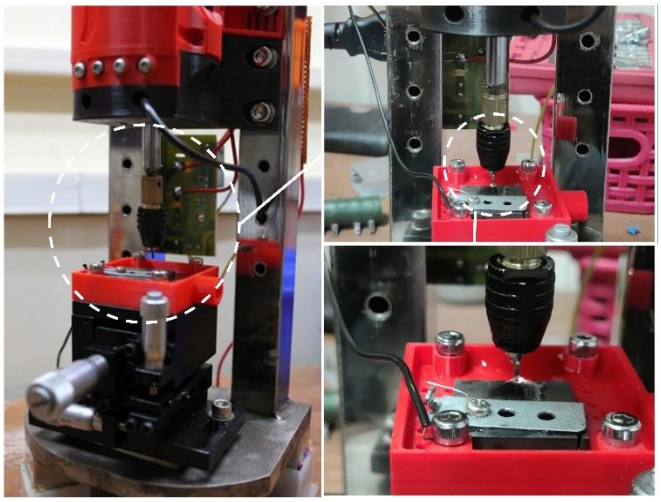
Abstract

The current research inspects the geometrical deviation of fabricated micro-hole attributes during the machining operation in MagLev micro-EDM. The dimensional errors and inaccuracy during manufacturing of micro-features impacts negatively towards the product quality and applicability on desired locations. The precise evaluation of micro-hole features has been executed through extensive assessment of hole overcut, circularity error and taper angle. The investigation has been performed using a tungsten micro-rod (ø = 500 µm) tool for machining Ti-64 alloy plate. The machining operation has been executed at a discharge voltage of 28V and current of 1.2A using deionized water as dielectric. The machining operations were performed at a duty cycle of 95% for every experimental repetition. The performance outcomes such as average hole overcut (OC), circularity error (CE) and taper angle (TA) have been acquired at variable dielectric flow rate. The machined surface has been inspected using a 3D surface profiler to acquire the roughness parameters at variable machining conditions. Furthermore, the analysis of voltage-current characteristics waveforms depicts stable and consistent pulses with negligible irregularities. It also illustrates the absence of arcing and short-circuiting phenomena leading to better energy utilization as compared to conventional system. Moreover, the SEM micrographs help analyze the machined hole characteristics by observing the crater orientation, distribution and surface anomalies.

Fig 1. MagLev micro-EDM operation using bipolar self-servo linear actuator mechanism



Mechanical Properties and Characterization of Hybrid Composite Reinforced with Natural Fibers

Arunkumar Bheemanalli

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Abstract

The evince of natural fibre reinforced composites in construction, aerospace, Electronic appliances & furniture works etc draws enormous attention of innovation in their category since the natural fibres are promising reinforcement for use in composites on account of its easy availability, renewability, low cost, bio-degradability, ease of fabrication process, creates sustainable environment, the much lower energy requirement for processing, high specific properties, and no health risk. Hence an attempt was made to develop a hybrid composite which is reinforced with natural fibers and their mechanical properties were studied. Also the characterisation of the fabricated hybrid composite was carried out for to study the fractured surfaces using SEM. Modal analysis was done to record the natural frequency of free vibrations and also to observe the damping ratios in terms of percentage.

The current work involves fabrication of hybrid composite by using Sisal and Roselle natural fibers as reinforcing elements or fillers with epoxy resin (LAPOX L12) and Hardener or catalyst (K6) by hand lay-up method with a 35:75 ratio. The potential combination of roselle and other fibers demonstrates its excellent mechanical properties on polymer hybrid composites. The effect of loose and Continuous fiber (CLFR) and woven mat fiber reinforced (WMFR) hybrid composite laminates were tested to evaluate the mechanical and physical performance exhibited by them. Water absorption test along with thickness swelling test is carried out and the data was recorded for reference. Finite elemental analysis was employed using ABAQUS module. The tensile strength and modulus of WMFR Composite (dry) reduced by 35% and 17% respectively And Compressive Strength and modulus of WMFR Composite (dry) reduced by 17% and 33% respectively. It was also notioced that Erosion rate of the samples increases as the increase of sand particles size, sand concentration, and Erosion rate is high in case CLFR (4.93%) composite. Water absorption is high in CLFR than WMFR composite. SEM analysis revealed that, fiber pull-out, de-bonding, matrix softening, fiber rupture, sliding tracks, debris, cracks were the reasons for the failure composites.

Simulation of Incremental Sheet Metal Forming of Titanium Alloy for Producing Complex Shapes

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Abstract

ISMF (incremental sheet metal forming) is a flexible and cost-effective manufacturing method that includes deforming a sheet metal with small incremental deformations. This article presents a study on the simulation of incremental sheet metal forming of complex-shaped parts made of a titanium (Ti-6Al-4V) alloy. Finite element analysis (FEA) using the ABAQUS® package was carried out. Linear brick elements were employed to simulate the process and investigate the effects of process parameters such as tool path, tool diameter, and step size on the resulting part geometry and quality. For a particular product, the optimal process parameters came out as follows: tool diameter of 10 mm, step size of 0.5 mm, and forming(wall) angle of 60 degrees in four stages. This study is part of a project for the manufacturing of complex-shaped components for the aerospace and biomedical industries.

Keywords: Incremental sheet metal forming, Finite element analysis, Complex shape, Linear brick element, Titanium alloy

Geometric Form Errors in Hollow Cylindrical Parts Manufactured by Powder Bed Fusion

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Abstract

Powder bed fusion (PBF) fabricated parts contain residual stresses and anisotropic mechanical properties due to rapid cooling rates and layered manufacturing. The residual stresses lead to part distortion. A stand-alone hollow cylindrical part may be preferred to be manufacturing in a build orientation with its axis vertical to minimize geometric distortions. However, when the cylindrical hole or protrusion feature is only a part of a component of complex geometry governing the build orientation, the feature may have its axis in any direction. In the present work, the geometric form error, namely the cylindricity error, is investigated in a hollow cylindrical part with its axis perpendicular to the build direction. To reduce the residual stresses and homogenise the microstructure necessary heat treatment is required. Numerical simulation is used to predict the distortions in the PBF fabricated parts and the effect of the heat treatment on it. These simulation helps in optimizing the process parameters of the PBF process and heat treatment cycle time. Necessary validatory experiments are conducted to verify the results of the simulation. A transient thermal model coupled with structural is used to predict the distortions of the PBF manufactured components. Geometric form errors of the hollow cylindrical components made by PBF with and without heat treatment are estimated both by numerical and experimental techniques and the results are compared.

Acknowledgments (if any)

The authors are grateful to acknowledge the financial support granted by DST/SERB, India.

Integrating System Engineering into the Design and Development of an Amphibious Surveillance UAV for Aerial and Underwater Missions

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Abstract

This paper presents a system engineering approach for the design and development of Unmanned Aerial Vehicles (UAVs) capable of performing surveillance operations in both air and underwater environments. The study covers the design steps, challenges, and solutions involved in the systematic development of UAVs for aerial and underwater missions, including simulation, mission planning, quality test control, and quality assurance. The research aims to explore the opportunities in the limited field of amphibious UAVs and to discuss the system engineering strategy for each event in the design, prototype, and maintenance of UAVs. UAVs have numerous applications in military systems, delivery services, emergency relief, and evacuation, particularly in the area of surveillance, including land and water bodies. However, there is limited research and development in the field of amphibious UAVs, which presents an opportunity for exploration. The study highlights the challenges associated with implementing this technology, such as the variation in parameters like drag, density, and other forces associated with water, which must be considered when designing UAVs for underwater surveillance. The paper discusses the benefits of using UAV technology in various disciplines and businesses, such as photography, distribution, agriculture, and surveillance. Rapid advancements in design and flying technologies, including faster control signals, smaller motors, and light processors, have significantly contributed to the evolution of UAV technology in recent decades. The research aims to provide answers to questions related to the implementation and analysis of the system engineering approach in UAV operation in air and underwater environments. The objectives of the study include implementing system engineering for UAVs, discussing status problems and solutions in designing UAVs, deriving a systematic approach to schedule each event in UAV development, studying the system engineering approach to select system requirements of sub-systems and all components of UAVs, and maintaining the UAV throughout its life cycle, including operation and evaluations. Overall, this paper emphasizes the importance of a system engineering approach in the design and development of UAVs for aerial and underwater surveillance operations, with a focus on addressing the challenges and exploring opportunities in the field of amphibious UAVs.

Study on Rheological Behavior of Alumina Ceramic Slurry for Direct Ink Writing Process

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Abstract

Colloidal processing of ceramics is being increasingly used for the consolidation of powders to produce the green body as it leads to better microstructural control during sintering. 3D- printing has gained attention for the fabrication of complex ceramic structures and surpassed traditional fabrication routes in terms of versatility, efficiency and design complexity. Several 3D-printing techniques have been currently being practiced for fabrication of ceramics. Direct ink writing technique (DIWT), a material extrusion based process which involves extruding concentrated ceramic suspension through a nozzle, is a promising method among all the 3D- printing techniques due to its low cost, design freedom and multifunctionality. The control of rheological properties of ceramic suspension is a highly challenging task to match the requirements for 3D Printing. The rheological behavior of ceramic suspension is greatly affected by particle size, particle shape, choice of binders. This study aims at rheological analysis of suspension using different concentration of binders and dispersants. In this research, Alumina suspension has been analyzed using varying concentration of Isobam and rheological parameters such as viscosity, storage modulus and loss modulus has been studied to determine feasibility for direct ink writing process. It is shown that the suspensions with alumina solid loading of 75 wt% at Isobam concentration of 0.8 wt% and alumina solid loading of 65 wt% at Isobam concentration of 1.0 wt% shows the required rheological behavior suitable for DIWT. The further work will be carried out by performing the 3D- printing of these suspensions in combination with various parameters such as air pressure, nozzle speed, nozzle diameter, extrusion width etc. and evaluation of the parts in terms of quality by performing mechanical tests. microstructural characterization and surface roughness measurements.

Keywords: 3D-Printing, Direct Ink Writing, Rheology, Alumina

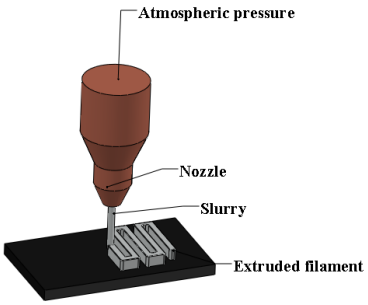

Fig. Schematic of Direct Ink Writing Process

Development and Evaluation of a Hybrid Agricultural Drone for Precision Farming

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Abstract

The application of crop protection materials is a critical operation in agriculture to meet the increasing demand for food production. However, the traditional method of manual pesticide spraying poses many harmful side effects on personnel involved in the process, ranging from mild skin irritation to severe health problems such as birth defects, tumours, genetic changes, blood and nerve disorders, endocrine disruption, coma or even death. To overcome these issues, smart farming solutions, including the use of drones, are being considered for agriculture applications. UAVs are highly capable and their use has expanded across all areas of agriculture, including pesticides and fertiliser spraying. This study focuses on the design and development of a drone-mounted sprayer for pesticide spraying. The drone-mounted sprayer mainly consists of a BLDC motor, LI-PO battery, pesticide tank, and supporting frame. Four BLDC motors were mounted to the quadcopter frame to lift a payload capacity of 5kg. A generator was used to supply the necessary current required for the propulsion system. A fluid tank was used to hold the pesticide solution, and a 12V DC motor water pump was used to pressurise the spray liquid, which was then sprayed through three nozzles. The entire operation of the drone-mounted sprayer was controlled with the help of a transmitter at ground level. The study evaluated the uniformity of the spray by varying the height of spray and operating pressure. The results showed that the spray uniformity increased with an increase in the height of spray and operating pressure. This drone-mounted sprayer technology is especially useful in situations where human involvement is not possible for spraying of chemicals on crops. Moreover, this technology greatly helps small farming communities in reducing the cost of pesticide application. In conclusion, this study presents a design and development approach of a drone-mounted sprayer for pesticide spraying in agriculture. The use of such technology eliminates the harmful side effects of traditional manual pesticide spraying on personnel, thus improving safety and productivity. The results of this study indicate that drone-mounted sprayers have a promising future in agriculture applications and can contribute to the growth of the farming industry.

Optimizing Design of a Vertical Take-Off and Landing (VTOL) Blended Wing Body Aircraft through Modeling and Simulation

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Abstract

This paper focuses on the modeling and simulation of a Blended Wing Body (BWB) with VTOL capabilities and highlights the crucial parameters that should be taken into account during the design process. VTOL aircraft are those that can take off, hover, and land vertically, and can include fixed-wing aircraft, helicopters, and other aircraft with powered rotors such as cyclo-gyros and tilt rotors. Some VTOL aircraft can operate in multiple modes, while others, such as certain helicopters, are limited to VTOL due to a lack of landing gear that can handle horizontal motion. VTOL is a subset of V/STOL, which stands for vertical or short take-off and landing. A Blended Wing Body (BWB) is a fixed-wing aircraft with a smooth blend between the wing and body structures, creating a seamless transition between the two. This design reduces the wetted area and associated form drag commonly found in conventional wing-body junctions. BWB aircraft may have a wide aerofoil-shaped body, allowing the entire craft to generate lift and reducing the size and drag of the wings. Some BWB designs may be tailless. This type of aircraft offers several benefits, including increased payload capacity and a 27% reduction in fuel consumption per seat, thereby reducing total operating costs. The lift-to-drag ratio is also improved by 15-20%. The objective of this paper is to develop a CAAD model and mathematical model for a BWB with VTOL capabilities and to identify the key parameters that should be taken into consideration during the design process. The CAAD model will enable accurate simulations of the BWB's flight characteristics, while the mathematical model will provide a comprehensive understanding of the aircraft's behavior under various operating conditions. The paper also discusses the challenges associated with designing a BWB with VTOL capabilities, such as the need for a reliable lift system, optimal weight distribution, and efficient propulsion. Overall, this paper contributes to the ongoing development of VTOL aircraft technology, with a focus on BWB designs. The results of this study will be of interest to researchers, engineers, and manufacturers working in the field of aviation, as well as to those interested in the broader applications of VTOL technology

Spark Plasma Sintered Sic-Zrn Composites for High Temperature Sliding Wear Resistance Applications

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Abstract

High temperature wear resistant and conductive SiC ceramics with (10 to 30 vol%) ZrN reinforcement were fabricated using spark plasma sintering at the lowest sintering temperature of 1800 ℃. The mechanical characteristics, such as hardness, decreased with ZrN content. To assess the tribological performance of sintered SiC-ZrN composites, dry reciprocating sliding wear tests against SiC ball were investigated at room and high temperature (600 ℃). The composites exhibited low friction and wear at high temperatures compared to room temperature. The variation in the composites' mechanical and tribological behavior is explained in terms of the microstructural properties.

Keywords: SiC Composites; Spark plasma sintering; Sliding Wear; Electric discharge machining;

Acknowledgments

Science and Engineering Research Board (SERB), India (project No. CRG/2021/004948) is acknowledged for the partial support.

Characterization of Functionally Graded Ni Based EWAC-TiB2 Cladding on Maraging Steel Using Microwaves

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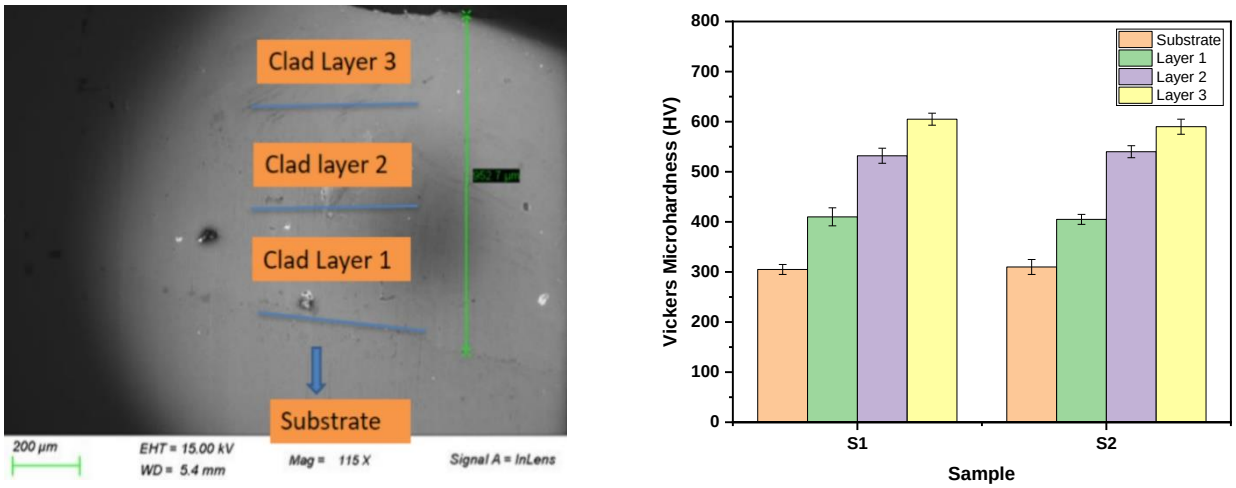
Abstract

Functionally Graded Clads are tailored layers of materials with gradually changing properties along thickness of cladding. In the present work we developed Ni based EWAC-TiB2 FGC comprising 100% EWAC, 90% EWAC + 10% TiB2 and 80% EWAC + 20% TiB2 as 1st, 2nd and 3rd layers respectively, using microwave hybrid heating technique in a domestic microwave applicator operating at 900 W power, 2.45 GHz frequency for a duration of 480 s. The average thickness of FGC was ~ 900 µm with each layer varying in the range of 200 – 300 µm. Functionally graded clads were developed earlier using microwaves in multiple steps which causes sharp boundaries between two layers and eventually stresses. The focus of present work was on developing all the three layers of functionally graded clads in single step processing. Microstructural investigations as shown in Fig. 1 (a) clearly indicate good metallurgical bonding between all the layers of clad and it is also evident that dilution of first clad layer with substrate surface is achieved. The Vickers microhardness profile of the FGC layers obtained at a load of 200 g for 10 s dwell time showed an increase in hardness value with an increase in the amount of reinforced TiB2 particles. A typical profile of the microhardness of the layer is shown in Fig. 1 (b).

Fig. 1. (a) SEM micrograph of metallurgically bonded thı (b) ered FGC developed on maraging steel substrate, (b) Typical Microhardness profile of the layers.



Keywords: Microwave hybrid heating, FGC, maraging steel, Ni based EWAC and TiB2, microhardness.

Investigation on Multi-Tool Machining of Ag Using µ-EDM Process

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Abstract

Machining of micro-holes, micro-channels, and micro-textures with multiple numbers is significant in productivity improvement and cost-effective production. Micro-Electro Discharge Machining (µ-EDM) is a thermal erosion process to machine such features with required accuracy and precision. The only constraint is it is a time-consuming process. The current study focused on machining multiple micro-square holes using in-house developed µ-EDM. A silver plate 0.6 mm thick is used as the workpiece electrode, and the customized copper electrode comprises square pins ranging from 1 pin, 2 pins, …10 pins, each size of 385 µm x 385 µm with 0.7 mm pitch. The tools are fabricated using the Wire-EDM method, with the anode as a copper sheet of size (200x200x0.38) mm, and the cathode as a brass wire of Ø 0.25 mm. A total 10 number of experiments are performed with fixed process parameters of current as 1 A, Voltage as 30 V, capacitance of 470 µF, Ton and Toff as 80 µs, and 120 µs with 1 to 10-pin electrodes. The responses like machining time, material removal rate (MRR), tool wear rate (TWR), and overcut are analyzed. The analysis concluded that it could be possible to machine up to 7 holes at a time with the same available power. Further, the power is insufficient for machining with 8 to 10 pins; it requires little more power. The number of pins increases, MRR and machining time increase, and overcut and TWR decrease. The research finding shows that employing multiple microelectrodes enhances the µ-EDM production rate of multiple holes in one stretch.

Keywords: Micromachining, Micro-EDM, MRR, TWR, and overcut

Figure 1 shows the fabricated tools used in the fabrication of multiple holes. These tools are fabricated using the Wire-EDM process

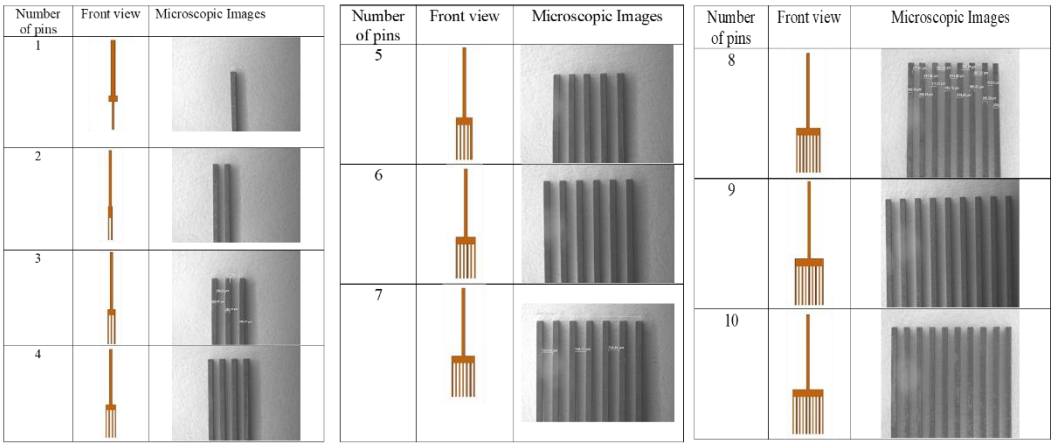

Figure 1. Fabricated multi-pin electrodes using Wire-EDM

References

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Analysis of Machining Characteristics Using Silica Mixed Dielectric in MagLev EDM

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Abstract

Currently, powder mixed dielectric application in electro-discharge machining (EDM) is an emerging field to improve machining efficiency and achieve better surface quality along with surface modification. In the current research, the machining characteristics of Inconel 625 alloy has been investigated using silica-mixed deionized (DI) water as dielectric in Maglev EDM. The newly developed Maglev EDM uses an electromagnet and two permanent magnets to provide better discharge gap control than conventional servo mechanism. The machining operation was conducted on an Inconel 625 alloy workpiece (15mm × 15mm × 3mm) using a cylindrical brass tool (ø = 3.3 mm) with 20g/l concentration of silica-mixed DI water dielectric. Performance measures such as workpiece erosion rate (WER), electrode erosion rate (EER) and roughness parameters were evaluated at variable machining conditions. The machining operations were performed at a duty cycle of 95% for every experimental repetition. Furthermore, the analysis of voltage-current characteristics waveforms depicts stable and consistent pulses with negligible irregularities. It also illustrates the absence of arcing and short-circuiting phenomena leading to better energy utilization as compared to conventional system. Additionally, the obtained results show a maximum average WER of 1.153 mg/min and a maximum average EER of 0.102 mg/min at discharge voltage (26V). Similarly, a minimum average WER of 0.717 mg/min and a minimum average EER of 0.066 mg/min at discharge voltage (20V). Lowest roughness (Ra) of 2.134 µm was achieved at 20V and highest Ra of 3.462 µm was achieved at 26V. Moreover, the SEM micrographs help analyze the machined workpiece's surface characteristics by observing the surface anomalies such as micro-cracks, recast layers, blow holes, and embedded debris for respective bio-dielectrics. The elemental analysis of machined workpiece surface through EDX reports depicts the recast formation and material migration phenomena from the tool and the dielectric.

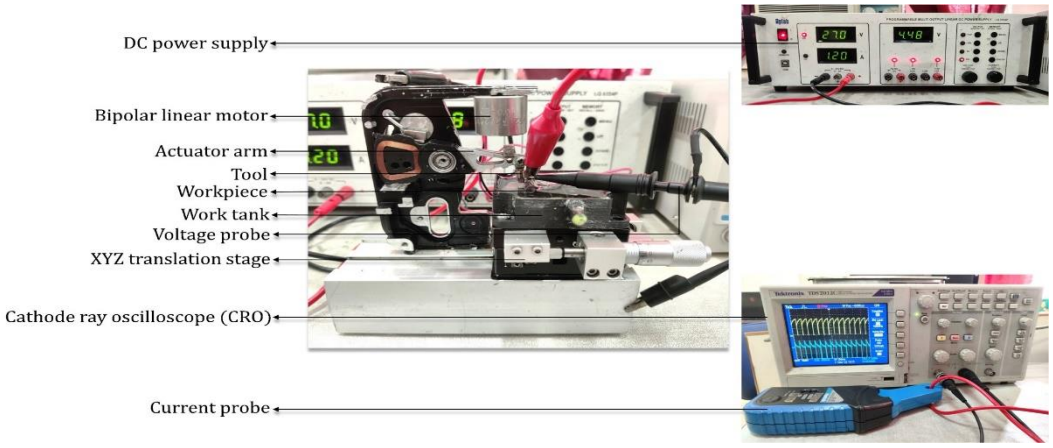

Fig. 1 Maglev EDM machining setup with assisted components

Evaluation of Machining Performances of Inconel X-750 in the Electrical Discharge Machining Process Using Cocoso Method

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Abstract

Inconel X-750 is a nickel-chromium superalloy that is well known for its outstanding mechanical properties, exceptional corrosion resistance, and oxidation resistance up to 700 oC. Inconel X-750 is capable of resisting chemical corrosion in both oxidizing as well as reducing industrial environments. Due to these exceptional properties of Inconel X-750, it is widely used in rocket engine chambers, nuclear power plants, gas turbine engines. In this research article, the machining of Inconel X-750 was investigated in SU-357 Daphne cut HL 25-S dielectric fluid using a copper tool electrode in the electrical discharge machining (EDM) process. The performance characteristics such as material removal rate (MRR), surface roughness (SR), and tool wear rate (TWR) were investigated by considering peak current, pulse on time, duty cycle, and servo voltage as process parameters. In order to plan the experiments, orthogonal array was considered. Recently developed combined compromise solution (Co-Co-So) method was implemented for multi-objective optimization of machining performances.

Effect of Process Parameters on Mechanical Performances of 3D Printed ABS Parts

Dipayan Chakraborty

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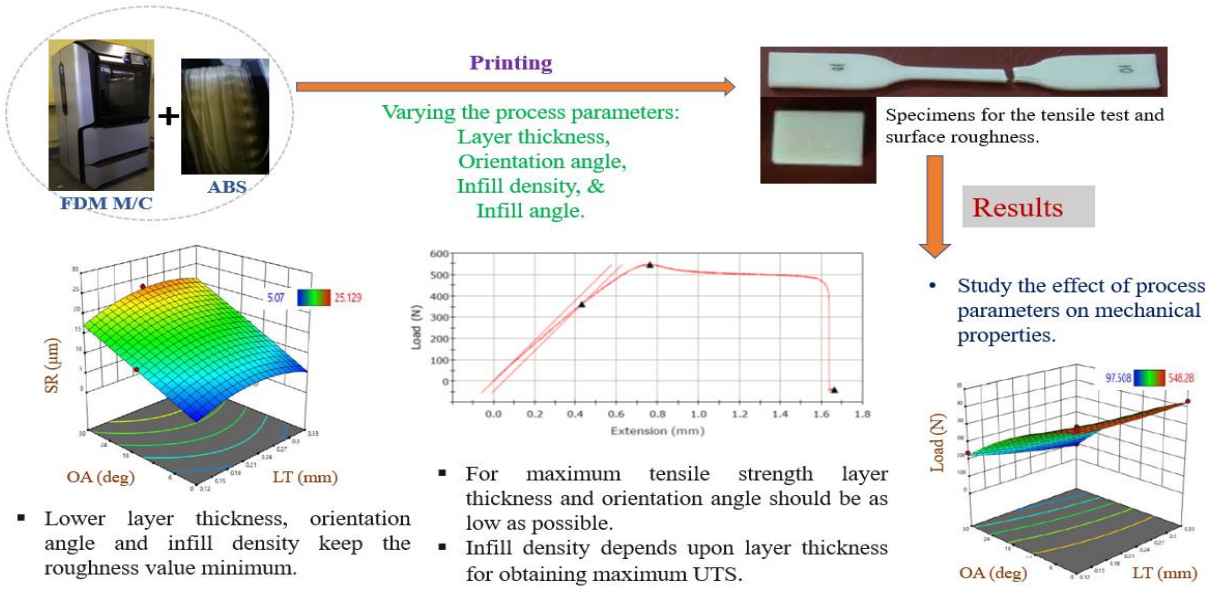
Graphical Abstract



Abstract

Fused deposition modeling (FDM) is one of the earliest methods in additive manufacturing history. Due to the affordable printing method, it is one of the most popular AM techniques worldwide for processing polymers and their composites mainly. FDM is an extrusion-based AM technique through which a component is fabricated by layer-by-layer deposit of molten material. However, choosing the best process parameters during printing is essential to make parts with the best qualities, such as mechanical strength. The paper has considered response surface methodology (RSM) for randomizing the process parameters such as layer thickness, orientation angle, infill density and infill angle to figure out their effect on the mechanical properties of FDM printed ABS parts. It has been found that the highest tensile strength is obtained at the lowest layer thickness (0.12 mm) and orientation angle (0̊) and highest infill angle (70̊). Yet in order to achieve higher tensile performances, infill density depends on layer thickness. For, minimum surface roughness, layer thickness, orientation angle and infill density should be as low as possible.

Keywords: Fused Deposition Modelling (FDM), Process Parameters, Layer Thickness, Orientation Angle, Infill Density, Infill Angle, Mechanical Characterization.

Additively Manufactured Ceramic Lattice Structures: Fabrication, Challenges, and Applications

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Abstract

Ceramic materials are used in the manufacturing of medical devices, aircraft components, and mould casting because of its high melting point, excellent compression strength, and high heat resistance. Ceramics are very difficult to manufacture by conventional techniques because of its hardness and brittleness, manufacturing difficulty also make it costly, fabrication of ceramic lattice structures (CLS) are even more difficult, but their extraordinary properties are attracting the researchers to do work in this field. CLS reduce the mass of the manufactured item which optimize the materials and cost for the required functionality. CLS fabrication by the additive manufacturing (AM) have too many challenges i.e., mixing of ceramic oxide powders into photosensitive resin (PSR), as the weight percentage (or the volume percentage) of ceramic powders in mixture increases, viscosity increases which affects curing of PSR. To get the sufficient strength, sintering of AM fabricated parts are necessary, this also shrinkage the volume of the parts. In this paper, the additive manufacturing (AM) processes and their steps by which CLS are being made, have been reviewed and also the previous experimental and simulation research works related to CLS in which static and dynamic mechanical behaviour of different CLS have been highlighted.

Tribological and Corrosion Characteristics of a Novel Al-Fe-Cr-Ti alloy processed by Laser Powder Bed Fusion

Vedanth Bhatnagar

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Abstract

Additive manufacturing has enabled the production of parts with complex geometries in addition to the ability to tailor material properties. Laser powder bed fusion (LPBF), as a part of metal additive manufacturing modalities, is a rapid solidification process that is suited to manufacture a novel Al-Fe-Cr-Ti alloy. The 'as printed' alloy, as characterized by optical microscopy, scanning and transmission electron microscopy (SEM and TEM), possesses chromium and titanium rich centers which act as heterogeneous nucleation sites for the face-centered cubic aluminium matrix. Besides a fine-grained microstructure, nanometric particles of an icosahedral quasicrystalline (iQC) phase are also present in the alloy. Tensile tests performed on miniature specimens revealed good yield strength and ultimate tensile strength at both room temperature and high temperature (250°C). The microstructure was further analyzed using thermodynamic simulations and calorimetric studies. The alloy exhibits a high degree of thermal stability upto 100 h at 250°C and 400°C, evaluated via Vickers microhardness measurements. Further, the alloy exhibits significant resistance to sliding wear, which is attributed to the hard iQC phase particles. Potentiodynamic polarization tests performed on the alloy reveal a good resistance to corrosion in NaCl solution. The excellent thermal stability, corrosion and wear resistance of this AM processed alloy make it suitable for use in aerospace applications.

Acknowledgments

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Processing and Fracture Resistance of ABS-TPU Multi-Material 3D Printed Parts

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Abstract

Complex-shaped parts are economically made using additive manufacturing. However, critical polymer components manufactured through layer-by-layer techniques are susceptible to failure at the interface. Additively manufactured components fabricated under different process conditions can behave differently due to various types of inhomogeneities possible during processing. Multi-material product design and development is a new way of building high-performance parts and the fused deposition method permits the development of the pars with multiple materials. The effect of the built interface in printed Acrylonitrile butadiene styrene (ABS) parts integrated with TPU has been studied with an effort to improve resistance to fracture at selective places. In this article, double cantilever beam specimens were prepared according to ASTM D5528-13 and were subjected to Mode I failure load. The interface energy strongly depends on the interlayer bonding mechanism between two raster beads. The effect of Thermoplastic polyurethane (TPU), with higher strain to fracture, has been tested by architecting the material amidst ABS through an optimised design. The fracture resistance of the multi-material samples is reported based on the standard DCB tests.

Acknowledgements

This research work is carried out with support from the Institute of Excellence Grant from MoE GoI, 'Architected Materials and Design for Next Generation Electric Vehicle and High-Speed Railway', and from the Centre of Excellence Grant for Application of Coir Exclusively or in Combination with Other Natural Fibres' established by Coir Board, GoI.

Solution Precursor Plasma Sprayed (SPSS) HAp/Titania Coating for Biomedical Applications - Fretting Damage Analysis

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Abstract

Solution precursor plasma spraying (SPPS) is a new deposition technique that is used to obtain bioactive coatings onto metallic implants for orthopaedic and dental applications. This method employs powders with sizes on the micron and submicronic scale in the form of solution and offers several advantages over other spray processes, such as resolving the problems of particle agglomeration and sedimentation and providing better control over the morphology and chemistry of the coating. It is important to assess the durability of the coatings and the current work is focussed on this direction. The mechanical properties of the coating, such as its porosity, hardness and indentation modulus, were estimated and analysed. The present investigation reports the wear characteristics of solution precursor plasma sprayed hydroxyapatite (HAp)/Titania on a titanium substrate with a weight percentage of 50:50 which is one prime requirement for implant applications. In order to gain an understanding of the micro mechanisms involved in fretting wear associated with the coating when it is used for orthopaedic application, experiments were conducted in a laboratory room atmosphere and lubricated condition using a variety of normal loads while maintaining a constant displacement amplitude. The porosity and the hardness values of the SPPS coating are higher than suspension plasma sprayed (SPS) coated HAp/titania coating. The wear test demonstrated, variation in fretting behaviour as the friction logs changes from gross slip to partial slip condition in the case of coated sample as load increases. Wear debris collected from the fretting wear test was observed to be in different shapes and ranges within 10 microns. Optical and scanning electron microscopes are used to examine the fretting damage and find the dominant wear mechanism.

Parametric Optimization and Performance Analysis of Adhesive Bonding of Automotive Steel

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Abstract

In the present study, adhesive bonding of automotive grade steel has been studied using an epoxy resin-based Araldite adhesive. Adhesive bonding of steel is largely affected by surface roughness, overlap length, bond line thickness, curing time and curing temperature. However, all the joint sample has been cured at room temperature for 72 hours. The design of experiments (DOE) method is being used in this study to create a reliable adhesive bonding process. Conforming to the experimental design, the surface roughness, bond line thickness, and overlap length are altered to examine their effects on lap sear strength and shock absorbing capacity. In addition, an attempt has been made to model these three response variables using the response surface technique (RSM). Analysis of variance (ANOVA) is utilised to analyse the significance of machining parameters. The test findings support and validate the established RSM model. Adherend surface has been characterized by measuring contact angle and surface roughness to study the wettability effect on bond strength. Further, SEM analysis have been performed to understand the failure mechanism of the bonded joint.

Keywords: Adhesive bonding; Automotive steel; Optimization; RSM; ANOVA; Box-Behnken design.

High Speed Drilling of Woven GFRP Composites : Optimization of Machining Parametrs

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Abstract

In modern manufacturing, High speed machining is a key method to ensure high production rate and quality leading to lower manufacturing costs. Drilling of fibre reinforced composites (FRP) is a challenging task, Conventional drilling was carried out at lower cutting speeds. However, high speed drilling (HSD) in woven glass fibre reinforced polymer composites (W- GFRP) laminates has not been explored substantially. Present research shows an experimental investigation by means of Full Factorial Design (FFD) performed on W-GFRP using K20 carbide drill by varying the HSD process parameters such as cutting speed (200, 250 and 300 meter per minute), feed rate (100, 200 and 300 milimeter per revolution) and drill point angle (1060, 1180, 1300) to evaluate optimum HSD conditions, for Parameters like Thrust force (TF) and torque. Analysis of variance (ANOVA) was carried out for TF and torque. Their percentage involvement in HSD were determined. Particle swarm optimization (PSO) was used to find and suggest best optimum drilling conditions for minimum damage during drilling. Single objective optiomization for minimum TF and minimum torque were 8.169677 N and 0.078425 N m yielded.

Keywords: High Speed Drilling (HSD); Thrust force (TF); Torque; Analysis of Variance (ANOVA); Particle swarm optimization (PSO);

Characterization of A 3D Printed Architected Composite for Enhanced Properties

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Abstract

Architectured composites are the composites where the unique designare used to achiveve the desired properties in the conpomposite. Recently, developing architected composites have drawn attention due to the tunability of properties they offer as well a wide range of designs that facilitate to develop "materials by design". the architectures often inspired by different patterns, and, many of them are taken from structures observed in biological materials. These architected materials enable improving the properties of the base material or often introduce competing properties that are otherwise poor in the material. For example, introducing weak interfaces in glass, CFRP enhanced the toughness of the glass and CFRP, that are otherwise brittle in nature [1,2].Topological interlocking architectures have resulted in enhanced energy absorption and fracture toughness than their monolithic counterparts [2,3]. Wang et al. [4] showed the effect of hierarchal fractal interlocking in increasing the toughness of the composite. Even the competing properties such as simultaneous stiffness and damping, stiffness and toughness which generally comes with a trade off in the traditional material can be achieved by use of architectured composite [5].

This work considers a novel architctected composite designed to achieve simultaneous stiffness and damping in the material. The structure is based on a hexagonal arrangement of gear-like building blocks that are interconnected by trianulgular shaped with a thin layer in between them. The gear shaped and triangular shaped building blocks are of a stiff material that contributes to the stiffness of the composite through the interlock and the thin layer, made of a soft material, contributes to the damping of the composite. The suture joint type interlock helps to retain the tensile stiffness as well as allow energy dissipation at the soft layer. In addition, the hexagonal arrangement results in planar isotropy in the propetirties.

In this work, the architected composite is fabricated by 3D printing with polylactic acid (PLA) as the stiff material that makes the gear and triangular shaped building blocks and thermoplastic polyurethane (TPU) as the soft material that fills in thin interlayer. PLA provide stiffness and PU provides damping properties to the composite. Experimental characterization is performed under tensile load and and cyclic load to evaluate the tensile stiffness and damping, respectively. The performance of the composite for simultaneous stiffness and damping is asseses with respect to the Wang-Lake line using the experimental data. Finite Element Analysis (FEA) is used to predict the properties and compare with the experimental measurements. Detailed results will be presented in the paper from the ongoing works.

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Fabrication of Delonix Regia Based Natural Fiber Reinforced Polymer Composites

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Abstract

The present experimental works aims at learning about the various materials which can be used as the natural fibers in the preparation of the composite materials. Also, this work focusses on the suitable fabrication method which can be used to fabricate the composite. And, the selection of the suitable matrix materials from the different materials have been studied.

The different composition of the fiber (reinforcement) and the resin (matrix) can be analysed for the suitable requirements.

Composite A (10% Delonix Regia + 90% Epoxy Resin), Composite B (20% Delonix Regia + 80% Epoxy Resin) and Composite C (30% Delonix Regia + 70% Epoxy Resin) were fabricated by using the Hand Lay method.

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Tool Based Electrochemical Polishing of Additively Manufactured Metallic Components

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Abstract

Additive manufacturing (AM) has been proliferating in the Bio-medical industry for its innate ability to fabricate customized biomedical implants with complex geometry and patient-specific features. Despite its unique attributes, such as mimicking natural bone architecture and rapid generation of freeform features, the high surface roughness of the AM part affects biocompatibility, wear performance, fatigue life, and corrosion resistance of the implant and mandates post-processing. An implant is majorly composed of two types of surfaces, one that integrates with the bone and tissues (rough surface of Ra 1 to 2 µm for osseointegration) and an ultra-smooth surface that slides against another (bearing surface of Ra lessthan 100 nm), which makes post-processing challenging for an implant [1]. Mechanical finishing processes, such as sandblasting, shape adaptive grinding, and magnetorheological finishing, result in residual stress and decreased corrosion resistance [2]. Thermal polishing processes such as laser polishing, electron beam irradiation, and laser peening induce thermal stresses, heat-affected zone and micro-cracks [3]. Though chemical polishing is a non-contact and non-thermal process, the material removal rates are significantly less. Electrochemical polishing (ECP) has unique attributes, such as its non-contact nature, no thermal and residual stress, uniform polishing, and improved corrosion resistance, making it the most attractive process for surface finishing of AM parts. The conventional ECP uses acidic electrolytes, which are not eco-friendly and ineffective in removing partially melted and unmelted particles from the AM component's surface and is incapable of generating differential surface finish. ECP of the surface with a tool localizes the electric field and attains a smooth surface by removing the asperities using ecofriendly electrolytes and can also generate a rough surface by controlling process parameters. This work presents a tool-based ECP process using eco-friendly electrolytes to reduce the surface roughness of bio-compatible 17-4 PH stainless steel fabricated by the atomic diffusion additive manufacturing (ADAM) technique [4]. An experimental setup is developed, and a diamond-lapped flat cylindrical tool is fabricated for the ECP of AM surface. The average surface roughness (Ra) is reduced from 11.026 µm to Ra of 0.45 µm over a polishing time of 50 sec. For comparison, the experiments are repeated for milled and rolled stainless steel 304 surfaces with an initial Ra of 1.642 µm and Ra 3.512 µm, respectively. An ultrafine surface finish with Ra of 0.086 µm and Ra 0.085 µm is achieved over a polishing time of 50 sec for milled and rolled surfaces, respectively.
A 2D tool-based ECP numerical simulation is developed in COMSOL software to analyze process parameters such as inter-electrode gap (IEG), voltage, tool diameter and electrolyte conductivity. The final anode shape (polished surface) is predicted considering the initial roughness data captured from the real AM fabricated part and validated experimentally and is observed to be in good correlation.

Acknowledgments

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Numerical Analysis on Friction Stir Processed Nickel 200 Alloy Plate with Al2O3 Reinforcement

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Abstract

The present work focuses on the Multiphysics modelling on friction stir processing (FSP) on Nickel (Ni) 200 workpiece with Al2O3 particle intermixing. The three dimensional (3-D) heat transfer analysis coupled with fluid flow physics used to estimate the temperature rise and fluid flow during FSP of Ni matrix with Al2O3 reinforcement. The COMSOL Multiphysics V5.3a software used for computing the model. The Al2O3 domain of size 1 mm width and 1.2 mm depth is model inside the Ni 200 plate of 3 mm thick. The level set (LS) method is used to established the mixing between two fluids (Ni 200 and Al2O3). The higher temperature is recorded on the tool leading edge due to high pressure zone forming at the tool tip/workpiece interface region. As the tool rotated, the Al2O3 particles moved to the Retreating side (RS) and when the tool moved forward, the particles separated from it and settled on Advancing side (AS). The particles near the shoulder surface are more concentrated due to the shoulder strong influence.

Keywords: Ni 200, Particle reinforcement, Fluid flow, Thermal analysis, Level set method.

Numerical And Experimental Study on the Effect of Tool Pin Profile of Friction Stir Additive Manufactured AA6061/AA7075 Joints

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Abstract

The current study deals with the effect of different tool pin profiles (square, tapered, and tapered threaded) on the local heat generation, material flow velocity, and strain rate of AA6061/AA7075 joints fabricated by the friction stir additive manufacturing (FSAM) process. Comsol multiphysics software that utilizes a 3D coupled thermomechanical modelling is used to compare the local properties at the tool-workpiece interface in the stir zone (SZ). The numerical study reveals appreciable material mixing, flow velocity, temperature generation, and strain rate in the case of tapered threaded pin profile. The experimental study also shows noticeable material mixing and interfacial bonding for AA6061/AA7075 joints fabricated using a tapered threaded pin profile. Interfacial microstructural properties were evaluated using an optical microscope (OM), scanning electron microscope (SEM), and electron backscattered diffraction (EBSD) analysis. EBSD analysis reveals the presence of fine-grain microstructural features in the SZ of the AA6061/AA7075 joints for tapered threaded pin profile. Thread pitch on the tool pin profile allows sound intermixing of dissimilar aluminium alloys in the SZ that promotes the generation of high heat input leading to continuous dynamic recrystallization (CDRX) in the region. The presence of a higher fraction of high-angle grain boundaries and finer grain size in the SZ leads to higher microhardness in this region.

Keywords: FSAM process, Material flow, Strain rate, Microstructure, Aluminium alloys.

Fatigue Performance of Wire Arc Additive Manufactured Aluminum Alloy 5356

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Abstract

Additive Manufacturing (AM) is the modern manufacturing process to produce components having intricate shapes and complex geometries that are challenge in other traditional manufacturing process. Wire Arc Additive Manufacturing (WAAM) is one among the AM techniques, which enables the building of near net-shape components. In this study, AA5356 aluminum alloy wire with a diameter of 1.2 mm is used as feedstock and electric arc as the heat source to deposit the melt on base plate. Molten metal wire is deposited layer upon layer by using arc welding technique. WAAM is a special and unique process to manufacture complex parts without much of tooling required or with less material wastage. In this study, the fatigue behavior of Wire Arc Additive Manufactured AA5356 alloy is investigated under a range of symmetrically applied loads below the yield strength with constant frequency and amplitude. Using a Fronius CMT welding machine with synergic parameters such as Voltage, Current, Stand-off-distance, travel speed, wire feed, etc, multiple layers of AA5356 were deposited onto a 15mm base plate of the same material. Optical microscopy has been used to inspect the built-up layers for observing grain size and orientation and further to investigate inclusions. WAAM built specimens displayed tensile strength up to145 MPa with 12% elongation. Higher surface and core hardness about 60HV 0.5 were observed as a result of finer microstructure produced due to intrinsic thermal processing. Fractography technique was employed to study the fracture mechanism during tensile testing. The WAAM built part display up to 65% of tensile strength in the longitudinal direction and provide satisfactory endurance at 40% of yield strength during fatigue tests.

Influence of Hybrid Reinforcement on Microstructure and Mechanical Properties of Magnesium Alloy Nanocomposites: A Study

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Abstract

In this paper, the results of a recent study on magnesium alloy (AZ91) reinforced with 1.5 % (weight percent) of alumina (Al2O3) and 0.5 % (weight percent) of ZrO2(zirconium dioxide) nano particles (less than 50 nm) is highlighted and discussed. The magnesium alloy nanocomposites were developed using the stir casting technique and under the protection of flux material. When compared with the monolithic magnesium alloy, microstructural characterization of the engineered nanocomposites revealed a near uniform dispersion of the fine nanoparticles through the magnesium alloy metal matrix coupled with an observable reduction in grain size. Addition of nanoparticles contributed to enhancing both the micro-hardness and ductility of the engineered composites. Both scanning electron microscopy observations and X-Ray diffraction analysis were used to systematically characterize the microstructural intricacies of the as-prepared composites. A contribution of the two chosen reinforcing nanoparticles to strengthening of the composite microstructure at the fine microscopic level is neatly documented and appropriately discussed. Microhardness of the AZ91 alloy was found to increase from 61.4 MPa (for the unreinforced alloy) to 86.680 MPa for the hybrid nano composite. Addition of reinforcing alumina (Al2O3) nanoparticles resulted in an observable refinement in grain size while addition of zirconium dioxide (ZrO2) nanoparticles contributed to increasing the microhardness. Overall, addition of the hybrid reinforcement mixture resulted in a noticeable improvement in mechanical properties by ensuring an acceptable balance of strength and ductility of the developed nanocomposites.

Keywords: Magnesium nanocomposite, reinforcements, nanoparticles, microstructure, mechanical properties

Influence of Friction Stir Processing on Microstructure and Mechanical Properties of as-cast Magnesium Alloy Nanocomposites

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Abstract

In the present study, AZ91-xAl2O3 (x =1, 1.5, and 2 wt. %) nanocomposites were prepared using the stir casting method, and then friction stir processing (FSP) was carried out to improve the casting defects. Microstructure reveals significant grain refinement with dense distribution of Al2O3 particles towards the retreating and advancing side of the stir zone. Due to the severe plastic deformation of FSP, the β-Mg17A12 precipitates are fragmented into finer particles distributed uniformly in the stir zone. The microhardness of FSPed AZ91-xAl2O3 nanocomposites increased on the retreating side and decreased on the advancing side of the stir zone. The tensile strength of FSPed AZ91 nanocomposites increases with an increase in Al2O3 content. The maximum tensile strength of 200 Mpa was achieved for 2% Al2O3 nanocomposite compared to FSPed AZ91 alloy (87 MPa). The fracture surface of the developed AZ91 nanocomposites revealed voids initiation at the matrix-particle interface regions.

Performance Evaluation of Multi-Cylinder Diesel Engine Fuelled with Blends of Methyl Ester of Used Vegetable Oil

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Abstract

Bio-diesel (Used Vegetable Oil Methyl Ester) which is derived from triglycerides by transesterification has attracted considerable attention during the past decade as a renewable, bio-degradable and non-toxic fuel. Several process for bio-diesel fuel production have been created, among which transesterification using alkali as catalyst gives optimum conversion of triglycerides to their corresponding methyl ester. A variety of edible and non-edible oils are considered for bio-diesel production. In the present work, used vegetable oil bio-diesel purchased from authorized agencies, and their important physical and chemical properties have been tested and compared. It could be found that these properties are approximately similar to petro-diesel fuel and suitable to use in diesel engine. Also petro-diesel is purchased from local authorized agency and used before and after the biodiesel for verifying the engine condition due to bio-diesel. The bio-diesel from waste vegetable oil is used in a Mahindra and Mahindra Turbo Charged make four stroke, four cylinders and water cooled direct diesel engine in pure and blended form without any much modification in diesel engine design or fuel system. The performance characteristics of an engine have been studied with different proportions of bio-diesel and petro-diesel. The power, torque, and brake thermal efficiency using bio-diesel are found higher at various load conditions than the petro-diesel; however specific fuel consumption is found slightly more. The bio-diesel blend B-20 shows better performance and lower emissions than that of neat diesel and other blends. The blend B-25 gives the lowest specific fuel consumption of 0.27 kg/kW.h at full load as compared to all other blends. At full load, B-25 gives the lowest NOx emission which is 2.52% less compared to neat diesel (B-0).

FDM Parametric Analysis for Determining Compressive and Impact Strength of PEEK using Multicriteria Decision Making

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Abstract

The development of three dimensional objects using fused deposition modelling (FDM) has been researched since quite a few years from now, and also fundamentally started using in various sectors for example automobile, medical, aerospace, bio-medical, food, pharmaceutical etc. The most commonly used thermoplastic materials for FDM 3D printing include PLA- poly (lactic acid), ABS (acrylonitrile-butadiene-styrene), PETG (glycol-modified PET), Nylon, TPU (thermoplastic polyurethane), and others because of their availability, affordability and providing range of valuable properties. However, with the evolvement of new and exciting materials such as high-grade polymers (HGPs) over the periods, has posed a many challenges to the full-scale implementation of existing fused deposition modelling (FDM) and other 3D printing technologies because of the compatibility issues with the existing 3D printing machines setup and its corresponding processes. In some cases, new materials may require modifications to the printing hardware, software, or settings in order to achieve the desired results. This can be time-consuming and expensive, especially for companies that rely on 3D printing for their manufacturing processes. In addition, the development of new materials can also lead to concerns about quality control and consistency. Each material may require its own unique set of parameters and processing conditions, and these parameters can be difficult to optimise and control. This can lead to variability in the final product and can make it challenging to produce parts with consistent quality. Indeed, it is difficult to consider specific FDM parameters to obtain optimum mechanical properties mainly in case of HGPs e.g. PEEK. It has a unique combination of properties, which makes an ideal substitute for metals. With the high thermal gradient and heat distribution during printing, possibilities of residual stresses and deformations are unavoidable, which directly affects its quality and the mechanical properties e.g. tensile, compressive and impact strength. There is a countable research found on determining the tensile strength, however very less researches done on finding compressive and impact resistance. Therefore, in this article multi-criteria decision making (ref fig.1) is used to identify the most important process parameters (layer height, print speed, print direction and nozzle temp.) to determine the compressive and impact strength of PEEK.

Keywords: Fused deposition modelling (FDM), Poly -ether ether- ketone (PEEK), Taguchi Design of Experiment, Mechanical properties, Multi-objective optimization, Multicriteria Decision Making (MCDM)

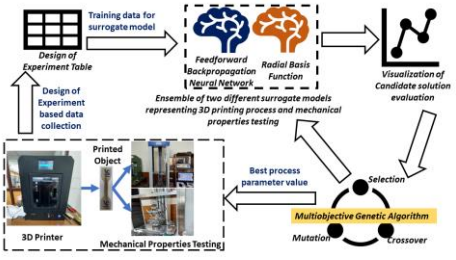

Fig.1 Proposed methodological flow

Investigation of Mechanical Properties and Tribological Performance of Al-B4C Metal Matrix Composites

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Abstract

Aluminium metal matrix composites (Al-MMCs) have amazing properties like elevated resistance to wear and erosion, better strength-to-weight ratio, lower cost and could be used in land, sea, space applications. Al could be reinforced with ceramic dispersions to improve mechanical, physical and tribo-properties. The most used dispersions are silicon carbide, alumina, and boron carbide. All the reinforcements used have their own effect on the properties of prepared MMCs. The Al6061-B4C MMCs were manufactured by stir casting technique. The microstructure observation confirms the distribution of reinforcement in the matrix alloy. The uniqueness of different reinforcements and their effect on tribo-properties have been elaborated in the article. The tribo-property of Al-B4C has been examined and scanning electron micrograph is observed to comment on the change in the resistance to wear with increase in the addition of particulate into Al metal matrix. It is observed that the resistance to wear has improved with addition of filler material. The load and sliding distance have been kept same for both the compositions. The compositions of Al-B4C MMCs are 2 and 3 weight(wt.) %. The improvement in resistance to wear further confirms the utility of Al-B4C MMCs for suitable engineering applications. The processing technique used to manufacture the Al-B4C MMCs is stir casting. The successful manufacturing of MMCs with B4C as a reinforcement further confirms on the suitability of process used to synthesis.

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Tribological Study of Surface Charactertization of Basalt Fiber with and Without Surface Modification with Silane

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Abstract

This study aims to investigate the tribological behaviour of basalt fiber surfaces with and without surface modification using silane. Brake noise is major problem for EV manufactures, the noise is caused due to friction induced vibrations which lead to lot of irritation and disturbance. Using fibers in brake pad formulation will eliminate brake noise. Fiber reinforcement in polymer matrix contribute significant role in improving mechanical and tribological behaviour of any composite for friction application. Basalt fibers have better tensile strength than the E-glass fibers, greater failure strain than the carbon fibers as well as good resistance to chemical attack, impact load and fire with less poisonous fumes. The surface characterization of the fibers was conducted using scanning electron microscopy, X-ray diffraction. Tribological performance evaluation of the developed brake pads based on IS1742 Part 4 standard and Physico-Mechanical performance evaluation of the composites using IS2742 part 1 - 3. 12 % of basalt fiber is used in formulation. The results show that the silane-treated basalt fibers exhibit improved wear resistance and reduced friction coefficient compared to the untreated fibers. The surface characterization analysis revealed that the silane treatment improved the surface roughness and reduced the presence of surface defects.

Keywords: Friction coefficient, tribological behaviour, fiber reinforcement, scanning electron microscopy, wear resistance.

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Forming Analysis of Metal-Polymer-Metal Sandwich Sheets

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Abstract

The sheet metals are exclusively used with the single materials in the industry, which is expensive and more weight. This can be overcome by introducing the new sheet metal concepts as Metal-Polymer-Metal (MPM) sandwich sheet composite. This MPM sandwich sheets are less weight and cost effective. Many researches already attempted on various Al alloys and Steel alloys along with polymer for their formability studies. Any MPM sandwich sheets after the fabrication, tensile behaviour has to be studied by which formability of MPM sandwich sheet can be predicted using finite element software's. The present work aimed the forming behaviour of AA5052-PVC-AA5052 (Al-PVC-Al) sandwich sheets though numerical simulations using PAMSTAMP 2G software. For forming behaviour prediction of Al-PVC-Al, along wirh the base material AA5052 alloy respectively. The mechanical properties of Al-PVC-Al were evaluated through uniaxial tensile testing and obtained the properties such as yield strength (YS), ultimate tensile strength (UTS), strain hardening exponent (n), material strength coefficient (K) and Plastic strain ratio (R). These mechanical properties were used for numerical simulations by modelling the limit dome height tests in the PAMSTMAP finite element software. Simulation will be performed and extracted the limit strains. From the obtained limit strains, forming limit diagram will be developed.

Keywords: MPM, sheet metal, forming, limit strains, mechanical behavior.

Analysis of Fibre Length, Dispersion, and Orientation during Injection Moulding of Short Natural Fibre-Reinforced Biocomposites

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Abstract

Fibre dispersion, orientation, and length are the key factors that influence the properties of biocomposites. The current experimental study investigates the different injection parameters affecting the fibre length, dispersion, and orientation during injection moulding of a biocomposite based on bamboo fibre (BF) and polylactic acid (PLA). BF/PLA biocomposite was developed considering 4 mm fibre length and 10 wt.% fibre loading. Taguchi's L9 orthogonal array was chosen to investigate the effect of injection parameters on fibre length, dispersion, and orientation. The injection parameters considered for the experimentation were injection pressure (70, 90, and 110 bars), injection speed (40, 50, and 60 mm/sec.), and injection temperature (165, 175, and 185ºC). The effect of injection parameters on fibre dispersion and orientation was examined using a toolmaker's microscope. The top layer of the fabricated biocomposite specimen was removed by the mechanical process to investigate the dispersion and orientation of the short fibre into the matrix. Whereas composite specimens were dipped into acetone solution to separate the matrix and fibre to study the variation in the fibre length during injection moulding. The tensile and flexural behaviour of BF/PLA biocomposite was also experimentally evaluated. ANOVA was carried out to verify the significance of injection moulding parameters on the mechanical properties of BF/PLA biocomposite.

Keywords Green Composite, Bamboo Fibre, Injection Parameters, Fibre Length, Fibre Dispersion, Fibre Orientation

Influence of Processing Conditions on Thermal Insulation Characteristics 0f 3D-Printed Thermoplastic Polyurethane

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Abstract

Fused deposition modeling (FDM) 3D printing technology has revolutionized the manufacturing industry with its design flexibility, economic effectiveness, minimal waste, and customization capabilities. Efficient insulating materials contribute to significant energy saving in infrastructure and automotive sectors. 3D printing permits the development of insulating materials with controlled porosity with appropriate design and the current project is focused towards the processing of the insulating materials and characterization using experimental and numerical studies. In Fused deposition modeling (FDM), process conditions play a major role in deciding the end product's overall behavior and its physical properties. Thermoplastic polyurethane is an ideal choice for automotive applications due to its low thermal conductivity, flexibility, durability, flexural strength, chemical, and abrasive resistance. To measure the thermal conductivity of the 3D-printed samples, an in-house thermal conductivity measurement setup that complies with ASTM C177/C1044 standards is used. Steady-state heat conduction analysis was done by finite element method using commercially available ABAQUS software and the effect of porosity on the thermal conductivity is reported. The thermal conductivity of the 3D-printed samples is also measured and reported.

Architected Polymer Insulation Coating Design for Traction Motor Bearings – Numerical Simulations

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Abstract

Development of new materials and coatings are attempted to prevent passage of electrical current in bearings of traction motors in electric vehicles that leads to premature failures. The bearings generate shrill noise due to morphological damages and lubricant degradation caused by the different type of currents due to usage of various power electronics. In order to prevent this type of failure, bearing manufacturers use polymer and ceramic insulation coatings. The polymer insulation coatings offer good insulation properties and are not susceptible to failure by mechanical loads as compared to ceramic insulation coatings. However, they have inherently low thermal conductivity and the heat generated due to friction may not be dissipated effectively, thereby limiting the coating thickness. With advances in capabilities of additive manufacturing such as multi-head printing, it is possible to manufacture products in an architected manner where different locations can have different properties using two different materials. Numerical simulations are conducted on different architected shapes of polyphenylene sulfide (PPS) and its blends. The effective thermal conductivity and dielectric constant are determined. Heat dissipation in insulation coated bearings is modelled in multiphysics software The preliminary studies will assist in ongoing coating design and development activities in the laboratory.

Prediction and Validation of Peak Temperature during FSSW of AA 6063-T6 Aluminium Alloy and CRCA/IS-513 Steel Alloy Using a Consumable Sheet

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Abstract

In this investigation, a novel technique has been used where FSSW joins AA 6063-T6 aluminium alloy and CRCA/IS-513 steel alloy with the help of a consumable sheet. In this technique, the faying surfaces of the base materials are placed at a specific gap, and a consumable sheet is placed on top of the base materials. The plasticized consumable material is extruded into the gap as the tool moves into the consumable sheet and gets bonded with base sheet materials. The tool is never in contact with the Steel base material, resulting in no tool wear. In this present study, both experimental and numerical investigations are carried out to validate the peak temperature generated during FSSW of AA 6063-T6 aluminium alloy and CRCA/IS-513 steel with the help of a consumable sheet. DEFORM-3D finite element (FE) code is used to perform FE simulation of the FS spot welding. The FSSW simulation and experimental findings show a good correlation for the peak temperature. The peak temperature predicted by the simulation has been found out by optimizing the shear friction factor (m) and heat transfer coefficients (h). The predicted temperature for m = 0.4 and h (at the tool/workpiece interface) = 300 w/m2°C matches the experimental data rather well. The exact value has been treated as a constant for all FE simulation of FSSW.

Keywords: FSSW; DEFORM-3D; Peak temperature; Shear friction factor; Heat transfer coefficients

Artificial Womb Technology: Addressing Philosophical Challenges and Ethical Implications through Machine Learning Analysis

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Abstract

Artificial womb technology has become a significant development in recent years. The progression of this technology heavily relies on the use of machine learning techniques, which optimizes artificial womb environments and simulates physiological processes during fetal development. To safeguard the rights and well-being of both the fetus and the mother, regulatory frameworks must be established to ensure ethical and responsible use of artificial womb technology. This technology offers potential benefits, such as improved outcomes for premature infants and expanded reproductive options for individuals who cannot carry a pregnancy to term. For future research and development in artificial womb technology, careful consideration of ethical implications and regulatory frameworks is crucial to ensure responsible and ethical use, ultimately improving reproductive health outcomes for future generations. In this review paper, we explore the innovative use of machine learning technology as a crucial component of the artificial womb, its advantages, and potential impact on the field of obstetrics and gynecology

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Mechanical Properties of Bidirectional Silk Fibre Fabric and Bidirectional Glass Fibre Fabric Reinforced Nanoclay Hdpe Hybrid Composites

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Abstract

Hybrid glass and silk fiber reinforced composites are gaining popularity as the reinforcements in different matrices play a vital role in bringing up the mechanical and tribological properties. In this context aspiration of both Silk and Glass fibers find their usefulness in High-Density Polyethylene (HDPE) matrix for the application . in various engineering industries especially in the automobile field as they tend to exhibit very good mechanical properties.
In present research work, mechanical properties of silk-glass fibric reinforced HDPE hybrid composites were prepared in a hot compression molding press with different levels of laminate arrangements as well as loading of Nano clay (NC) at 0.3,0.5,0.8, and 1%wt levels. The tensile, flexural, compression, hardness and wear tests were conducted for characterizing the composites. It is observed from the data that tensile strength, flexural strength hardness as well as young's modulus, and flexural modulus of the samples increased with increasing in wt.%. NC content. The 1 wt.% NC Hybrid composites have shown the optimum set of mechanical as well as tribological properties, with silk and glass fiber ratio kept constant. Also, the coefficient of friction (CoF) reduced up on the addition of silk and glass fibers and further decreased in CoF with the incorporation of NC at different levels. The SEM images pertaining to tensile and wear damages have paved way and given able support to the tensile and wear data generated in this work.

Keywords: Silk; Glass; HDPE; slide wear; Tensile; compression, flexural

Analysis and Optimization of Material Removal Rate, Recast Layer Thickness and Radial Overcut in Electrical Discharge Machining of Magnesium Alloy-ZE41 with Different Electrodes

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Abstract

ZE41 Magnesium (Mg) alloys are being widely used in the automobile, military, biomedical, consumer electronics and aerospace industries due to lightest structural metal, high strength to weight ratio, better ductility and cast ability than aluminum and steel. Since it is highly cumbersome to machine this alloy of complex shapes using conventional machining processes, it can be machined by unconventional machining process i.e. EDM process. In the present study, three electrodes such as copper, brass and EN8 were utilized for machining of ZE41 because these electrodes have dominant effect on machining performance and widely used in industries. Metal removal rate, recast layer thickness and radial overcut were considered as machining quality characteristics and input process parameters like type of electrode, peak current, pulse on time and pulse off time. Experiment were conducted based on Taguchi's L27 orthogonal array. Analysis of quality characteristics was done using analysis of variance and optimization was performed using analytical hierarchy process coupled with TOPSIS. Analysis showed that type of electrode and peak current had significant effect on metal removal rate and radial overcut, whereas type of electrode and pulse on time had significant effect on recast layer thickness. Optimization results indicated that the best solution obtained by proposed method corresponds to brass electrode, peak current of 18A, pulse on time of 100µs and pulse of time of 100µs and the worst solution corresponds to copper electrode, peak current of 6A, pulse on time of 500µs and pulse of time of 100µs.

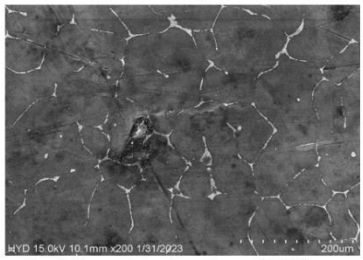

Fig. 1 Unmachined surface of ZE41

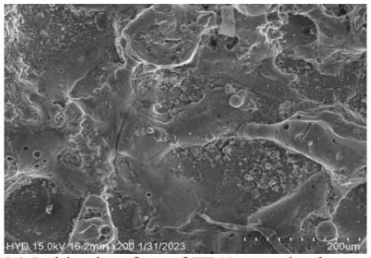

Fig. 2 Machined surface of ZE41 at optimal

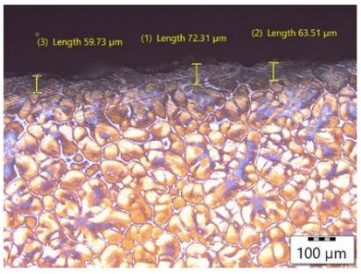

Fig. 3 Recast layer thickness –Expt. No. 1

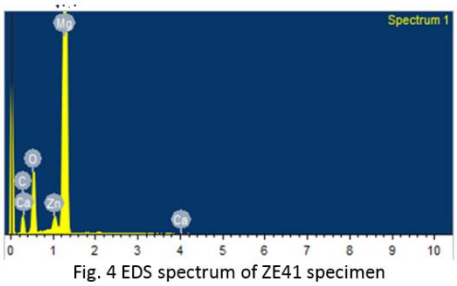

Fig. 4 EDS spectrum of ZE41 specimen

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Investigational Study on Mechanical Behaviour of Mathematical Model on Atomic scale of Aluminum and Magnesium Alloys

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Abstract

Aluminum and Magnesium Alloys and Metal matrix composites are having high strength to weight ratio than many other steels. The atomic model is developed based on 2 atoms of Al, 1 atom of Mg and 1 molecule of SiC. These Mg and SiC form angles with an two Al atoms in line. The nonbonding potentials are matched with bonding potentials to arrive at an orce and stiffness. From the Stiffness strength values, we can arrive at microscopic levels by knowing critical stress strain path in a group of atoms with various kinds in a grain. From microscopic levels of Stress Strain a phenomenological model can be developed to determine mechanical behaviour properties. These can be compared with the experimental values of phenomenological models of yesteryears. With this conclusion we arrived at an complete understanding of mechanical behaviour of Al Mg alloys.

Effect of Build Orientation on Mechanical Strengths of Additive Manufactured AlSi10Mg Alloy

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Abstract

Additive Manufacturing (AM) is one of the leading disruptive technologies of fabricating 3D objects or components from a CAD model by adding materials layer by layer. Unlike the conventional manufacturing processes, the consumption of raw materials is reduced by this AM technique, and more complicated items that cannot be produced or highly challenging to produce can be simply made. Due to its superior properties, such as its extreme light weight to strength ratio, and excellent resistance to heat and wear, aluminium alloy is one of the frequently utilised materials in AM. In this study, AlSi10Mg alloy is 3D printed using Direct Metal Laser Sintering (DMLS) technology in four different orientations: horizontal (H), vertical (V), on edge (SH), and 45°(T). The intent is to comprehend how the specimens respond to different mechanical tests and determine whether build orientation significantly affects the different strengths of the materials. For testing its hardness, tensile strength, impact strength, the specimens are printed as per ASTM standards. Vickers microhardness test results showed that the specimens that are printed horizontally had the highest hardness, followed by vertical, on edge, and 45 degrees, respectively. Regarding tensile strength, there has been evidence of a descending order of V, T, H, and SH build orientations. According to toughness, specimens with H orientation tops the list, followed by T and V.

Keywords: AlSi10Mg alloy, DMLS, Build orientation, Vickers microhardness, Tensile strength, Impact strength.

Investigation on Machining Performance During Ultrasonic Vibration Assisted Turning of Magnesium AZ31B Alloy

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Abstract

Magnesium AZ31B alloys are promising materials for biomedical, aviation, and automotive industries. Severe plastic deformation processes such as machining processes have shown capabilities to improve the performance of magnesium AZ31B alloys. However, the usage of water and oil-based coolants during the machining of magnesium AZ31B alloys generates hydrogen and hazardous gases, which can explode and create a hazardous environment for nature and human beings. Therefore, machining without using any coolants has been preferred to machine magnesium AZ31B alloys. Ultrasonic vibration assisted turning (UVAT) is an eco-friendly and advanced machining process to machine various materials than conventional turning (CT). In this study, experimental analysis is carried out to investigate the machinability of the magnesium AZ31B alloy during the CT and UVAT processes. The effect of cutting speed and feed rate are analyzed during the UVAT process of magnesium AZ31B alloy and compared with the CT process in terms of machining forces, machining temperature, tool wear, chip morphology, surface roughness, and surface damage. Results showed that machining forces, surface roughness, and surface damage is decreased for the UVAT process when compared with the CT process. However, a higher maximum machining temperature is found in the UVAT process than in the CT process. Flank wear is obtained for the CT process; however negligible tool wear is observed during the UVAT process. Chip segmentation is observed for both the CT and UVAT processes although higher chip thickness is obtained during the UVAT process in comparison to the CT process. The outcomes revealed that the machining performance is enhanced for magnesium AZ31B alloy during the UVAT process than that of the CT process.

Keywords: Hybrid machining; Ultrasonic vibration assisted turning; Conventional turning; Magnesium AZ31B alloy; Machining performance.

Evaluation of Conventional Drilling and Helical Milling for Hole Machining in Ti6Al4V Titanium Alloy

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Abstract

The conventional drilling process is used extensively for hole-making in structural assemblies made of titanium alloys. However, low thermal conductivity and work hardening behavior make it a difficult material to machine. Moreover, these properties can lead to temperature build-up and material adhesion, accelerating tool wear and failure. Also, high temperatures during drilling can alter microstructure and decrease fatigue and stress corrosion resistance. The study, therefore, investigates the utility of helical milling as an alternative for processing holes in Ti6Al4V titanium alloy. The two processes were evaluated by studying the cutting forces, tool wear, surface roughness, and machining temperature. Holes were drilled using different cutting speed and feed conditions, while the parameters used for helical hole milling were axial feed, cutting speed, and tangential feed. The experiments were conducted under sustainable dry machining conditions, and the levels of process parameters were chosen taking into consideration the parity in productivity. The data showed that hole-making using helical milling was advantageous as it produced lower cutting forces. The measured machining temperature was significantly lower with the helical milling process. Hole drilling resulted in a heat-affected zone (HAZ), whereas helically milled holes were devoid of any visible HAZ. The helically milled holed displayed superior quality holes with lower surface roughness; however, at higher productivity conditions, chatter marks were noted. Furthermore, the evaluation of the cutting tool revealed tool damage in terms of coating loss and abrasion. The severity of tool damage was significantly lower during the helical milling operation. The initial assessment indicates helical milling as an adept process for hole-making in titanium alloys.

Investigations on the Laser Ablation of Sintered Silicon Carbide Ceramic for Precision Optics Applications

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Abstract

Silicon carbide (SiC) material is gaining importance for optical telescope mirrors due to its superior mechanical rigidity and optical surfacing feasibility which is quite useful for large-area high-resolution optics. Since the properties of the SiC substrate can be reconfigured depending on the manufacturing method used, sintered SiC is one of the most popular methods of substrate preparation. The as-developed substrate, however, cannot be used directly for high-end optical applications like high-resolution imaging or spectroscopy and calls for specific cladding on the base SiC substrate. This is because the substrate has an inherent α-HCP phase and for optical use ß-cubic phase is a must. Several methods of modifying the surface of SiC have been reported, including laser-based ablation method on the sintered SiC. Laser ablation behaviour of SiC ceramic is of extreme significance for the development of anti-laser ability of mirrors of for laser and space optical applications. In this study, sintered SiC ceramic substrates were ablated with laser pulses that were 20 nanoseconds duration and operating at 1533 nm. The laser-induced damage threshold (LIDT) value of about 0.5 J/sq cm has been maintained, and the damage morphology resulted in the formation of the "burning crater" with a distinct boundary on the SSiC surface. It has been observed that during the ablation process, the SiC surface primarily underwent a decomposition process of the Si and C elements along with some alteration of the SiC crystal orientation, thereby forming a dense phase layer of SiC. The decomposition of SiC dominates in the laser process of SiC ceramics, whilst the formation of SiO2 from the oxidation can only be observed in small amounts due to a lack of O2 atmosphere in the ablated area. It has been ascertained that laser energy is accumulated and converted to heat in a specific area on the SiC surface as a result of multi-photon absorption, impurity absorption and photon scattering within SiC, leading to the crystal orientation change with the decomposition and oxidation of SiC.
The investigations on the laser ablation mechanisms of SiC ceramics involved comparing the composition distributions between unprocessed and laser treated portions of the substrate. A first level mapping of the laser-ablated SSiC is attempted with Micro-Raman spectroscopy and the characterization of micro-structural properties are carried out using XRD, SEM and EDAX techniques. Further, the laser-modified surface is subjected to polishing and the feasibility of high surface micro-roughness of 2nm rms is being experimented.
It is found that for the sintered SiC ceramics, laser ablation is an effective and precise surface preparation tool (using nanosecond or even shorter pulsed lasers). SiC ceramic surface modification and preparation can be further optimized in order to remove material and lattice flaws, increase the density and enhance the surface quality to produce low-absorption and high-LIDT mirrors used for high power lasers and in space optical systems.

Keywords: Sintered silicon carbide (SSiC); laser ablation; micro-Raman mapping technique; densification; optical polishability; decomposition; microstructure.

The authors gratefully acknowledge the support rendered by M/s.ARCI, Hyderabad for supplying the sintered SiC substrate. They are also thankful to Mr. Sridhar Raja RVLN and Mr.Venkateswaran.R, Deputy Director, OSA, LEOS for their grateful support.

Investigation of Microstructural Influence and Synergistic Effect of Zinc and Magnisium Nanoparticles on Mechanical Propeties of Al6303-T6

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Abstract

This project aims to investigate the effect of zinc and magnesium nanoparticles on the microstructure and mechanical properties of AL 6063-T6. The microstructural and mechanical properties of materials are critical factors that determine their suitability for various engineering applications. Previous studies have been showing that the addition of nanoparticles improves the mechanical properties of materials by creating stronger interfaces, reducing grain size, and promoting the formation of nanoscale precipitates.

The main objective of this study is to investigate the influence of different volume fractions of zinc and magnesium nanoparticles on the microstructure and mechanical properties of AL 6063-T6. The results of this investigation will provide insight into the mechanisms responsible for the enhancement of mechanical properties and may lead to the development of advanced materials with improved strength and toughness. And Optical microscopy will be used to analyze the microstructure of the samples, and tensile and impact strength tests will be performed to evaluate the mechanical properties. effective approach to evaluating the influence of nanoparticles on the material properties.

In conclusion, this project aim to investigate the microstructural and mechanical properties of AL 6063-T6 reinforced with zinc and magnesium nanoparticles. The project will employ microstructural analysis and mechanical testing to evaluate the influence of different volume fractions of nanoparticles on the material properties. The results of this investigation may contribute to the development of advanced materials with improved mechanical properties and have significant implications for various engineering applications.

Selective Laser Melting of Al2O3 – EIP Composite: Single Track Study

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Abstract

Selective laser melting (SLM) is growing in the manufacturing sector as it is suitable for the fabrication of fully dense parts of composite materials. The intricate and accurate part is built by selectively melting and fusing powders within and between layers using a high-powered focused laser. The recent research work in SLM involved the fabrication of new composites and alloys. This work includes the single track study of Al2O3 – Electrolytic Iron Powder (EIP) composite at different weight percentage compositions. Al2O3 is a widely used reinforcement that can be incorporated using various technological methods, including casting and sintering. The SLM process fabricated parts of Al2O3 - EIP powder composite has potential applications where they can improve the mechanical and thermal properties of the printed parts. This experimental study covers mixing powders to prepare the MMC, tracking the morphology, element mapping of the layer at different Al2O3 compositions, microhardness, and scratch test results discussed at the end. Results demonstrated that microhardness is nonuniform, increasing the Al2O3 percentage in the composite. The element mapping confirmed the presence of composite powder and showed the separate substrate at the interface. The scratch test was also performed and found that single layer likely replicated similar surface profile and load of traction affected by Al2O3 percentage in composition.

Keywords: Selective laser melting, Al2O3 – EIP composite, Element mapping

Acknowledgments

The laser system used for this study was established through grant received from Department of Science and Technology (DST), India under project number DST/TDT/AMT/2017/026.

Hybrid Machining of Nanoparticle-Reinforced Fused Silica-Based Composites

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Abstract

The development of nanoparticle-reinforced composites has gained significant attention in recent years due to their superior mechanical and physical properties. However, machining these composites remains challenging due to their high hardness and abrasive nature. The present study proposes a hybrid machining technique for nanoparticle-reinforced fused silica composites to overcome these challenges. The hybrid machining technique combines the advantages of ultrasonic machining (USM) and electrical discharge machining (EDM) to achieve a superior surface finish and precision machining of these composites. The experimental results showed that the hybrid machining technique effectively removed material from the nanoparticle-reinforced fused silica composites with minimal damage to the machined surface. The surface roughness and material removal rate (MRR) were evaluated. The results indicated that the hybrid machining technique achieved a superior surface finish and higher MRR than conventional USM or EDM alone. The microstructure analysis of the machined surface revealed that the hybrid machining technique effectively removed the nanoparticles from the machined surface, resulting in a smoother surface finish. The study also investigated the effect of process parameters such as machining voltage, feed rate, and concentration of nanoparticles on the machining performance. Hence, this study is a practical approach for machining nanoparticle-reinforced fused silica composites with superior surface finish and higher material removal rate. This technique can potentially find applications in various industries, such as aerospace, automotive, and biomedical, where these composites are used extensively.

Nature Inspired Shape Shifting Soft Magnetic Materials: Inspiration, Fabrication, Mechanism and Application

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Abstract

Natural organisms (such as Venus flytrap, pinecone, mimosa, flowers, inchworm, etc.) display a variety of motions over time with the change in the surrounding atmospheric condition (i.e., moisture, temperature, pH, light, etc.) to survive and thrive. This change in the physical form of natural organisms became a source of inspiration for engineers and researchers all over the globe. It motivated them to create new techniques and materials which can perform complex tasks that rigid machines are unable to perform efficiently and sustainably.

Magnetically active soft actuators are gaining popularity in this regard due to their fast response, remote controllability, wide field of compatibility, and large-scale penetration range in various conditions [1]. Magnetic soft actuators exhibit a reversible change in their shape and size when kept under the influence of the controlling magnetic field. The change in their shape and size in the magnetic field is significantly large and fast in comparison to the response of actuators under other stimuli. These magnetic soft actuators are comprised of a soft polymer matrix and magnetic particles as fillers.

In this study, we used very thin iron needles with a high aspect ratio varying between 1:8 to 1:10 as magnetic particles to endow magnetic properties to the soft polymer. The alignment, dispersion, and position of these magnetic needles in the soft polymer matrix play an important role in the shape-morphing ability of the magnetic actuators. First, actuators with CI (Carbonyl Iron) particles programmed with different shapes are prepared and analysed under a high magnification microscope to understand the dispersion and alignment of the micro-CI particles which are responsible for programmed shape generation. The CI particles in the soft matrix are isotopically dispersed before programming but after programming under the magnetic field, these particles aligned along magnetic field lines and reached an anisotropic state [2]. Later, we mimicked the same pattern at the macro level using different shaped and sized magnetic particles to attain the same actuation pattern. Iron needle-like particles with a high aspect ratio provided the most possible control over the shape change of these actuators.

Due to the magnetostriction effect in iron needles, it is possible to control the shape of the soft actuators just by controlling the orientation and alignment of these iron needles. The fabricated soft actuator is then tested for reversible shape change in the magnetic field, the effect of the magnetic field on the amount of deformation or actuation, and force quantification at different amounts of the magnetic field intensity. Further, a soft gripper and a soft locomoting robot are prepared to investigate the motion generated by the shape change. The locomoting soft robot is tested for its speed due to fast shape change for different frequencies of the magnetic field. It is found that by controlling the arrangement of magnetic particles in a soft matrix, we can preprogramme the actuators with different shapes without keeping them in the magnetic field.

Keywords: Shape morphology, Magnetic actuation, soft polymer, magnetostriction, soft locomotion.

Effect of Interlayer Copper Micropowder Addition on the Mechanical as well as Metallurgical Properties of Wire Arc Additively Manufactured Ferritic Steel

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Abstract

Wire arc additive manufacturing is the process of layering materials from a constantly supplied molten filler wire for the manufacturing of desired products. The products thus fabricated are mostly having similar mechanical and metallurgical properties compared to the filler wire properties, in as-deposited conditions. In this research, each WAAM deposited layer of a ferritic low-carbon steel ER70S6 was modified by interlayer micropowder alloying. This paper aims to manufacture complex phase steel out of ferritic low carbon steel and then studying the metallurgical as well as mechanical properties of the WAAM fabricated complex phase steel. A multilayered wall of 150 mm in length, 6 mm in width and 100 mm in height was manufactured by applying copper micropowder in between every deposited layer. The manufactured wall was inspected using x-ray radiography, the whole wall was defect free except the topmost end of the wall where some gas pockets were observed. Metallurgical characterization was carried out using optical microscopy, scanning electron microscopy, energy dispersive spectroscopy, and X-Ray diffraction for the identification of various phases present in the WAAM-manufactured steel. The microhardness of the manufactured steel increased significantly due to the formation of ferritic-bainitic microstructure with retained austenite. The toughness properties of the manufactured steel were also evaluated at room temperature as well as at -25°C.

Keywords: Wire arc additive manufacturing, interlayer powder reinforcement, copper micropowder, microhardness, low temperature impact toughness

Controlled Texturing on Silicon Carbide Dispersed Aluminium Matrix Composite Using Ultrashort Pulse Laser Irradiation for Tribological Enhancement

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Abstract

Aluminium metal matrix composites are a class of materials that have demonstrated effectiveness in fulfilling the majority of attributes required in applications where light weight, high stiffness, and moderate strength are desired. Attaining of attributes such as low coefficient of thermal expansion and strong thermal conductivity has made silicon carbide dispersed aluminum matrix have large applications in aerospace, autoboliles, medical, etc. Due to its mixed inherent properties of ceramics and metal, it is highly challenging to texture the surface using processes such as electric discharge machining, ultrasonic assisted turning, etc. In addition, presence of ceramic particle has made it difficult to achieve the desire texturing on the composite surface. In this regards, laser processing is one of the most suited technique used for the removal of materials in silicon carbide aluminium composite. Among the lasers, ultrashort laser provide the minimal alteration of material property having the pulse duration in the range of femtoseconds. In the present work, ultrashort pulse laser is utilized to texture silicon carbide (SiC) dispersed aluminium matrix composite surface for investigating wettability of various textured surfaces. Different texturing directions have been selected for texturing. The textured pattern is carried out using different having width (a) and pitch (b) as shown in Figure 1. The optimal texture design parameters for producing the best hydrophobicity is identified. The present work is highly beneficial in producing hydrophobic surfaces without any coatings.

Keywords: Ultrashort pulse laser; Texturing; Aluminum based silicon carbide composite; Hydrophobic surface.

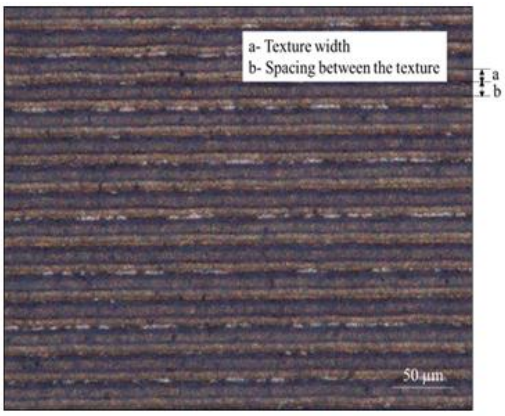

Figure 1: Textured surface feature

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Thermomechanical Finite Element Based Simulation of μEDM

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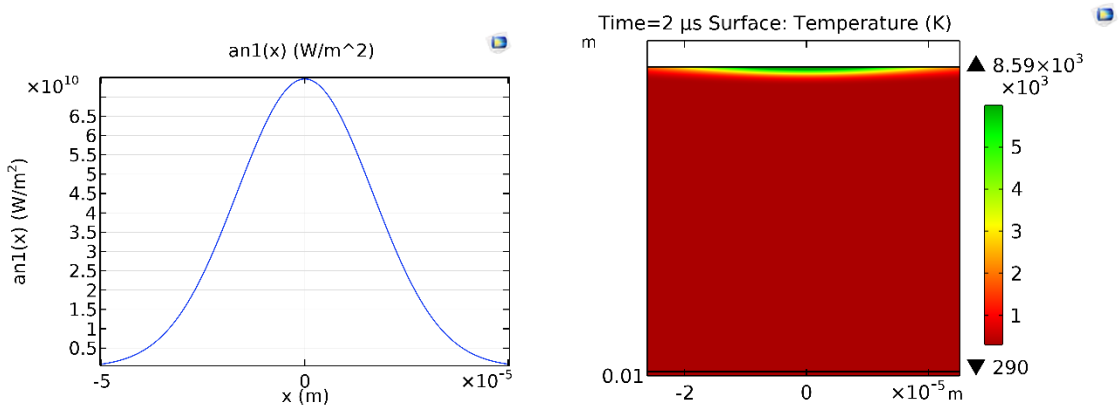
Abstract

Electrical discharge machining (EDM) is a most popular unconventional machining process for cutting hard metals to generate complex shapes and deep holes. Material removal is achieved by repeated electrical discharges between the conductive electrodes in presence of a dielectric. Micro-EDM (μEDM) is a variant of conventional EDM. The high temperature gradients generated at the gap during EDM result in large localized thermal stresses in a small heat-affected zone. In a narrow heat-affected zone, the high temperature gradients generated at the gap during EDM causes significant localised thermal stresses. Thermal stresses have the potential to cause micro-cracks, a reduction in strength and fatigue life, and even catastrophic failure. In the present work, a physics-based numerical model of μEDM is applied to study the temperature evolution and the thermal stresses developed during the process. A more realistic assumptions has been considered in this analysis such as Gaussian distribution of heat flux, effect of latent heat of melting and temperature dependent properties, but plasma radius has been kept constant. Numerical analysis of the single spark operation of EDM process has been done considering the two-dimensional model to estimate the temperature field and thermal stresses due to Gaussian distributed heat flux (as represented in fig 1(a). The effects of various process variables (discharge voltage, capacitance and duty cycle) on temperature distribution and thermal stress distribution have been reported. The results of the analysis show high temperature gradient zones and the regions of large stresses where, sometimes, they exceed the material yield strength. Peak temperature of 8590K is observed with voltage 120V capacitance 100nF and pulse on time of 1μsec as seen in Fig1 (b)

(a) (b)

Figure 1. Plot of (a) Gaussian heat input and (b) temperature profile of the μEDM for discharge voltage 120V and capacitance 100nF at pulse on time of 1 μsec.



Experimental and Numerical Investigation of Laser Wire-Directed Energy Deposition of SS 308L

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Abstract

In the present work, laser wire-directed energy deposition (LWDED) is being carried out to deposit a uniform continuous single layer of SS 308. The effect of laser input parameters on the deposition's width, depth and microstructural evolution using continuous near-infrared fibre laser operating at 1070 nm are investigated. The laser power of 400, 500, 600, 700 and 800 W and wire feed rate of 30, 40, 50 and 60 mm/s are varied at a laser scan speed of 1 mm/s. The deposition is shielded from ambient surroundings during the deposition process using an argon gas supplied coaxially to the laser beam. The laser beam is Gaussian in nature, and the beam diameter is 1 mm. The study reveals uniform deposition with the smooth transfer of feedstock and fusion of the feedstock material onto the base material, as seen from the microscope image of the deposited cross-section Fig 1(a). The microstructure images obtained from SEM images show the presence of dendritic structure, as shown in Fig 1(b). 2D axisymmetric numerical simulation of LWDED is also performed to study the effect of laser beam parameters on the melt flow of the melt pool created during the deposition process. The model couples the thermal and hydrodynamic effects of the laser-melted layer. The model captures the temperature profile distribution as well as the solidification gradient present in the deposition process numerically.

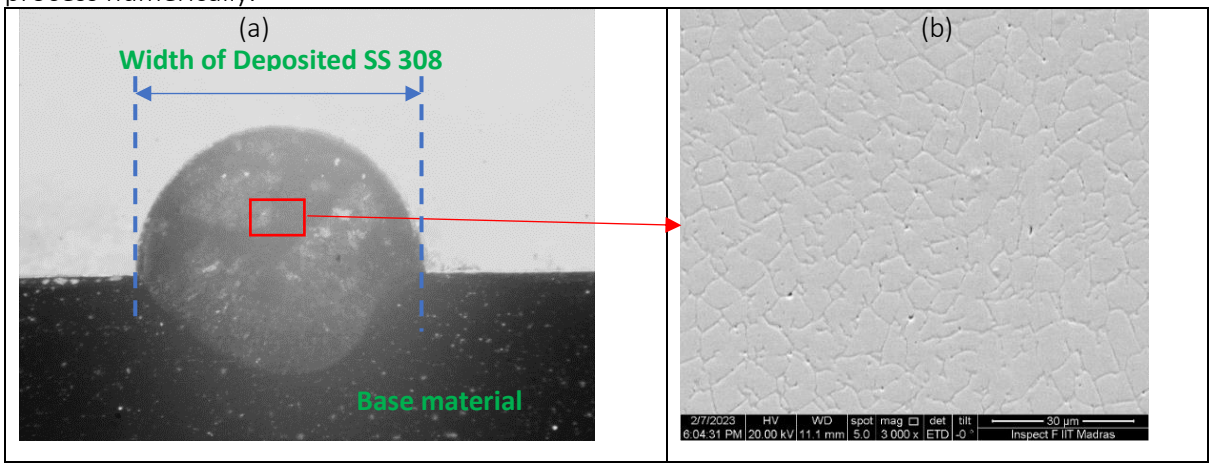

Figure 1. Laser wire deposited single bead (a) Microscope image of cross-section and corresponding (b) SEM image showing the dendritic microstructure form at a laser power of 700W and wire feed rate of 50 mm/s

A Comprehensive Study of High Quality Film Cooling Holes, Machined on IN718 by Using a Femtosecond Laser Trepan Drilling Technique

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Abstract

Film cooling represents one of the technologies that has allowed the achievement of today's high firing temperatures, high-efficiency and longer life parts of gas turbine engines. Micron-size holes (<1mm) are highly demanded for improving the performance of gas turbine engines. These micro-holes are being manufactured either by micro electric discharge machining (micro-EDM) or by short pulse lasers. Micro EDM is a well-known machining process that achieves microfeatures of excellent quality for any conductive material. However, it has slow machining speed, low material removal rate, and high tool wear are the main limitations of this process. Laser ablation using a femtosecond pulse laser is a fast and non-wear machining process. Nickel-based superalloys (IN718) are generally used in technologically advanced industries like aerospace, nuclear and marine etc. This study is focused on the quality evaluation of the micro-holes drilled by femtosecond pulsed laser. The drilling strategy consists of two steps: drilling a through hole and enlargement, in which the sample is placed in the opposite direction and drilling is done until half the thickness of the plate is reached. Which is able to produce cylindrical film cooling holes with diameters of 600 µm on 650 µm and 900 µm thick plates. According to the material thicknesses, the corresponding drilling scanning strategies are proposed. The effects of different processing parameters on the hole quality are described and discussed in detail. The hole quality has been evaluated in terms of inlet and outlet circularity, taper angle, and surface roughness of microholes. In conclusion, the two-step drilling approach is an effective hole processing method that provides high quality machining of film cooling holes. Moreover, there is no recast layer, micro-cracks, and no obvious heat affected zone (HAZ) on the wall and hole surface.

Improvement of Mechanical Properties in Al7075 Metal Matrix Composites with SiC Nano-Particle Inclusions

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Abstract

Metal matrix composites (MMCs) with nano-particle inclusions have received a lot of attention recently due to their enhanced mechanical properties. The mechanical properties of MMCs with nanoparticle inclusions are thoroughly studied, with special attention paid to the impact of volume fractions. The tensile strength, fatigue behaviour, and hardness of MMCs containing nanoparticle inclusions are discussed.

The mechanical properties of silicon carbide (SiC) nanoparticle-included aluminium matrix composites have outperformed those of their conventional equivalents. This investigation looks into how SiC nanoparticle inclusions affect the mechanical characteristics of Al7075 metal matrix composites (MMCs). Stir casting method is used to fabricate the Al7075/SiC nanocomposites, and their mechanical attributes such hardness, tensile strength, and fatigue behaviour are assessed. In comparison to the pure Al7075 matrix, the results demonstrate that the inclusion of SiC nano-particles significantly improves the mechanical properties of Al7075 MMCs, increasing hardness and tensile strength by up to 55% and 34%, respectively. In addition, compared to the pure Al7075 matrix, the Al7075/SiC nanocomposites show improved fatigue behaviour. The improvement in mechanical properties is attributed to the uniform distribution and effective reinforcement of SiC nano-particles in the Al7075 matrix.

Smartex QD-100 Based SLS-Mediated Immediate Release Tablet: Sintering, Characterisation and Novel Material Finding for Selective Laser Sintering

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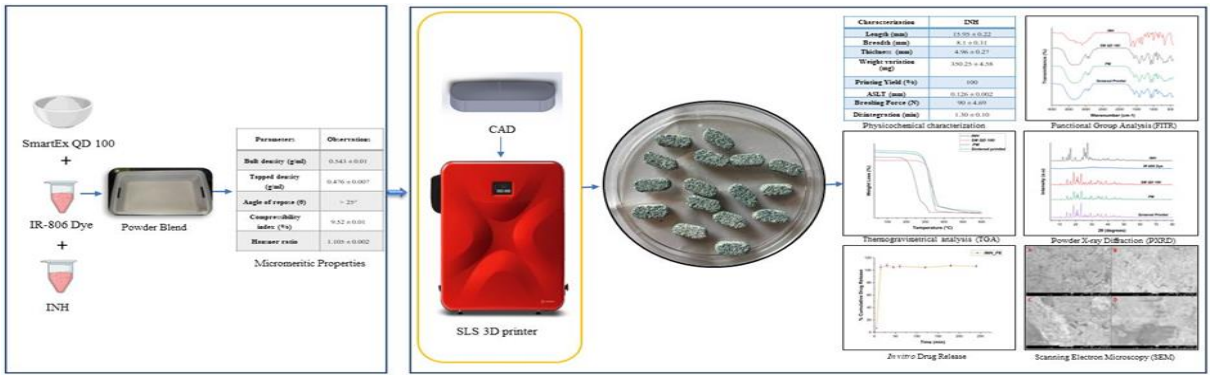
Abstract

Among all the 3D printing technologies, selective laser sintering (SLS) is the green AM technology that enables to fabrication of the complex geometrical, high-dose loaded solid oral dosage form in bulk quantities with a tuneable drug release pattern, utilizing the single-step approach. SmartEx QD-100 is



a co-processed excipient which consists of D-Mannitol (93.1%) as filler, L-HPC (5.9%) as a disintegrant, and PVA (0.2%) as a binder. The sintering of the smartEx QD-100 by SLS-mediated 3D printing was quite challenging owing to the D-mannitol concentration in the SmartEx QD-100. The primary objective of this study was the sintering of SmartEx QD-100 for SLS-mediated 3D printing, which was successfully achieved by optimizing the process parameters. This could be an innovative finding in the area of the material required for SLS-mediated 3D printing. Initially, the flow behaviour of the powder blend containing 94.85% smartEx QD-100, 5% isoniazid (INH), and 0.15% IR-806 dye was assessed, and it was found that the prepared powder mixture was ideal for the movement from the feed bed to the print bed by the recoater. Subsequently, the sintering conditions and sinterability of smartEx QD-100 were optimised and assessed using smartEx QD-100, IR-806 dye, and INH. Finally, the best-sintered batch in terms of physical characteristics was subjected to the assessment. The results of the physicochemical analysis of the best-optimized batch were in the acceptance limit according to the IP. The thermal analysis reveals that the INH and smartEx QD-100 were stable at the printing temperature and after laser exposure. The SEM data resulted that the smartEx QD-100 being partially melted at printing temperature and observed needle shapes indicating the stable presence of INH in the sintered printlets. The drug content was found to be within the acceptance limit (90-110 %). The release of INH from the best-optimized batch was found to be 100% in 15 min. Hence the printlets showed the immediate release behaviour with an weibull model as the best fit mathematical model for in vitro dissolution profile of INH from sintered immediate release tablet. Further the in vivo pharmacokinetic study was going to perform and that will conquer the obtained results.

Impact of Ageing Treatment on Microstructural Evolution and Tensile Behavior of Alloy 625

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To improve power efficiency and reduce CO2 emissions, AUSC power plants have been developed that work at temperature and pressure conditions above 720oC & 350 bar, respectively. It is crucial to design suitable materials that can perform well under such conditions. Ni-based superalloy 625 is a promising candidate with desired properties (high strength, creep strength, corrosion resistance etc.) for high-temperature applications. Thermal exposure during the service period could alter the microstructure and hence mechanical properties of the alloy. Therefore, it is imperative to understand the impact of heat treatment on the microstructural and mechanical characteristics of the material. In the present study, the effect of pre-deformation and ageing on the phase evolution and tensile behaviour of homogenized (HN) alloy 625 has been observed. Firstly, HN alloy was subjected to cold rolling up to 10% thickness reduction. For ageing heat treatment, both HN and pre-deformed alloys were exposed to 700oC temperature for different intervals of time (till 1000h) followed by microstructural analysis and RT tensile test. SEM, TEM and EBSD were selected for the microstructural characterization of aged and deformed samples. The quantification of physical characteristics of γ'' precipitates was done with the help of Image J software. The results depicted ellipsoidal γ'' precipitates as the major strengthening phase with three mutually orthogonal variants. There was a gradual increment in average precipitate size and area fraction with ageing time. However, the precipitate size was reduced and the number density was raised by the pre-deformation. Moreover, the peak hardness value corresponding to HN and pre-deformed alloys was achieved at 650 and 800h, respectively. the ageing response was sluggish in the case of strained alloy. Furthermore, primary MC carbides transformed into secondary carbides according to the following phase transformation paths: (I) MC+ γ→M23C6 and (II) MC+ γ→M23C6 + δ. Deformation prior to ageing promoted the later route (II) of MC carbide transformation route and hence the precipitation of δ was enhanced by pre-deformation. The yield strength was increased with ageing, however, the ductility dropped immensely due to the formation of carbides along the grain boundary that facilitated the crack nucleation as well as propagation and led to intergranular fracture.

Analysis of Hole Quality of Copper Oxide Nanostructured CFRP Composite

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Abstract

Many sectors currently make substantial use of carbon fibre reinforced polymer composites. But CFRP composites does not show good machinability property. This paper proposes to do an analysis of the machinability of CuO nanostructured carbon fiber reinforced polymer composite. Micro drilling operation has been performed using a semi-high-speed micro machining center. A drill bit of 400-micron diameter has been used. The spindle speed of 20000, 30000, and 40000 are taken, and feed rates of 1,3,5 mm/min are taken. Analysis of the hole quality after machining is done. Delamination damage, fiber pull-out, and roundness are taken into consideration. Comparison has been made with CFRP composites.

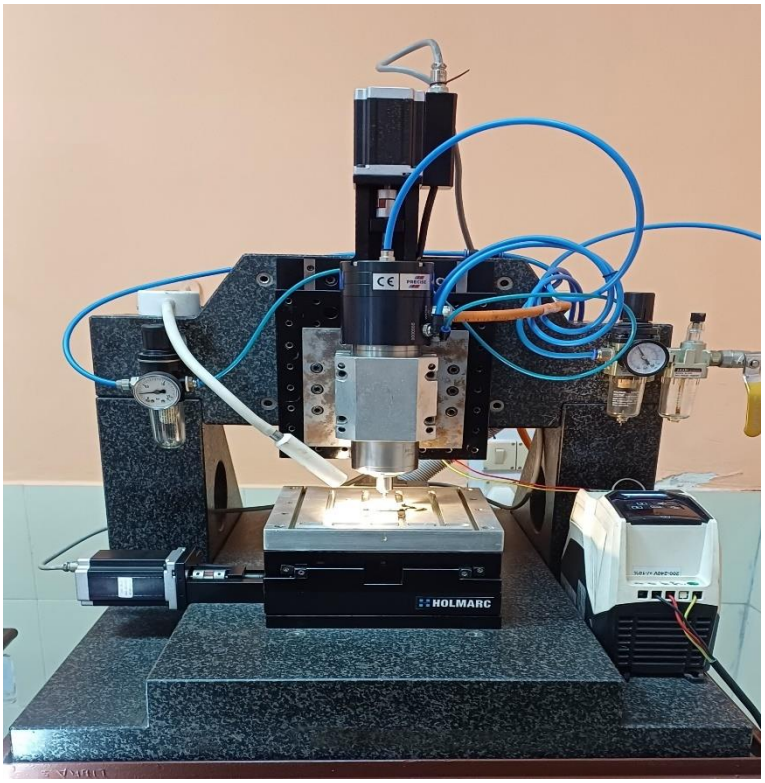

Figure 1 Semi High Speed Micro Machining Center

State of the art on additive manufacturing of moulding dies with conformal cooling channels

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Abstract

The cooling system of the mould/die plays a vital role in terms of part quality and cycle time during the production process. Conventional cooling channels are often drilled straight holes with limited geometric complexity causing restricted cooling fluid mobility within the mould. Additive manufacturing enables the designing of a complex cooling system conforming to the mould geometry. These channels 'conform' to any shape for optimum efficiency.

In this paper, the Conformal Cooling Channel (CCC) parameters like channel profile, geometry, layout etc. are designed and simulated using software based on Computer Aided Design (CAD) and Computer Aided Engineering (CAE). The process parameters of the mould with CCCs are optimized using dedicated software like Moldflow Insite and Moldflow Advisor.

After optimizing the cooling performance numerically, an appropriate additive manufacturing process based on mould material and channel support material is selected for 3D printing of mould/die.

The experimental cooling performance of mould with CCCs is then compared with the mould without cooling channels. Experimental results have shown reduced cycle time with uniform part temperature distribution leading to defect-free cost-effective production.

Keywords: Moulding die, Conformal cooling channel, Additive manufacturing.

Analysis of Plasma Channel and its Effects

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Abstract

When dealing with high voltages and arcs, an important factor to count in is the plasma it produces. The Electric Discharge Machine is no exception to this effect. It is wise to count in the factor of the plasma channel that is produced during the machining process. The plasma generated in this high voltage process allows the lingering of residual heat which has its effects on the process. Its growth during the pulse on time can have various effects on the machining process. This will also have an effect on the layers which have resolidified on the surface of the work piece. Here we will use a thermal model to show the growth of the channel alongside the effects on various factors of the machining process. We will also specify methods we will use to calculate the layer thickness of the layers that have resolidified.

Machinability of Ti6Al4V in High Speed Micro Turning Under Dry Condition

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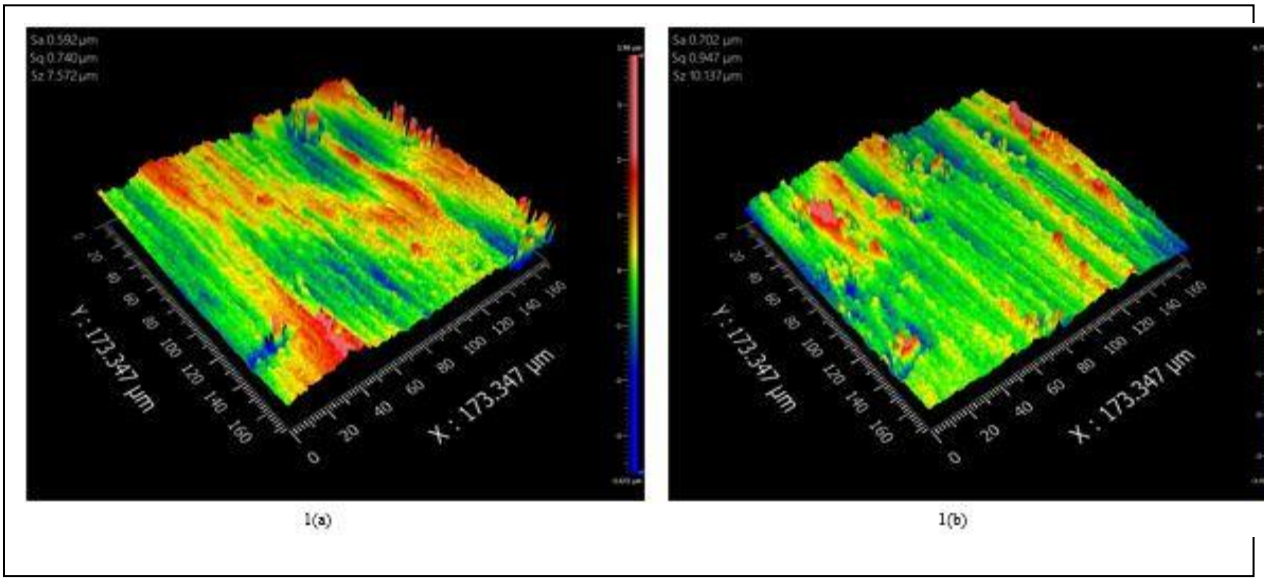
Abstract

Ti6Al4V alloy is increasingly being used in the biomedical, aerospace, and automotive applications due to its outstanding corrosion resistance and increased specific strength. Due to high chemical reactivity, lower thermal conductivity and low elastic modulus the machinability of Ti6Al4V is very poor causing high tool wear as well as surface roughness. Micro turning is a technology to fabricate miniaturize cylindrical components however the poor material removal rate promote the requirement of high speed micro turning. In this work high speed micro turning in dry condition have been performed on work piece of 3mm diameter with constant feed rate (2 µm/rev), constant depth of cut (50 µm) and two levels of cutting speeds (10000, 15000 rpm). Two different combinations of cutting speed has been used because during high speed operation rapid spark was generated as the heat completely accumulated in the chip tool interface carried out by the chips and the tendency of spark has been increased at higher cutting speed which might damage the machine tool. Investigations have been performed on the topography of the surface, the burr formation and tool wear. Surface roughness of 0.592 micron have been achieved during the experiment at lower cutting speed however when we increase the cutting speed the surface roughness has been increased due to rapid heat accumulation. Additionally, rapid crater and flank wear have been observed on the cutting tool. The tendency of exit burr formation has been increased at higher cutting speed. All of these phenomena are expediting the requirements of cooling technologies during high speed micro turning of Ti6Al4V.

Fig. 1 Surface profilometry achieved on the machined surface at 1.a (10,000 rpm) and 1.b (15,000 rpm)



1(a) 1(b)

Mechanical and Tribological Property Evaluation of Friction Stir Deposited and Hydroxyapatite Reinforced Surface layers on Ti6Al4V

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Abstract

Fabrication and processing of super alloys such as titanium and nickel alloys involve notable complexity. Although liquid-state processing provides viable solutions to an acceptable level, issues such as porosity and loss of strength are inevitable. In the recent past, solid-state processing is gaining its grip in handling a wide range of advanced materials. The present work explores the potential of friction stir deposition (FSD) in the controlled build-up of nano/micro grain-sized high-performance layers on Ti6Al4V. The approach is hypothesized to simultaneously improve the strength and ductility of the base material surface. Tribo-tests are conducted (Mode: reciprocated sliding, Tribo-pair: ball-on-flat) for varying sliding frequencies (1, 1.3, and 1.5 Hz) and constant normal load (L = 30 N). Tensile strength and elongation of the deposited layers (with and without reinforcement), notably increased by 10.17 and 25.74% (for FSD-HAp) and 13.6 and 0.3% (for FSD-N), respectively. During interactive sliding conditions, the hydroxyapatite-reinforced layers over the base material demonstrated significant wear resistance. Superior strength and hardness acquired through competent grain refinement (caused by controlled grain growth) played a critical role. Pinning of prior β grains during processing substantially restrained the size of the transformed grains, as compared to those of the deposits lacking added reinforcements.

Keywords: Ti6Al4V, Friction stir deposition, Hydroxyapatite, Grain growth, Pinning effect.

Maglev Electric Discharge Machine (MEDM): Design and development

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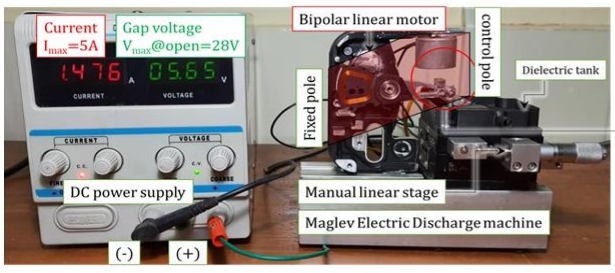
Abstract

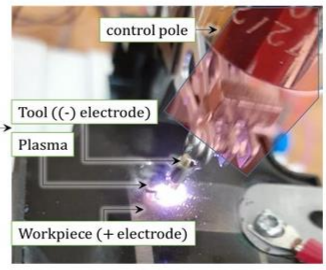
EDM is a non-Traditional thermal machining process for material removal through the electrically controlled spark. A pulsed/RC power supply is connected with a gap maintaining mechanism known as servo mechanism. The discharge gap is responsible for the smooth discharge. It affected by polluted environment due to debris, ions and uneven surface of the electrodes. Despite of the above problems it is commercialized and available in the open market. Other issues with the existing system are: slow response, less precise, intricacy, import of key components.

A solution of the above problems has been identified, designed and developed. A self servo bipolar linear actuator has been developed to control the interelectrode gap with a pure DC power supply. A simple electrical circuit has been implemented so that, it decreases the magnetic strength when the tool goes closer to the job and increases the magnetic strength when the tool goes away from the job. Therefore, it balances at a fixed discharging distance. Any generic DC power supply/DC adapters/battery/a battery charge/an electric arc welding machine can be used as power source. Since the proposed mechanism is replacing the two major components, i.e. servo mechanism and power supply, its proposed cost may be much lower than the existing EDM system. First prototype and working product is shown in Fig 1.

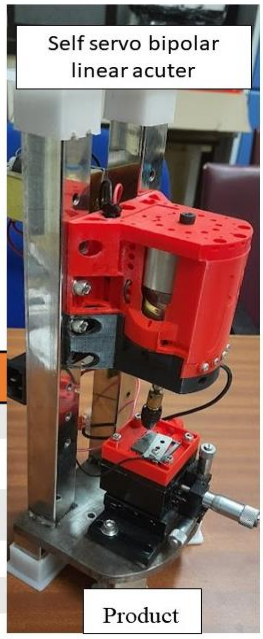
Fig. 1: Prototype of the maglev EDM and the product based on the maglev EDM technology



Power supply EDM mechanism



Plasma



A comparison between the conventional EDM and proposed maglev EDM

Sr. No.	Feature	Conventional EDM	Maglev EDM
1.	Power supply	Pulsed power/RC Power	Conventional DC power supply simple and low in cost
2.	Servo Mechanism	Voltage governed servo retraction mechanism	Self servo, direct connection between the electrodes and retraction mechanism.
3.	Power efficiency	Very low	Very high
4.	Maintenance	High	Very low
5.	Import	Key components are imported	Local components
6.	Size	Very heavy	Light weight with compact size

Direct Ink Writing-based 3D Printing of Graphene Electrodes

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Abstract

Direct ink writing (DIW) is a promising additive manufacturing technique for fabricating complex structures with nanomaterials. Graphene, a two-dimensional material, has attracted significant attention in recent years due to its remarkable mechanical, thermal, and electrical properties. However, the rheological behavior of graphene inks and its printability using DIW remains a challenge. In this paper, we present a comprehensive computational and experimental study of the rheology and printing behavior of inks used in DIW. We will discuss the development of computational models that simulate the flow behavior of inks inside the nozzle, extrusion from the nozzle tip and the deposition of material during printing. These models allow for the prediction and optimization of ink properties for optimal printability. The material and rheological properties of inks will be investigated to check their suitability for supercapacitor applications. The electrochemical and mechanical testing results of printed supercapacitors will be discussed for their potential for flexible electronic devices.

Performance Evaluation on Electrical Discharge Machining of Commercially Pure Titanium Using Two Different Dielectrics

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Abstract

Electrical discharge machining (EDM) is an electro-thermal non-traditional machining process to machine difficult to machine materials used in aerospace, automotive, marine and automotive industry. Commercial pure titanium (CPT) is exclusively used in exterior of aircraft and as material for dental implants. In EDM, the dielectric plays a major role as it directly affects the functional performance of the machined components. Among the available dielectrics, the hydrocarbon based dielectric is most commonly used in industry. However, while machining a component using hydrocarbon based dielectric emits benzene, PAH, mineral oil vapors, aerosols, and other by-products that have a serious impact on the health of operators [1, 2]. The present study aims to evaluate the performance of electrical discharge machining (EDM) of commercially pure titanium (CPT) using two different dielectric fluids, hydrocarbon oil and glycerol with ammonium fluoride solution under varying current and voltage conditions. The surface roughness, material removal rate (MRR), and tool wear rate (TWR) were investigated as performance indicators. L9 experiments were conducted for each dielectric to compare the performance measures. The surface roughness was measured using a surface profilometer, while the MRR and TWR were calculated based on the weight loss of the electrode before and after machining using equation (1) and (2) respectively

$$\text{Material removal rate } (MRR) = \frac{m_b - m_a}{t_m} \quad (1)$$

$$\text{Tool wear rate } (TWR) = \frac{t_b - t_a}{t_m} \quad (2)$$

where

m_b, m_a – mass of workpiece before and after machining respectively

t_b, t_a – mass of tool before and after machining respectively

t_m – machining time

Acknowledgments (if any)

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Microstructure and Mechanical Properties of Non Equiatomic CoCrNi Alloy Fabricated by Wire-Arc Additive Manufacturing

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Abstract

The current study investigated the non-equiatomic CoCrNi medium entropy alloy manufactured using dual Metal Intert Gas (MIG) Wire Arc Additive Manufacturing (WAAM). The evolution of microstructure, texture, and mechanical properties of deposited CoCrNi alloy and the effect of torch travel speed on the mechanical properties of the samples were examined. Microstructure evolution showed variations in grain sizes and structure in different layers of samples—the top and bottom layers consisting of fine grains and cellular structures. The hardness results showed that the sample's average microhardness value slightly increased from 430 HV to 490HV with the increase in the travel speed. Similarly, the deposited sample's yield strength (YS) and ultimate tensile strength (UTS) enhanced with the increase in the travel speed. The result showed that the WAAMed CoCrNi sample's mechanical properties were better than the as-cast sample. It demonstrated that the non-equiatomic CoCrNi alloy could be fabricated by WAAM process.

Acknowledgments

Authors are grateful to MEMS department, IIT Bombay for EBSD (OIM lab). Also, thankful to Mr. Upendra Kumar (Laser additive manufacturing laboratory, RRCAT Indore) for his experimental support. Finally, this current work is financially supported by SERB, India - Grant no.SRG/2021/001217.

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Underwater Laser Bending of Stainless-Steel Sheet

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Abstract

Laser bending is a promising and innovative manufacturing process that utilizes laser energy to shape and deform metallic materials without any external tool. Its contactless, flexible, and precise material processing capabilities make it a promising technology for applications such as repairing, alignment, and precise bending in industries like marine, aerospace, automobile, electronic, and medical. The present experimental study explores underwater laser bending and analyses the effect of various process conditions (water height, laser power, beam diameter, and scanning speed) on the bending of submerged stainless-steel sheets. The bending is found to be reduced with an increase in water height and scanning speed. The bending increased with higher laser power, suggesting that higher laser power levels can result in more pronounced bending. The effect of beam diameter was found to be more complex, with an initial increase in bending up to a peak value, followed by a decrease. This study provides valuable insights into the underwater laser bending process and its sensitivity to different process conditions. The findings contribute to the understanding of the bending behavior of submerged stainless-steel sheets. Further research in this area holds great potential for advancing the capabilities of laser bending in underwater environments and expanding its range of applications in diverse industries.

Acknowledgments

The laser system used for this study was established through a grant received from the Department of Science and Technology (DST), India, under project number DST/TDT/AMT/2017/026.

Laser Transmission Welding of Polycarbonate Sheets Using Dry Graphite Absorber

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Abstract

This study presents the experimental investigation of laser transmission welding (LTW) of polycarbonate sheets using dry graphite absorber. The experiments are conducted by means of a fiber laser on 2 mm thick sheets of polycarbonate. The effect of laser power and scan speed is studied on weld strength and weld width. The tensile tests of the welded specimens are performed to measure the breaking resistance of the welded joints. In addition, the fractured surface is analyzed to evaluate the flow trajectory and bond morphology of the joints. The results show that a maximum breaking force of 590 N is obtained at 110 W of laser power and 200 mm/min of scan speed. Higher power leads to the burning of the weld seam due to the good absorptivity of the graphite. Small laser power can provide good strength with the least weld width.

Keywords: Laser; Transmission; Welding; Graphite; Polycarbonate

Acknowledgments

The laser system used for this study was established through grant received from Department of Science and Technology (DST), India under project number DST/TDT/AMT/2017/026.

Simulation of 4D printing of a Thermally Sensitive Memory Material

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Abstract

Memory alloys and polymers are materials that can be deformed by variation of temperature and can be returned to the pre-deformed state. The parts made from such alloys can potentially become alternatives to kinematic parts having actuating function. While the memory alloys have been conventionally manufactured, there are research attempts to manufacture them using 3D printing techniques. This new approach is called as 4D printing where the fourth dimension is the stimuli which actuates or alters the form of the 3D printed part. This stream of technology is evolving with more responsive materials being explored and potentially could help in developing aerospace test technologies. In our research, one such component has been considered for characterizing the behavior of a memory material under varied thermal circumstances. This paper details about the approach of 4D simulation, results of the simulation and benefits of performing the simulation before fabrication of the actual component. The demonstration of simulation process is done using Abaqus COTS. The coupled thermo-mechanical simulations are performed to enable efficient 4D printing and ensuring effective performance of the 4D printed part under operating conditions. In this paper the simulation methodology will be verified against the published data and the future validations are planned against the physical test data.

Investigation on Tribo-Mechanical Behavior of Areca Fiber Reinforced Alumina Filled Epoxy Composites

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Abstract

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The research work investigates the Mechanical and dry sliding wear behavior of (AL2O3) alumina filled Areca fiber added Epoxy composites. The specimens with varying percentages of Alumina filler (0, 4%, 8%) by weight were prepared by using the compression molding technique. The machine driven properties such as D-Shore hardness, impact strength, and tensile properties were studied as per the ASTM standards. The Tribological behavior of composite were studied as per the ASTM Standard by varying the load 10N to 30N.In all the tests 8%AL2O3-A-E composite shows highest hardness of 81 shore D, impact strength 180J/m2, Tensile strength 23Mpa.For improvement of hardness and strength the main contributing factors were uniform dispersion of AL2O3 particles and better load transfer between AL2O3 particles and Epoxy matrix. The wear studies show that wear loss and specific wear rate raises as the load raises but load bearing capacity of (8wt%) AL2O3 due to its mesh size, and shape acts as antiwear properties and hence shows lower wear loss and specific wear rate values as related to neat Areca fiber reinforced Epoxy composites. The scanning electron microscope examination on the wear mechanisms of AL2O3 loaded A-E specimen were investigated

Acknowledgments (if any)

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Surface Analysis of Inconel Alloy Machined by μ-EDM with Nano-Powder Blended Dielectric

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Abstract

Material removal using micro electrical discharge machining (m-EDM) has gained importance over the past few years. m-EDM helps in the machining of complex metals and alloys which are electrically conductive in nature. Although this process has advantages, its low Material Removal Rate (MRR) and high surface roughness limit the range of applications. To minimize this problem, a study has been conducted to investigate whether mixing graphene nano-powders with the dielectric medium will increase the rate of metal removal and improve surface quality of the super alloy. Taguchi design is employed to carry out the experiments considering both plain and powder mixed dielectric as input parameters. The effect of machining factors in □-EDM such as current, capacitance and pulse-on time on Material Removal Rate (MRR) and Overcut (OC) is explored and analyzed for their significance. While juxtaposed to the standard dielectric, it has been found that the nanopowder mixed dielectric medium provides a better surface quality and a higher rate of metal removal. Subsequently, the machined surface has been observed under Scanning Electron Microscopy (SEM), which reveals a significant reduction of micro-cracks, micro-holes, and uneven surface during the nano-powder mixed m-EDM process.

Keywords: Micromachining, powder mixed dielectric, super alloy, graphene nanopowder, material removal rate

Optimization of Machining Variables During Nano Powder Mixed µ-EDM of Niti Shape Memory Alloy

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Abstract

Smart alloy miniaturization has become a new trend for the modern manufacturing industry. Nickel-titanium (NiTi) shape memory alloy is one of the smart materials which has a huge application in the aerospace and biomedical industry due to its certain supreme features like shape memory effect, high ductility, strong corrosion-resistance, and elevated wear resistance. The addition of conductive nano powder into the dielectric oil enhanced the machining efficiency of µ-EDM. Thus, the present study investigates the impact of process parameters like Gap voltage, powder concentration and pulse on time towards the material removal rate (MRR) and diametral overcut (DOC) during graphene nano powder mixed µ- EDM of NiTi SMA. Taguchi's L9 orthogonal array is selected for the experimental design. ANOVA analysis has been carried out to calculate the percentage distribution of each machining parameter towards all responses. It is observed that the application of graphene nano powder into the dielectric oil significantly enhanced the MRR. Both single and multi- response optimization has been conducted to find the maximum MRR along with the minimum DOC. The obtained results depicted a parametric combination that maximizes the MRR and lessens the DOC after graphene nano powder mixed µ- EDM process on NiTi SMA.

Study of Various Flank Surface Textured Coated Carbide and Ceramic Tools and their effect on the Performance Parameters during Machining of Hardened H13 Steel

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Abstract

Cutting tools with plain cutting surfaces are sometimes unable to fulfil the machining quality requirements of certain materials especially with increased hardness. In such a condition, cutting tool with flank surface textured comes as a viable method for improving the performance parameters during machining of such hard materials. Flank surface textures of the cutting tool can be fabricated by micro-electric discharge machining, femto-second laser, focused ion beam machining, grinding process etc. Thus the present study investigates the implementation of different flank face textures on cutting tools of different materials and their effect on performance parameters such as surface roughness of the workpiece, tool wear and temperature generated during machining of such hardened materials. Dot textures (DT) and groove textures (GT) are fabricated on the flank surface of coated carbide and ceramic cutting inserts by the use of micro-electric discharge machining (µ-EDM) process. Turning experiments were carried out with these textured tools on hardened H13 steel to study the effect of the textures on the performance parameters. Finally, a comparison of textured and non-textured tools of each material was carried out in terms of the performance parameters. The results showed that DT helps in improving the performance parameters the most for both the coated carbide and the ceramic tools. Also, the improvements in performance parameters due to the DT were higher for coated carbide tool compared to the ceramic tool.

A Novel Approach to WELD FLOW ANALYSIS oF ELECTRIC RESISTANCE WELDED (ERW) TUBES: Significance and Implications

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Abstract

Carbon pipes manufactured using the techniques of Electric Resistance Welding (ERW) and High Frequency Induction welding (HFIW) processes offer considerable savings in cost to the potential end user when compared one-on-one with both seamless and Submerged Arc Welded (SAW) pipes. In the past, this sort of pipes was not fully trusted for selection and use in applications in the industries spanning oil and natural gas essentially because of the occurrence of sudden and catastrophic failures while in service. This necessitated the need for important quality checks into the process with the prime objective of avoiding catastrophic failure during service while concurrently ensuring a healthy synergism of trust and reliability in the industries spanning oil, gasoline and even automobiles. In this energetic and elegantly enunciated presentation the significance and need for this research study, resultant impact and far-reaching applications will be highlighted . This presentation will elegantly highlight all the intricacies specific to the analysis of weld flow lines formed during Electric Resistance Welding (ERW) process and its concomitant influence on mechanical properties and overall mechanical performance. To have sound welded electric resistance welded (ERW) tubes, there are a couple of parameters which are important and need to be taken into consideration. An important parameter is the optimal compressive force that is applied during the manufacturing process used for the welding rolls to achieve deformation. This parameter is assessed from the pattern of weld flow lines that are formed.

Once the product is ready, an examination of the weld flow lines is carried out at the junction of the heat-affected zone (HAZ) of the electric resistance welded (ERW) tubes. Results and details of the examination will help the manufacturer to assess overall quality of the weld on the electric resistance welded (ERW) tubes by a careful and systematic analysis of the weld flow lines pattern and the angle of bend in the Heat Affected zone (HAZ). This essentially involves metallographic sample preparation followed by precision etching and microscopic examination with the prime purpose of observing the weld flow lines in the heat-affected zone (HAZ). The weld flow lines, and pattern is analyzed using an optical microscope and at magnifications of 50 to 100 x.

The Effect of Heat Treatment and Squeeze Casting on the Microstructure and Creep Behavior of Die-cast AZ91 Magnesium Alloy

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Abstract

The microstructure and creep behavior of AZ91 (Mg-Al) alloy fabricated using gravity die casting, and squeeze casting have been evaluated in the present study. The effect of T4 and T6 heat treatments on the creep performance of the die-cast alloy is also investigated. There are wide applications of AZ91 in the automotive industry, owing to its good mechanical properties (at room temperature) and excellent die castability. The density for both alloys is computed using the Archimedes principle, which is higher for squeeze-casted alloy, resulting in reduced porosity and defects compared to die-cast alloy. The microstructure refinement is observed in the case of squeeze-cast alloy, which makes the alloy harder, resulting in a higher microhardness (82Hv) than die-cast alloy (72Hv). The Vickers microhardness test was performed with a 300gf load and 20 seconds dwell time. The microstructure analysis using scanning electron microscopy shows that the alloys comprise α-Mg (Mg-Al solid solution) and massive β-Mg17Al12 intermetallic phases with irregular morphology, with a continuous distribution in the squeeze-cast alloy. However, the distribution is discontinuous in the case of gravity die-cast. Due to incoherency at the interface of the Mg matrix and β-Mg17Al12 phase, the cavity formation is observed in the crept samples, where these cavities are more significant with the gravity die-casted alloy. Tensile creep tests were carried out within the stress range of 25MPa-50MPa and temperature range of 100oC-150oC. It was found that the squeeze-cast alloy exhibited a lower creep rate, thus, improving creep resistance compared to the gravity die-cast alloy, where die-cast AZ91 alloy with T4 and T6 heat treatments shows significant improvement in the creep performance when compared with the as-cast alloy.

Key Words: AZ91 Mg alloy; Creep; Cavity formation; Microstructure; Squeeze-casting

Microstructure and Mechanical Properties of Ni-Al-Co-Cr-Fe-Ti-Ta-Mo-W based High Entropy Superalloy

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Abstract

The present analysis used the CALPHAD method to develop the Ni-Al-Co-Cr-Fe-Ti-Ta-Mo-W-based high entropy super alloy (HESA). The composition is melted using the Vacuum arc melting technique, then X-ray diffraction (XRD) and scanning electron microscope (SEM) techniques are used to characterize its microstructural and structural characteristics. The microstructure of the as-cast HESA is found to consist of two phases, i.e., FCC-ordered γ′ and disordered γ phase. The existence of the expected phases is also confirmed using differential scanning calorimetry (DSC) analysis, which is found to be in great agreement with the CALPHAD prediction. Further, the mechanical response of the as-cast HESA is examined at room temperature using microhardness and tensile tests. Hardness, yield strength, and ultimate tensile strength are found to be 354±8.6 HV0.2,1021MPa and 1098 MPa, respectively. Further, Fractographic analysis has also been done to understand the failure mechanism better.
Keywords: High Entropy superalloys, Microstructure, Mechanical Property, EBSD

Micromachining of NiTi SMA Composite Bimorph for Smart Actuators Using a CO2 laser

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Abstract

Composites developed by depositing NiTi thin films onto a flexible substrate like Kapton polyimide can be utilised in micro electro-mechanical systems (MEMS) such as actuators. However, fabricating customized actuators using thin film bimorph is still a challenge. Laser energy has been employed for micromachining of bulk materials and thin metal and plastic sheets for static structures. Continuing on the similar lines, this work attempts for micromachining of flexible composite of NiTi/Kapton polyimide bimorph to develop smart actuators. NiTi SMA bimorph was fabricated using e-beam evaporation technique followed by micromachining using 10.60 µm CO2 laser. The deposited film thickness was 513 nm. The micromachined edge was created at a laser fluence of 5.1 J/cm2 at scan speed of 40mm/min without any heat affected zone. The micromachined edge was smooth, however, carbonization of polyimide was observed. Delamination of the deposited NiTi film was not observed after the interaction of laser with the bimorph. However, the laser interaction with the film increases the surface roughness near the micromachined edge compared to that of middle of the actuator.
Keywords: Shape memory alloy, NiTi, laser micromachining, CO2 laser.

Does the Atomic Order Hinder the Diffusion in Multicomponent Intermetallics?

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Abstract

High Entropy Alloys (HEAs) as a new class of materials provide wide opportunities to research on fundamental and technological applications. The presence of multi-principal elements and simple crystal structures in HEAs resulted in superior mechanical properties, especially at high temperatures. These properties mainly depend on the composition and microstructural stability, which is primarily influenced by the elemental behaviour within solid solutions. Hence it is important to understand the thermodynamic interactions among the alloying elements and their activity/mobility inside the matrix. Diffusion studies provide a very powerful and sencitive approach to understand the fundamental behaviour of atomic mobilities, kinetic and thermodynamic interactions and their influence on microstructural stability.

The present paper highlights a novel alloy design of HEAs to obtain fully ordered pseudobinary multicomponent aluminides and is focused on the underlying diffusion behaviour. Microstructure and sublattice ordering in multicomponent alloys starting from binary to hexanary B2 aluminides are studied. A radiotracer technique using the 57Co, 59Fe, 54Mn, 63Ni and 65Zn radioisotopes is employed to measure the diffusion kinetics of individual elements. Diffusion in multicomponent B2 ordered alloys is found to be faster in comparison to binary AlNi. Furthermore, an approach to measure tracer diffusion under a composition gradient is followed, combining the inter- and tracer diffusion techniques. Addition of Co to AlNi is observed to slow down diffusion and Fe is established to enhance diffusion. The measured diffusivities are correlated with the presence of the respective alloying elements and the type of defects that they stabilize.

Lubricant Wetting Transitions and Scuffing in Nano-Micro Topographies

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Abstract

Nano-micro scale surface topographies can influence engineering surfaces' lubricant wettability, flowability, and entrapment capability. This work discusses the influence of nano-scale surface roughness frequencies, roughness parameters, and surface energy on mixed wetting and its transitions. The work has been carried out to explore the tribo-chemical reactions and interactions leading to scuffing in traction drives. Sessile drop experiments were conducted on hierarchical engineering surfaces having multiple nano-micro scale roughness frequencies. Results show that the net roughness Ra or Rq (RMS roughness) solely cannot dictate the wettability behavior. Fourier Band Pass Filtering (FBPF) and Power Spectral Density (PSD) analysis revealed that all roughness frequencies in a hierarchical rough surface contribute to the net roughness Ra and Rq; however, all need not contribute to wettability transitions.1,2 In addition, Surface Energy could potentially affect these wetting behaviors exhibited by lubricants. The insights obtained extend to exploring the lubrication possibilities of lubricant Nano-Wear-additives to alter the surface tension and tribo-chemical interface reactions to reduce scuffing in tribo-components. 3

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Key-hole Plasma Arc Welding of High Thickness Titanium Using Modified Single V Groove Joint

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Abstract

Moderate strength, low weight and outstanding corrosion resistance possessed by Titanium have led to wide range of successful application in aerospace, chemical plant, power generation, oil/gas extraction and other industries. Welding of titanium by various processes is widely practiced. Being reactive metal, titanium needs extreme cleanliness so Gas Tungsten Arc (GTA) welding is first choice for welding of titanium. One of the application required welding of 16 to 20 mm thick range titanium plates. For welding higher thickness material by GTAW process, numerous number of weld passes are required for filling double groove joint. Level of distortion and chances of defect are increases with increase in number of passes.

Plasma arc welding is explored to take advantage of high penetration key-hole mode welding. Key-hole plasma arc welding is satisfactory for obtaining full penetration weld in single pass up to 8 to 10 mm thickness with square edge preparation. In present work, key-hole plasma arc welding (PAW) is used along with Machine GTAW process for welding of 20 mm thick titanium to reduce number of passes and filler metal consumption. Edge preparation is modified from double V to single V with 8-10 mm root face. 8-10 mm root face is successfully welded by key-hole PAW and other side of V groove is filled with machine GTAW process. Productivity is considerably improved and heat-input/ distortion is significantly reduced with implementation of plasma arc welding as compared to gas tungsten arc welding.

Keywords: Key-hole Plasma Arc Welding, Modified V Groove, Machine GTAW, Productivity, Titanium

Dynamics and Load Analysis of Micro Hydraulic Actuator Controlled Through Multiple Micro Pumps

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Abstract

This research paper investigates the dynamics and load analysis of a micro hydraulic actuator controlled through multiple PZT micropumps. The miniaturization trend in electronic components has led to increased interest in micromechanical systems. Micro actuators offer advantages of speed, accuracy, and cost-effectiveness compared to larger systems, making them suitable for various applications in biotechnology, industrial automation, and healthcare. Hydraulic actuation, with its high power density and immunity to electromagnetic and electrostatic interferences, has emerged as a promising method for high-performance micro actuators.

In this study, we present detailed investigations on load analysis for an asymmetric micro hydraulic actuator. An experimental setup was developed, consisting of the actuator, multiple PZT micro pumps, micro pump drivers, and data acquisition systems. The micropumps were operated in parallel to control the actuator at different frequencies and voltages. Measurements of actuator displacement under various load and no-load conditions were recorded using sensors and instrumentation. The results provide valuable insights into the dynamics and load characteristics of the micro hydraulic actuator, enabling the optimization of its performance. The study demonstrates the feasibility and effectiveness of using multiple micro pumps in parallel to control the actuator, opening new possibilities for advanced micro hydraulic actuation systems.

Keywords — fluid power systems, hydraulic circuits, safety, reliability, machine tools.

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Finite Element Analysis of Stress Distribution in Artificial Bone Plate and Fractured Femur Bone

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Abstract

Increasing risk of serious diseases and accidents, medical science needs the most suitable artificial biomaterials for various medical applications. Demand of such biomaterials are increasing day by day that leads development in biomaterial field. In current scenario, various advanced modeling and simulation software are available in research field, which are very helpful in prediction of behaviour of any material in its actual working condition. These software provide a virtual platform to understand the performance of targeted biomaterial without implanting inside the human body. This work focuses the same study in which different artificial biomaterials are used as fixation bone plate. Different materials having different mechanical, metallurgical and chemical properties that affect the human femur bone differently. Hence, real femur bone is taken for creating real environment, designed a bone plate with specific dimensions and assembled with real femur bone using screws. Further, stainless steel (SS), titanium and titanium alloy are selected by putting their specific properties with some assumptions. Stress distribution is analyzed in femur bone, artificial bone plate and screws by applying load with boundary conditions. SS bone fixation plate depicted high stresses than titanium and titanium alloy due to less strength than titanium. Stress shielding effect is also observed in this fixation plate that creates problem in human body due to non-uniform stress distribution over host tissue and artificial implant. This study is very useful for selection of suitable biomaterial as per the application according to the load bearing capability of material and host tissue. Results of this study can be helpful for surgeon as well as manufacturer for designing of customized bone fixation plate, screws with appropriate biomaterial.

Acknowledgments

Authors acknowledge Dr. Vishwanath D. Karad MIT World Peace University, Pune, India for providing all simulation workstation for conducting this work.

Anti-Fungal Activity of Redox Metal-Organic Frameworks (R-Mofs) Through Synergistic Release of Sodium Lignosulphonate

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Abstract

In this research, we developed a novel one-step method to prepare a composite material consisting of redox CeO2 nanoparticle- loaded carbon nanotube (CNT)-based metal-organic frameworks (R-MOFs). This composite material exhibits a highly effective and targeted antimycotic drug delivery system (DDS). We loaded sodium lignosulfonate (SLS) onto the formulated R-MOFs-based DDS and investigated the synergistic antifungal activity of SLS-loaded R-MOFs (SLS/R-MOFs) against Aspergillus fumigatus, a common fungal strain causing Histoplasmosis. CeO2 NPs are incorporated into the framework of CNT-MOFs to enhance their antifungal properties due to their interchangeable valency states (Ce (III) and Ce (IV)) and production of ROS to damage fungal cell wall. The structure and morphology of the composite material are characterized, confirming the successful doping of CeO2 NPs onto the surface of CNT-MOFs. We evaluated the antifungal activity of R-MOFs and SLS/R-MOFs against Aspergillus fumigatus and compared it to conventional sodium lignosulfonate delivery methods. The results demonstrate the superior synergistic antifungal effect of the composite materia and sustained drug delivery, highlighting its potential as an effective drug delivery system for combating Aspergillus fumigatus infections.

Keywords:Redox Metal-Organic Frameworks (R-MOFs), Reactive Oxygen Species (ROS), Antifungal activity-Aspergillus fumigatus, Sodium Lignosulphonate, Sustained drug delivery

Transient Stealth Coating of Liver Scavenger Sinusoidal Wall Enables Retargeting of Nanomedicines

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Abstract

Site-specific delivery of nanomedicines has tremendous potential for improving the diagnosis and treatment of diseases. However, the reticuloendothelial system (RES) organs, particularly the liver, capture most of the injected nanomedicine dose upon systemic administration, causing a substantial decrease in the delivery efficiency of nanomedicines into the target diseased tissues and often raising toxicity concerns. Here, we addressed this issue by in situ stealth coating of liver scavenger sinusoidal wall cells using one-armed or two-armed poly(ethylene glycol) (PEG)–conjugated oligo(l-peptide). PEG-OligoPeptide polymers are selectively bound to liver sinusoids for PEG coating, leaving the other tissue endothelium uncoated, thus, accessible to the nanomedicines. OligoPeptide with a two-armed PEG configuration was progressively removed from sinusoidal walls to the bile. In contrast, OligoPeptide possessing a one-armed PEG persisted on the liver sinusoidal walls, possibly causing prolonged disturbance of normal physiological functions of the liver. Ultimately, the transient and selective stealth coating of liver scavenger cells by two-arm-PEG-OligoPeptide effectively prevented the sinusoidal elimination nanomedicines, thereby boosting their targeting efficiency to the target tissues.

Acknowledgments

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Solidification Behavior and Microstructure Evolution of Al-12.5wt%Si-(Tib2+Al2O3) Hybrid Composite

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Abstract

The solidification behavior and microstructural evolution of an Al-12.5%Si-(TiB2+Al2O3) hybrid composite was investigated using differential scanning calorimetry (DSC) and cooling curve analysis. The composite was fabricated using the in-situ stir casting technique, involving salt-metal reactions. The DSC/DTG curve analysis revealed exothermic reactions occurring in the Aluminium melt, leading to the formation of oxides on its surface. The study focused on the evolution of microstructures and the growth of silicon in the eutectic phase. It was observed that silicon was predominantly dispersed in a needle-like shape within the matrix. Additionally, plate-like (primary) structures of silicon were also identified. To examine the cooling behavior of the hybrid composite, a data acquisition system was employed to record the cooling curve during the pouring of the composite melt. The analysis of this curve allowed for the identification of various temperatures associated with nucleation, growth, recalescence, and the cooling rates. Overall, this research provides valuable insights into the solidification behavior and microstructural characteristics of the Al-12.5%Si-(TiB2+Al2O3) hybrid composite. These findings contribute to a deeper understanding of the properties of the hybrid composite and may pave the way for its improved application in various industrial sectors.

Design & Static Analysis of Connecting Rod of A Petrol Engine Using FEA

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Abstract

The Connecting rod is one of the functional elements of an I.C. engine. It transmits the gas force from the reciprocating part to the rotating part of an engine. The design of connecting rod majorly influences the performance of an IC engine. In the present work, the design and finite element analysis are carried out for connecting rod of a 124cc Honda shine bike. The modelling of the connecting rod was carried out using SOLIDWORK® 2017-18 software. The performance of the connecting rod was analysed by finite element analysis using SOLIDWORK® software. The static stress analysis was performed under cyclic tensile and compressive load of 4702.64 N. The I-type connecting rod has the maximum stress of 235 MPa with factor of safety of 2-4.2. The newly designed connecting rod has decreased stress and increased factor of safety compared to existing I-type connecting rod.

Temperature and Fluid Velocity Field Estimation in Melt-Pool using Multiphysics Based Numerical Simulation for Multi-track Selective Laser Melting Process

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Abstract

Selective Laser Melting (SLM) process involves various physics-based phenomena with many process variables, so predictions of its characteristics and part quality is tedious. Researchers are developing numerous numerical and analytical formulation models to simulate the SLM process realistically and efficiently to compute various functions and part characteristics. The present work developed a fully developed Multiphysics 3D Finite Element numerical model for the multi-track SLM process by incorporating transient heat transfer, fluid flow, Marangoni effect, and material phase transformation. The porosity and deformation behaviour of the powder bed is also considered to replicate the possible contraction in the powder bed. The temperature-dependent material properties of Ti6Al4V alloy were used to run the simulation. The temperature and velocity distribution obtained after incorporating fluid behvaiour and Marangoni convection gives the final melt-pool dimensions by extrapolating the temperature isotherms. Melt-pool dimensions increase with the subsequent tracks due to higher temperature regions in consecutive tracks, which further stabilizes once it attains steady-state temperature. The model can be further improved to study the part distortion and residual stresses in SLM process.

Keywords: Selective Laser Melting; Multiphysics Modelling; Melt-pool; Fluid-flow; Marangoni Effect.

In-Situ Dispersion of Electrospun Nanofibers in PDMS For Fabrication of High Strength, Transparent Nanocomposites

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Abstract

The polymer nanocomposites find applications in diverse areas ranging from smart materials to bioengineering. They are developed by dispersion of nanomaterials in a bulk phase of a polymeric material. Although several methods facilitate efficient dispersion of nanomaterials in a bulk polymer matrix to create nanocomposites, majority of them follows “heat, beat and treat” processes. These processes are high energy demanding processes. Moreover, the challenge increases when nanomaterials need to be dispersed in a viscous polymeric material. This results in spatial heterogeneity in the dispersion of nanomaterials, eventually leading to compromised mechanical properties of a nanocomposite. Therefore, in the current work, we propose an in-situ, on-step fabrication process of polydimethylsiloxane (PDMS) nanocomposites. Electrospun polyvinyl alcohol (PVA) nanofibers are homogenously dispersed in a PDMS matrix to create a high strength, transparent PDMS nanocomposite. The homogenous dispersion of nanofibers in PDMS matrix is characterised by scanning electron microscopy (SEM), confocal imaging and rheological studies. Further, the prepared PDMS nanocomposite exhibits improved mechanical strength and comparable optical transparency in comparison to native PDMS. Hence, the fabricated PDMS nanocomposites, being resistant to mechanical stress and optically transparent, will find applications as transdermal patches, flexible electronics, microfluidic devices and others.

Acknowledgments

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Investigation into the Shock Attenuation Response of a Hybrid Closed Cell Aluminium Metallic Foam under Shock Loading

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Abstract

The utilisation of foam material for its application in the field of aerospace, defence, and auto sector industries has been the subject of intense research over the past few years because of its light weight and shock/blast/impact mitigation properties. This paper deals with the study and analysis of the effect of foam density and pore morphology of the foam structure on the shock attenuation behaviour of the metallic foams subjected to high pressure shock wave impact loading, in order to protect the object behind it from shock impact. In our present investigation, a hybrid aluminium metal matrix closed cell composite foam samples having composition of Aluminium alloy (LM-13) with varying concentration of $CaCO_3$ (2 wt%, 2.5 wt% and 3 wt%) as a blowing agent being reinforced with boron carbide (B_4C) of concentration (3 wt%) and 0.5 wt% of graphene nanoparticles respectively, has been investigated for its response to high pressure shock wave impact in a conventional shock tube. The drop in reflected pressure and time delay for the shock waves to dissipate through the different foam samples has been studied and compared to that of no foam condition. It was observed from the results that the rate of pressure rise and the peak pressure achieved for the foam sample decreases substantially with the increase in the foam's relative density and decrease in the porosity level of the foam sample. According to the study's findings, it can be concluded that closed-cell aluminium metal foam can be employed to defend and protect structures against blasts and shock impact by acting as a sacrificial layer.

Magnetorheological Characterization Assessment of Developed Composite Magnetic Abrasive Towards Surface Finishing

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Abstract

A magnetisable composite magnetic abrasive is one of the most promising candidates for overcoming the material removal rate limitation in the polishing/finishing of engineering materials. A composite magnetic abrasive (EIP-Al_2O_3) was developed via powder metallurgy and the conventional sintering route. SEM analysis of the composite particle shape morphology and VSM analysis of the magnetic characterization were both carried out. A parallel plate rotational rheometer was used to measure the rheological properties of a finishing slurry containing composite magnetic abrasive powder in magnetic field (~ 0.5T) under shear rate, shear strain, and shear stress sweep mode. The rheological response to temperature changes was also studied. A slurry made of composite magnetic abrasives has notable and coherent rheological characteristics. Additionally, temperature variations have minimal impact on rheological properties, improving its prognostication power for surface finishing. A preliminary surface-finishing test on the planar surface of Al-6061 confirmed its excellent finishing capabilities.

Keywords: Composite magnetic abrasive; rheological properties; finishing slurry, Al-6061.

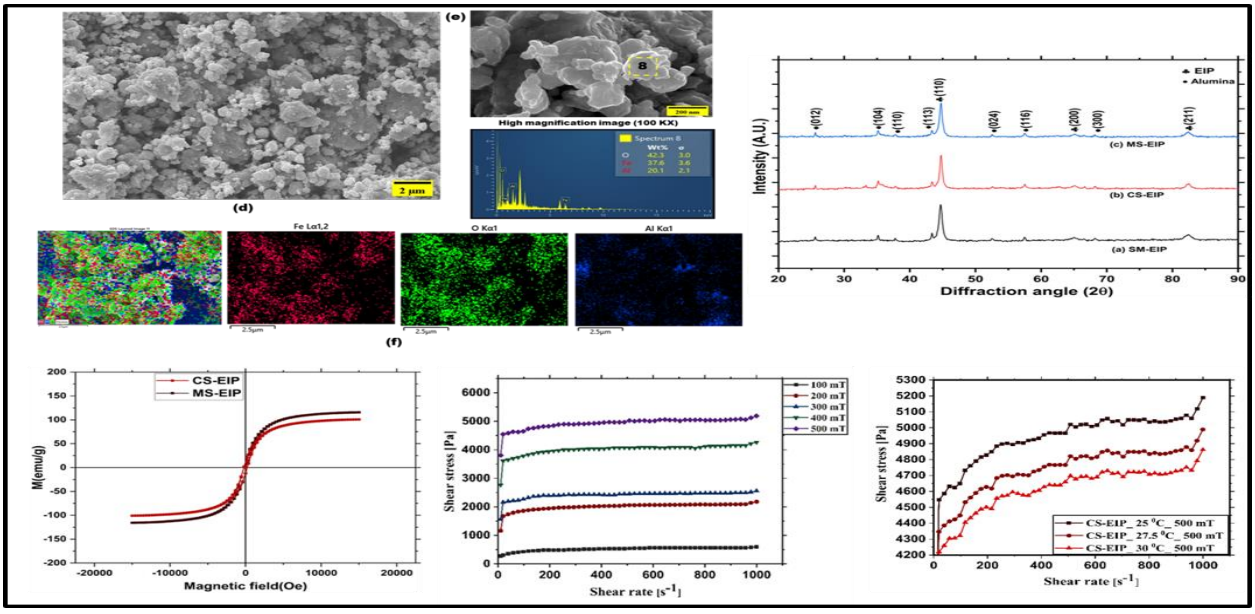

Figure1. Graphical representation of characterization results of developed composite magnetic abrasive.

Stress and Vibration Behaviour of 4 Bladed Composite Marine Propeller

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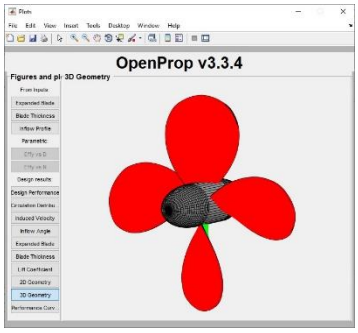
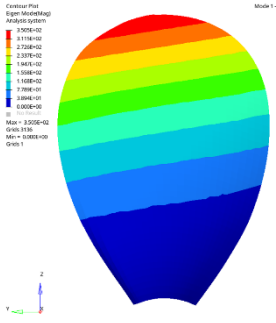
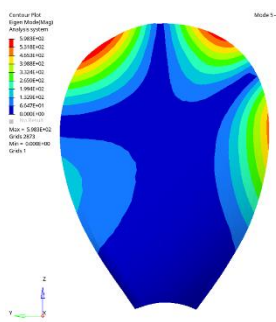
Abstract

The marine propeller used in the ship is a critical part whose stability and life play important role in selecting particular material. Generally, steel was used from past several decades, and very widely used alloys are NAB and MAB. This propeller is subjected to dynamic loads like Torque, Thrust and Centrifugal bending and centrifugal force. Research work mainly focused on suitability of composite materials tested for marine propeller application. The static structural and free vibration analysis on composite marine proper is carried. the geometry developed for scaled model is used for present simulation. An Attempt is made to modify the propeller geometry by combining 4 bladed B-series propeller and 5 bladed 4381 propeller an modified 4381 propeller geometry developed and used in present work. Propeller size is scaled down to 6 times to reduce the computation time. The torque, thrust force acting on propeller and efficiency of the propeller were computed for actual and scaled propeller by using open prop MATLAB tool for advanced velocities from 0.4 m/s to 1.1m/s. Structural and model analysis is carried on the scaled propeller blade, the composite layup was arrived at using Hypermesh and analysis is carried with Altair-Optistruct solver. The torque and thrust forces obtained from open water characteristics study using MAT Lab, were given as input to the structural analysis. Results revealed that metallic propeller has lowest displacement, whereas CFRP composite propeller has next lowest displacement, GFRP composite has highest displacement. The model analysis carried by using Altair-Hypermesh, the first 10 natural frequencies were extracted, the results revealed that CFRP composite has higher natural frequency than NAB propeller in first 4 modes. GFRP has far low natural frequencies when compared to CFRP.







Hydroxyapatite Synthesis from Cuttlefish Bone for Biomedical Application

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Abstract

In the present study, the hydroxyapatite was synthesized from coral cuttlebone, which was achieved by the mechanochemical method. The synthesized material was characterized using a Field Emission Scanning Electron Microscope (FESEM), Fourier transform infrared spectroscopy (FTIR), and Thermogravimetric Analysis (TGA) to identify their phases and functional groups. FESEM of the developed material shows one-dimensional nanorod morphology, and XRD confirms that the main phase was hydroxyapatite with slight traces of tricalcium phosphate found when calcined at 800 °C. The spectra showed only phosphate and hydroxyl peaks, and TGA results confirm no traces of the organic phase. Moreover, synthesized hydroxyapatite showed excellent microbial activity against Escherichia coli and Staphylococcus aureus bacteria. Cytocompatibility against mouse L929 fibroblast cells indicates that these materials are antimicrobial, cytocompatible, and suitable for biomedical applications.

Keywords: Hydroxyapatite, Cuttlefish bone, Biomaterial, Mechanochemical method.

Negative Poisson Ratio Metamaterial Structure for Wing Morphing

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Abstract

Additive manufacturing (AM) has advanced from prototyping to production technology in recent years. The use of additive manufacturing is expanding in various industries, fostering the innovation and productivity of design engineers. Design for Additive Manufacturing (DfAM) seeks to optimize product design to handle the complexity of the manufacturing processes while also defining significant advantages of the AM-based product in the usage stages of its life cycle. With the part consolidation capabilities offered by metal 3D printing technology, manufacturers can now achieve the reduction in cost, supply chain risk, and improved performance they seek. Using DfAM, the Advanced Turboprop (ATP) reduced the number of components from 855 to just 12. Due to this extensive consolidation, fewer parts need to be designed, certified, inspected, and manufactured. 3D printed technology was successfully demonstrated in a civilian turboprop engine, which increased power output by 10 per cent, reduced engine weight, and improved fuel burn by 20%. We can identify three key areas where

the AM-centered design tools could have the most significant influence when looking at the specific advantages of DfAM: design freedom, part consolidation, and lightweight. Good knowledge of design (DfAM) can improve the sustainability of AM. The design for additive manufacturing is essential because the geometry of a component affects the CO2 emissions of manufacturing that component. In the aerospace industry, even a small component weight reduction using AM techniques like lattice structures or topology optimization can save much fuel. Recent developments in DfAM enable us to quickly fabricate distinctive materials with complex microstructures, opening new possibilities for material development.
Materials, which exhibit unusual properties at the micro- and nanoscales due to their logically planned architectures, are widely used in creating metamaterials with enhanced physical and mechanical properties. Auxetic metamaterials exhibit the unexpected behaviour of a negative Poisson's ratio (NPR), meaning they expand transversely when stretched longitudinally. The arrangement of the individual unit cells in an auxetic lattice causes them to behave in this manner. This poster presentation focuses on developing a morphing airfoil that draws inspiration from birds, which changes the shape of their wings to achieve manoeuvrability and the best performance under various flight conditions. The demand for efficient airfoils is growing along with the demand for more aerodynamically efficient structures that can result in fuel efficiency. Due to its flexibility in adapting to different mission conditions, the morphing airfoil has many applications, such as unmanned aerial vehicles (UAVs), missiles, and military operations. The aerospace industry is becoming increasingly interested in integrating mesostructures in morphing wings because of their improved aeromechanical attributes and lightweight characteristics. A re-entrant honeycomb structure integrated within an Eppler 420 airfoil was designed as part of our lean manufacturing project. These two chambered airfoils were chosen because they have an excellent lift-to-drag ratio. To investigate the characteristics of an airfoil, 3D structural models are necessary. Re-entrant honeycomb structures made of Glass Fiber Reinforced Polymer (GFRP) are subjected to structural analysis. This is done to determine the displacement of the airfoil's trailing edge on the given range of loadings and to comprehend and assess the compliance of the unit cell pattern. The GFRP is chosen due to its high flexibility leading to the higher displacement of the trailing edge at the same load compared to Al 6061 T6 alloy.

At 150 N force, we achieved a negative Poisson ratio of - 0.693 and a trailing edge displacement of 0.027m. We advanced our project by using additive manufacturing technology to prototype it. We scaled down the model and manufactured it with another flexible material like TPU instead of GFRP due to manufacturing constraints, including the size that can be printed on the printer and material non-availability.

Therefore, DfAM is crucial to the development of additive manufacturing. Recent studies have shown that one of the obstacles to the further adoption of AM is the need for more knowledge about DfAM tools and techniques. Ensuring a constant, seamless flow throughout the part is one of the biggest challenges in achieving good design for additive manufacturing. DfAM procedures should focus on imagining the finished product, its intended use, and the stresses it will be put through. Advances in multi-material printing capabilities will help designers make a part using different materials with varying properties. Despite the advancements, some significant obstacles must be overcome before DFAM can be widely adopted. These factors include financial considerations, a need for more available materials, certification, repeatability, and software advancement to keep up with the demand momentum. Training engineering teams in DfAM principles is a requisite, but investing in the right generative design, topology optimization, and simulation software can provide a real jumpstart to change engineering mindsets. In the final poster, a DfAM design and analysis of the auxetic airfoil structure for wing morphing applications, along with its 3D printed prototype, will be presented.

Microstructure and Mechanical Behaviour of Ti6Al4V Specimens Fabricated Using Laser Powder Bed Fusion

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Abstract

The Ti6Al4V alloy is used in lightweight structural applications, particularly in the design of compressor components for aircraft engines. However, manufacturing these components is a major challenge for the industry. Therefore, the Laser Powder Bed Fusion (LPBF) process was chosen for its flexibility in handling customized geometries, microstructure customization, and tool-free manufacturing with minimal wastage. However, due to the rapid heating and cooling cycles, the LPBF process produces high temperature gradients that lead to significant changes in the microstructure and mechanical properties of the manufactured parts. The microstructure evolution of Ti6Al4V alloy is complex and mainly influenced by the input parameters of LPBF process. Therefore, Ti6Al4V specimens were fabricated considering three different sets of input process parameters to perform tensile tests and microstructure investigations. The test results such as yield strength, ultimate tensile strength and elongation at break and the microstructure behavior of different specimens are presented in this paper.

Keywords: Laser powder bed fusion, process parameters, energy density, tensile strength, fractography, microstructure and Ti6Al4V alloys.

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Effect of Plasma Sprayed Tio2-15wt% Inconel 718 Coatings on Salt Spray Corrosion of on SS304 Steel

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Abstract

Today's trends in mechanical engineering has long been characterized by very stringent requirements; on one hand high performance, light weight and long life are expected, on other hand minimum use of resources and cost are expected. To increase the life of metal components, the effect of environment on components should be reduced. This is possible by application of coating on components. There are many methods of coating available in the market and a continuous research is underway regarding the choice of methods. Now a days, to improve corrosion resistance, thermal spray coatings are widely used to enhance the performance and corrosion resistance. In view of this, an attempt has been made to develop plasma sprayed TiO_2-15wt% Inconel 718 coatings on SS304 steel and study the corrosion behavior under the effect of salt spray. Salt spray tests showed that TiO_2-15wt% Inconel 718 coatings exhibited greater corrosion resistance compared with uncoated specimen.

Keywords: Plasma Spray Coating, Salt spray test, Inconel718, Titanium Dioxide

Micro Channel Fabrication by Additive and Subtractive Methods

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Abstract

Micro Channels are widely used in micro-electronics and micro fluidics. Their performance is mainly depending on its surface quality and dimensional accuracy. Micro milling is a widly used for micro channel fabrication of different materials. However, burr formation and tool wear are the major issues related to the quality of the micro channels. Laser Powder Bed Fusion (L-PBF) is a versatile additive manufacturing process by which micro channels can be fabricated. However, layer by layer fabrication process and the adhered powder particles decrease the surface quality of the micro channels. So, there is need of post-processing of these channels.

In the present study, micro channels of different cross sections are fabricated by L-BPF process on aluminum alloy. Similar size of micro channels are fabricated by micro milling on aluminum alloy block fabricated by L-BPF. Surface roughness, dimensional accuracy, and cross section area of micro channels are analysed using 3D surface profiles and scanning electron microscope. Finally, both fabrication processes (direct metal printing and micro milling) are compared with reference to the quality of micro channels.

ZEISS Solutions for Electronics and Electronics component manufacturing.

Mr Manoj K Sundaram

Abstract

With Electronics manufacturing growing in the Indian market, with initiatives from government such as PLI and investment of Electronics OEM in India, we see a wonderful growth opportunity in the future. This growth will be dependent on the quality and capability of our existing ecosystem and the improvement that can be done in order to align with the China+1 strategy. ZEISS known for its optics and optoelectronics products, has already catered to many OEMs in this field, in India and outside India. This session will be focused on this experience of ZEISS for the industry. With products such as Microscopes for Visual inspect of Electronic components to CT and X-ray microscopy technology for PCB inspection, this session will include some of the best practices in Metrology and quality of electronics manufacturing.

Confront Challenges of Materials Research with State-of-the-art in Situ Microscopy Solution from Zeiss

Aloysius Daniel

Abstract

Microscopy has always been key to engineers and scientists enabling the observation of 2D and 3D microstructures, to quantify their evolution over time, or observe the result of external stimuli e.g., temperature or force. Efforts to refine imaging and analysis techniques have led to a new branch of materials science in which samples are analyzed in situ. This enables the characterization of performance under relevant operating or environmental conditions. ZEISS light, X-ray, electron and ion microscopes are uniquely suited to the characterization of materials under variable environments in 2D & 3D. A complete microscopy portfolio is at your disposal to address multi-scale research challenges in situ and in 4D to investigate metals and alloys, polymers, bio- and nanomaterials, energy materials, or composites and ceramics.

Poster Presentations

Cladding Deposited By: Gas Tungsten Arc Welding (GTAW)

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Abstract

In numerous industrial applications such as energy, construction, shipping and mining, the failure of mechanical components has been observed due to several abrasive wear conditions. Many surface engineering techniques, such as laser cladding, electroplating, thermal spraying and Tungsten Inert Gas (TIG) cladding, have been employed to minimise the abrasive wear conditions. This work focuses on using TIG cladding as TIG is not only preferred for welding or cladding but is also employed for rapid prototyping, better known as Hot Wire TIG-based Rapid Prototyping.

In the present work, the materials' mechanical properties and tribological behaviour have been investigated by TIG cladding on the substrate using WC-4Co-1Cr. The cladding of the materials has been carried out by varying the current applied. The cladding width and depth from the cross-section of the cladded surface, along with the interface of clad and substrate, was analysed using FESEM (Field emission scanning electron microscopy), and it was observed that cladding width and depth increase with an increase in current. Furthermore, EDX (Energy Dispersive X-Ray) analysis of the cladding was carried out to investigate the interface and other interfacial product formations. The materials' hardness gradually decreases with increased cladding current due to the dissolution of WC particles over the substrate. The materials' wear resistance was significantly improved post-cladding, and maximum wear resistance was observed at the lower current. The wear mechanism and wear track of the substrate, as well as the clad surface, are also analysed using FESEM. In future studies, the residual stress analysis can be carried out and validated experimentally.

Keywords: WC-4Co-1Cr, TIG welding, FESEM, Micro-hardness, Abrasive wear

Numerical Investigation of Heat Transfer Improvement Forced Convection Applications Using PCM.

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Abstract

The Heat transfer is the important criteria in many industrial applications in the Present study a solid copper sphere and a hollow copper sphere filled with Paraffin Wax is Placed in side a tube and a constant heat flux of 100 Watts is to the Sphere where Air with different Reynolds number ranging from 4000 to 15000 is considered to investigate the Forced Convection Heat transfer between Spheres and Air the design of the setup is done in solid works and the simulation is done using Computational Fluid dynamics the comparison of heat transfer between Solid sphere and Sphere filled with Paraffin Wax is Done to investigate which gives best result.

Keywords: Phase Change Materials , CFD , Heat transfer , Forced Convection, Paraffin Wax.

Compatibilizing Effects for Improving Mechanical Properties of Biodegradable Poly(Lactic Acid), Acrylonitrile-Butadiene-Styrene (ABS) and Polypropylene Blends

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Abstract

A detailed mechanical characteristics investigation is done on the novelty composite material ternary blends of poly lactic acid (PLA), Polypropylene (PP) and Acrylonitrile-butadiene-styrene (ABS). The effect of the composition on the rheological properties also examined. The composite blends in various proportions are prepared with the help of a twin screw- extruder. Rheological characteristics are examined with the help of capillary rheometer, with this non-newtonian index, and shear viscosity are determined. Mechanical properties were studied in term of tensile properties, stress at break, strain at break, and Young's modulus determined and it is found to be superior.

Keywords: PLA; Ternary Blends; Rheology; Mechanical Properties

Study on Flexural Properties of Hybrid Composite Fabricated by VARTM Process for Automotive Components

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Abstract

Natural fiber composites have excellent applications in the automotive industry for door panels, seat belts, dashboards, wind turbine blades, household and medicine for hip replacement, blood bags etc., Hybrid composite is the combination of two or more fibers in which one type of fiber balance the deficiency of another fiber. In this study, a hybrid composite is fabricated using Jute and Flax fibers by vacuum-assisted resin transfer molding (VARTM) method. In this study, the flexural properties of hybridized jute and flax composite are studied. The hybridization is done by replacing jute fiber with flax, and the stacking sequence done by selecting different stacking arrangement for a fixed volume of fiber. 8 layers of jute fabric are completely converted to 8 layers of flax by replacing 2 flax layers each time, results in 5 laminates (J8, F2J6, F4J4, F6J2 and F8). For stacking, the fixed volume is F4J4 (i.e., four-layer of jute and four-layer of flax) is selected and five different arrangements have done based on placement of jute fiber as ((FJ)4, (FFJJ)S, (JJFF)S, (F4/J4) and (FJJF)S). The laminates with 3 different orientations (0º, 30º and 45º) are prepared for flexural testing. Flexural strength is the maximum stress in a material before yielding in the bending test. The flexural test is used to determine the bending behavior of a material and referred to as a transverse beam test. A three-point bending test is selected for this study and the testing procedure is carried out as per ASTM D 7264. The fracture behavior is observed as, the fibers below the neutral layer will experience tensile stress and above will experience the compressive load. The flexural strength found to occur maximum in the F2J6 laminate in 0º, 30º and 45º orientation with values 46.91, 35.53, 37.21 MPa respectively. This is because flax fiber at the bottom has higher tensile bending stress, and the jute layers in the middle is more flexible and can easily transfer the stress. In the stacking, the strength values resulted more when the fibers are placed flax fibers placed at bottom and top (FFJJ)s in the 0˚,45˚ orientations. The minimum values have resulted when jute fibers are placed at the top and bottom (JJFF)s in all orientations. This hybrid composite is used in an application where there is a requirement of tensile and compression strength together.

Magnesium Metal Matrix Composites for Biomedical Application: A Review

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Abstract

Magnesium-based composites and alloys have emerged as a promising alternative to traditional materials used in medical applications due to their biocompatibility, biodegradability and mechanical properties. In this review, we summarize recent progress in the development of magnesium-based composites for use in biomedical applications. Additionally, we explore the mechanical and corrosion properties of magnesium-based materials and their suitability for medical applications. Finally, we provide an outlook on future directions for research in this field, highlighting the need for further studies to optimize the properties and performance of magnesium-based composites in order to meet the diverse needs of medical applications.

Parametric Optimization and Performance Analysis during WEDM of P91 Steel

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Abstract

P91 steel is a typical heat-resistant material widely used in power plant and petrochemical industries. It is challenging to machine P91 steel using conventional methods. Hence wire electrical discharge machining (WEDM) is employed in the present study to machine P91 steel. The objective of this study is to construct a reliable WEDM process utilizing the design of experiments (DOE) approach. In accordance with the experimental design, the factors pulse on time (TON), pulse off time (TOFF), peak current (IP), and wire speed (WS) are changed to determine their impacts on cutting speed, surface roughness (Ra), and material removal rate (MRR). An effort has also been made to model these three response variables using the response surface methodology (RSM). To evaluate the importance of machining parameters, analysis of variance (ANOVA) is employed. The created RSM model is supported and validated by the test results. Further, test samples have been characterized using XRD technique. Thickness of the recast layer have been measured on BT-SEM. Additionally, microhardness test has been carried out for maximum and minimum MRR test samples.

Keywords: WEDM; P91 steel; Optimization; RSM; ANOVA; Box-Behnken design.

Transformer Based Memes Generation Using Text and Image

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Abstract

Memes have become an increasingly popular way for people to express themselves and communicate with others on the internet. They are used to convey humour, emotions, social and political commentary, and more. In social media, users are increasingly sharing their experiences and expressing themselves through images and videos. However, creating a meme from scratch can be time-consuming and requires a certain level of creativity and design skills. This can limit the spread and reach of memes, as not everyone has the ability to create them. Due to the growing tendency for expressing emotions through written and visual descriptions, image and textual sentiment analysis is gaining momentum.

To address this issue, we are creating an automatic meme generation model that have been developed using deep learning techniques including convolutional neural networks (CNNs) and recurrent neural networks (RNNs). As meme can evolve and have the power to amplify thoughts or ideas of people, so it is important to create a meme that are appropriate to all religious and cultural beliefs. Also, the generated meme is not intended to offend any religion or convey anything that hurts the sentiments or insults their religious and cultural beliefs.

In our work, we aim to develop an advanced meme generation model that can handle a diverse set of images and captions, and generate memes which are culturally and linguistically appropriate. The model should also be able to generate memes that are similar in content and style to human-created memes, with a focus on social commentary. The ultimate goal is to create a user-friendly tool that can help content creators, journalists, influencers to spread humour, emotions, and social commentary over the internet through latest trends.

Keywords: sentiment analysis, text, image, memes, VADER

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A Review On Non-Invasive Diagnostic Tools for Strength Analysis of Soft Tissue of A Muscle to Assist Physiotherapist

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Abstract

In our day today life we came across with many people who are complaining about back pain. They are mostly either frequent commuters or those who needs to work in sitting position for long working hours. These sitting postures induces Musculoskeletal Disorder MSD especially to the lower back. Back pain is a very common health problem and affects all ranges of the population. Back pain occurs in similar proportions in all cultures, interferes with the quality of life, day to day activities and work performance. In addition to these pain points, osteoporosis or prolonged corticosteroid, vertebral infections, tumors and bone metastasis are less common problem exists with lower back pain. The exact source of low back pain is often difficult to identify. Identification of lower back pain is thus becoming a major problem for diagnosis and treatment. Around 50 to 60% of the population in India suffers from lower back pain at some stage of their life and the age of the people suffering is in the range of 30 to 70 years. This is one of the biggest reasons to visit the physiotherapist doctors in India. Pulled, strained, stretched or sprained soft tissues produces local inflammation. These inflammation areas are generating pain due to chemical reaction of affected soft tissue with blood circulating nerve. Thus, the diagnosis of low back pain becomes tough with complexity of pain. The exact location of pain and complexity makes it tough task for physios to understand and treat the affected region. Analysis of muscle behaviour at subcutaneous level with limited range of non-Invasive tools is challenging task for Physiotherapists.

After a detailed literature review research gap reveals that, there are differences in male/female and age-specific distribution in muscle fatigue has been observed, in which children, older adults and males are more resistant to fatigue than adults and females.

A detailed review is taken on analysis of Soft Tissue behaviour in identifying the muscle fatigue with available non-invasive diagnostic tools like Tensiomyography (TMG), Electromyography (EMG), Shear Wave Elastography (SWE) etc.

Agro-Waste into Value Added Concrete

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Abstract

Ordinary Portland cement is recognized as a major construction material throughout the world. Researchers all over the world today are focusing on ways of utilizing either industrial or agricultural waste, as a source of raw materials for industry. This waste, utilization would not only be economical, but may also result in foreign exchange earnings and environmental pollution control. A good solution to the problem of recycling agro industrial excess would be by burning them in a controlled environment and use the ashes (waste) for more polite means. Utilization of such wastes as cement and fine aggregate replacement materials may reduce the cost of concrete production and also minimize the harmful environmental effects with disposal of these wastes. The compressive strength of the concrete increased at 5% replacement of cement by SCBA and 0.1% jute fibre then gradually decreased. The maximum compressive strength was obtained at 5% replacement of cement by SCBA and 0.1% jute fibre as 29.33% at 7 days, 31.7% at 14 days and 41.63% at 28 days. The strength has been increased by 11.02% as compared to CM.

Keywords- cement, compressive strength, concrete, agro-waste etc.

Advancements in Quadcopter Technology: Developing a CAAD Model and Mathematical Model for Amphibious Operations

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Abstract

This paper discusses the development of a sustainable and efficient CAAD model for an amphibious drone capable of traveling in both air and water. The use of UAV/ROV technology has been on the rise due to its versatility and numerous applications in fields such as agriculture, medicine, food delivery, military, and underwater vehicle technology. However, the combination of both technologies to create an amphibious drone has been a challenge due to design, fabrication, and operational difficulties faced by earlier models. To overcome these challenges, a buoyancy control mechanism was developed, comprising of two 12V DC water pumps and a water bladder. The weight distribution in the drone was carefully considered to maintain stability during flight and underwater operations. The position of the ballast tank/bladder was biased towards a particular sector of the circular cross-section geometry, and other internal components such as controllers, companion computer modules, batteries, and camera mounts were iteratively worked around in the CAD model based on actual dimension and weight of the components. This allowed for the determination of the CG location in both empty and filled ballast tank cases, and accordingly, changes were made to the position to obtain a suitable internal arrangement. Furthermore, a sustainable mathematical model was developed to describe the quadcopter's movement and behavior concerning the input values of the model and external influences on the drone for both air and water. This model was crucial in predicting the drone's stability and efficiency in both environments. The amphibious drone's potential applications are vast and include underwater habitat research, ship's damage/corrosion monitoring, and military surveillance and ammunition supply. The active buoyancy control mechanism and sustainable CAAD and mathematical models developed in this study could significantly enhance the drone's operational capabilities in various fields. In conclusion, this paper presents a sustainable and efficient CAAD model for an amphibious drone capable of traveling in both air and water. The development of an active buoyancy control mechanism and a sustainable mathematical model enhances the drone's stability, efficiency, and operational capabilities in various fields, including military, agriculture, and underwater vehicle technology.

A Comprehensive Design and Analysis Study of Agricultural Hybrid Drones

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Abstract

This paper discusses about the theoretical and analytical study of an unmanned aerial vehicle which can beat the conventional flight time at most 20mins averaging 5-6mins. This project adopts an IC engine as a hybrid power system which acts a generator to improve a endurance and also identify a material which gives high strength to weight ratio as it needs to withstand high structural loading. A spraying equipment is designed in such a way that it maintains the centre of gravity during the procedure of spraying. The design parameters chosen should also obey theoretical concepts and equations for safe flights across a long distance. For designing the frame and structures we will be using CATIA V5 which is a standard software used in the industry and the drones structural abilities and its aerodynamic performances are analyzed using Ansys software.

Application of crop protection materials is one of the crucial operations in agriculture to meet ever demanding food production. Manual pesticide spraying causes many harmful side effects to the personnel involved in the spraying process. The Exposure effects can range from mild skin irritation to birth defects, tumours, genetic changes, blood and nerve disorders, endocrine disruption, coma or death. For agriculture applications smart farming solutions are being considered including use of drones. Agriculture UAVs are highly capable and there use has expanded across all areas of agriculture including pesticides and fertiliser spraying. The drone mounted sprayer mainly consists of BLDC motor, LI-PO battery. pesticide tank and supporting frame. Four BLDC motors were mounted to quadcopter frame to lift of 5kg payload capacity. Generator were used to supply the necessary current required for the propulsion system. A fluid tank was used to hold the pesticide solution. A 12VDC motor water pump was used to pressurize spray liquid and then spray by means of three nozzles. The entire drone mounted sprayer operation controlling with the help of transmitter at ground level. The spray uniformity was increased with increase in height of spray and operating pressure. This sprayer is very useful where human involvements are not possible for spraying of chemicals on crops. This technology greatly helpful for small farming community in reducing cost of pesticide application.

A Comprehensive Survey of Speaker Diarization: Techniques, Challenges, and Future Directions

Peddabuddi Uma Devi

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Abstract

Speaker diarization is an important area of research that intends to recognize and separate the speakers in an audio recording. In recent years, a significant progress has been made in this field, driven by rapid advancements in machine learning and deep learning techniques. In this review paper, we provide an overview of the latest research trends in speaker diarization. These include deep neural networks, speaker embeddings, and unsupervised clustering techniques.This paper discusses the challenges in Speaker diarization, such as handling overlapping speech and dealing with noisy data .And also, this paper discusses potential future research directions in speaker diarization field, including incorporating contextual information such as speaker characteristics and language models, and the integration of multiple modalities such as audio, video, and text.

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Synthesis of AZ91 Mg composite with reinforcement of SiC particles through liquid stir casting method

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Abstract

Magnesium is one of the lightest structural metals on the earth and has the potential to replace heavy alloys in lightweight structures because of its high-quality creep and strength. Liquid stir casting in an inert gas environment was used to create AZ91 magnesium metal matrix composites (Mg-MMC) with SiC (20µm) content ranging from 5 – 10 wt.%. The use of inert argon gas makes low-cost, high-volume Mg production practicable. The microstructure and mechanical behaviour of the alloys are studied in their as-cast state. This study emphasized the synthesis procedure casting parameters of high-volume Mg-MMC with very low cost which is useful for industrial purpose.

Design and Devlopment of Suspension System For the Proyogan Planetary Rover

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Abstract

Now-a-days rovers are essential for the planetary exploration. These give required information and conditions on the planet without human interference. These are mainly used in planetary space exploration, dark caves mines and No-man entry regions. This paper reveal about design and development of the suspension system for the proyogan planetary rover. In this rover design the links lengths using function generation method and right angle triangle.these are developed and modified like a Bio-inspired ant leg structure. These structure links are modeled and analysis without modified(incline link) and with modified (like a Bio-inspiration ant leg structure). These two links analysis at same boundary conditions for shear stress, deformation and stain energy and final assembled rover complete model.

After complete assembly rover, manufacturing prototype for the physical analysis observe instability and uncontrolled of the links of the rovers. In order stability and control, design spiral spring as suspension system for the rover. This is helpful in control, stability and quick re back after climbing up hill and down hill of the rover. The spring deign and aseembly to link to analysis deformation, shear stress, strain in the spring with different material properties like spring steel,copper alloy and structural steel and applied boundary conditions of the 50 rad/sec on the spring. These paper reveals that using spring steel for the land application and copper alloy for space application.

Keywords: prayogan planetary rover,stability, prototype and spiral spring

Review on Challenges and Methods for Habitat Construction on Mars

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Abstract

The launching of the first satellite was successfully conducted in 1957 and since then, the solar system has been explored by various space research organizations adopting different probing technologies. In our solar system, Mars is the most accessible planet because of the water pattern and being close to the earth. The exploration of Mars is trending so much that by 2040 many space agencies like Indian space research organization (ISRO), National Aeronautics and Space Administration (NASA), and other space agencies are deciding to build a permanent solution by constructing a habitat for living. Using local resources as a construction material is known as In-Situ Resources Utilization (ISRU). The challenges facing the Martian environment, are the average temperature on mars is -81 oF, and extremely low atmospheric pressure of 1% to 2% compared to that of the earth's surface, with no magnetic field and high radiation. Building and construction on this place are very difficult and it's not possible to take everything from the earth. The challenge of making a habitat in a planetary environment necessitates the creation of new development technologies. Therefore, an advanced construction technique Additive Manufacturing (AM) is required to develop a dwelling structure. This paper identifies the key challenges during the construction, gives a detailed review and properties of local materials available with different binder composites of Martian simulants, and discusses the proposed idea of different structures design with an Additive manufacturing (AM) process.

Keywords- Regolith, In-situ resources utilization, Additive manufacturing, Martian simulant, Dwelling structure.

Novel Burr Measurement Technique

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Abstract

Burr measurement techniques are the subject of extensive research because burrs degrade the quality and performance of micro parts and features. Most of the researchers examine height and width of the top burr, entry burr and exit burr. Due to the fact that width differs from location to location, there is uncertainty in the measurement of width. Uncertainty in the width results in the uncertainty in the height of the burr.The purpose of the method presented in this work is to provide a comparative assessement of burr length, burr angle and shape of the burr with up milling and down milling operations and effect of process parameters on the burr length and burr angle.The proposed methodology is applied to milling on workpiece of steel and input variables consists of cutting speed(325 m/min), feed rate and depth of cut.

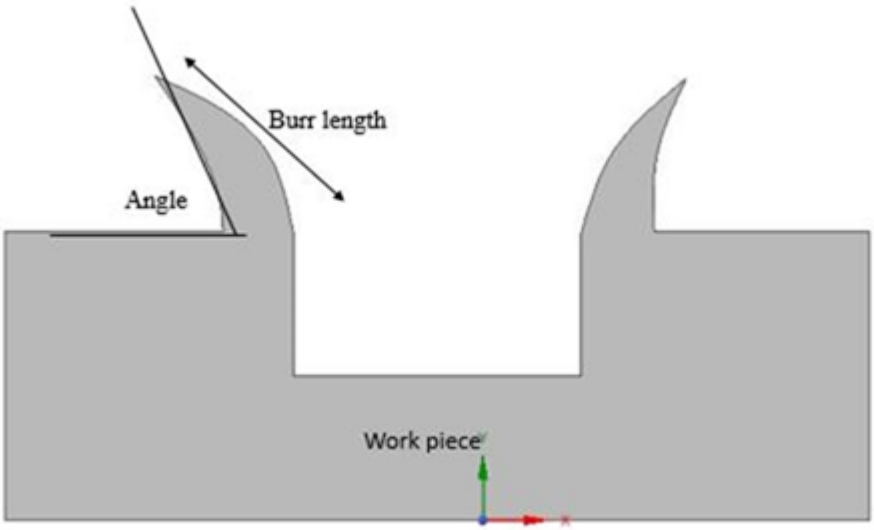

Fig.1 Burr length and Burr angle on workpiece

Nanotechnology and Additive Manufacturing, an integration: A review

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Abstract

This paper focused on the fabrication of the polymer structure using polymer composite (PC) with nanoparticle in additive manufacturing (AM). The number of scientific articles for use of nanoparticle in additive manufacturing is less, though individually both the use nanotechnology as well additive manufacturing are well explored domains. Nanotechnology facilitates creating NP materials with advanced properties compared to its bulk form due to quantum confinement effect. The Property at nanoscale depends upon factors like, size, phase and morphology of NP whereas in AM property depends upon factors such as, material used for printing, printing parameter and design parameter The material used for printing decides the physical, chemical, electrical, magnetic as well optical property of end product. Nanoparticles can be used as a reinforcement material in polymer matrix for producing materials with enhanced properties of end product. Additive manufacturing is a fabrication process in which material is incrementally deposited. It is one of the most booming sectors these days due to its versatility, robustness and integration with industry 4.0. This can help in studying the material aspect of the additively manufactured material, that how keeping printing as well design parameter same and using nanoparticle to main printing material can enhance the property.
Keyword: Additive manufacturing (AM), nanoparticle (NP), polymer composite (PC).

Review on Design, Optimization, Challenges and Application of Additive Manufacturing of Bio Inspired Cellular Structure

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Abstract

Cellular structures are composed of an interconnected network of plates, struts, or small unit cells. These structures have many distinct advantages, including a high strength-to-weight ratio, excellent energy absorption, and minimal material requirements and light weight. Cellular structures can also be thought of as having a cellular architecture. In AM process, components are designed using computer-aided design, sliced into thin layers, and then the sliced file is transferred to the AM machine to manufacture the component. Unlike conventional techniques, additive manufacturing (AM) technology can make practically complex geometry, even minuscule cellular structures. Cellular structures are prevalent in many scientific domains and major industries have taken advantage of the structures. This paper focused on different aspects of lattice structure, including design problems, optimization, characteristics, and uses of the AM of cellular structures. The advantages of the additively manufactured structure, as well as its potential uses and limitations, are discussed. The review identified limitations and gaps in the research as well as areas that need to be looked into more in terms of cellular structure design, optimization, features, and applications. This review would provide possible ways to solve the problems of designing and manufacturing cellular structures in industrial applications.

Keywords: Cellular Structure , Additive manufacturing, Lattice structure

Effect Of Cold Rolling and Heat Treatment on the Microstructure Evolution of Titanium Alloy Grade 2

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Abstract

In this study, we investigated the impact of cold rolling and heat treatment on the evolution of microstructure and hardness in Titanium alloy grade 2. We prepared three distinct samples subjected to cold rolling with reduction percentages of 10%, 20%, and 40%. Following cold rolling, heat treatment was conducted in an inert argon gas environment using a tube furnace set at 575°C, which is below the β transus temperature. A comparison was made between the cold rolled samples and the as-received samples. Microstructural analysis revealed that cold rolling not only caused grain elongation along the rolling direction but also refined the grain size. The extent of grain elongation increased with higher degrees of cold rolling. Subsequent heat treatment induced the formation of new equiaxed grains within the deformed structure. The number and area fraction of these new grains increased in proportion to the degree of deformation during the applied heat treatment. Microhardness exhibited an upward trend with increasing degrees of cold rolling but decreased after the heat treatment. To assess the spatial distribution of recrystallized grains after heat treatment with varying degrees of deformation, we calculated the inter-grain distance. This measurement provided an estimation of the spacing between recrystallized grains.

Effect of Cooling Media on Mechanical Properties of Sn–Cu Solder Alloy

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Abstract

Eutectic and near eutectic Sn–Pb solder alloy is widely used in electronic packaging applications for joining electronic components. However due to environmental health concern use of toxic lead (Pb) based alloys in electronic applications has been banned. Therefore, Pb–free solders are considered as potential alloys in electronic packaging applications to replace Pb based solder. Sn–Cu (Pb– free solder) alloy has attracted good attention. But, research studies on effect of solidification of Sn–Cu free solder are scant. Usually the solidification mode controls the microstructure of alloys and hence the mechanical properties. Good hardness and wear property are essential for reliability of Sn–Cu alloy in the real working applications such as in electronic industry. Hence in the current research work, the effect of casting moulds during solidification on microstructure, mechanical properties of Sn–0.7Cu alloy is investigated. Two different cooling moulds (Copper and Graphite around oil) and a different cooling media (Furnace) were used for solidification to achieve different cooling rates. An effect of grain morphology and hardness as well as on Sn–Cu alloy cooled in different moulds/media are assessed.

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Comparitive Analysis and Fabrication of Regenerative Braking System using Matlab

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Abstract

The paper proposes a regenerative braking system as a solution to the foremost issues hindering the mass use of electric automobiles, namely, battery charging time and a lack of charging stations. The system allows a vehicle to recuperate energy each time brakes are applied, thus reducing the need for external charging stations and decreasing the charging time. The proposed system uses a friction lining arrangement in a brake drum that generates electricity using motors as a dynamo. As the brake drum rotates, the friction lining does not touch the drum as soon as brakes are applied, but instead touches the drum from inside, moving the motors connected to the lining in the same direction. The lighter the brakes, the more energy is recovered, making the system more efficient.

The proposed regenerative braking technology can contribute to the development of a pollution-free transportation system. As the world moves towards the era of electric mobility, innovative solutions like the proposed regenerative braking system can help reduce the carbon footprint of transportation. The system converts the kinetic energy generated during braking into electrical energy that can be stored in the battery for later use, thus maximizing energy recuperation.

The paper comprehensively overviews the proposed regenerative braking system, discussing its working principle, components, and benefits. The system has the potential to revolutionize the electric automobile industry and pave the way for a more sustainable future. The proposed system is cost-effective, easy to implement, and can be retrofitted to existing automobiles, making it a feasible solution for the mass adoption of electric vehicles. The paper concludes by highlighting the importance of implementing regenerative braking technology and its role in achieving a pollution-free transportation system.

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Laser Powder Bed Fusion Followed by Efficient Post-processing Method

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Abstract

The inferiority in the properties like surface quality, residual stress and microhardness of the additively manufactured components restrict the wider applications of the additive manufacturing technologies particularly in the SLM-fabricated parts' and inhibited early adopters from using this method for actual industry production. So, the improvement in these properties is having the huge necessity to adopt post processing of the fabricated components. At present, adopting new post processing technique is fascinating which helps in enhancing the surface quality and mechanical properties of the fabricated parts. In accordance with the application criteria, geometry intricacy, part size, and desired surface finish, the post-processing techniques can be chosen. In the present work, we studied the effect of the post processing techniques on modification of surface quality and mechanical properties of the AlSi12 alloy fabricated by selective lase melting. Various post processing techniques like electrochemical polishing (ECP), abrasive flow finishing (AFF), laser polishing and wire-cut electric discharge machining (WEDM) were applied to enhance the surface quality properties of SL printed parts. After applying these post processing techniques, the surface texture and roughness, residual stresses, dimensional accuracy, hardness were studied with different machining parameters and electrical parameters like voltage, Ton and Toff for different surfaces of AlSi12 alloy components. The results obtained with post processing techniques were compared with as-built components.

Simulation and Experimental Analysis of Uniaxial Tensile Test of Fused Deposiiton Modelling Printed Acrylonitrile-Butadiene-Styrene

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Abstract

Acrylonitrile-Butadiene-Styrene (ABS) has good mechanical properties and a wide variety of applications, including household appliances, automotive, aerospace, etc. Testing the mechanical properties of Fused Deposition Modelling (FDM) ABS samples is costly and time-consuming. So, predicting FDM printed sample mechanical properties can give designers and researchers vital information. This paper reported uniaxial tensile test numerical modelling and experimental investigation of FDM-printed ABS. The nonlinear structural analysis was employed to simulate the uniaxial tensile test. Von-Mises stress, normal strain, and total deformation were predicted. The FDM-printed ABS samples were carried out the uniaxial tensile test. Stress-strain data was captured from numerical analysis (as shown in Figure 1) and experimental investigation. FDM printed samples' yield and ultimate tensile strength were 26.5 MPa and 30.6 MPa, respectively. The maximum tensile stress of 31 MPa was predicted via numerical analysis. The rupture in the tensile sample for both numerical and experimental analysis was at the same location. It can be concluded that the numerically predicted FDM printed tensile sample fracture follows the experimental one.

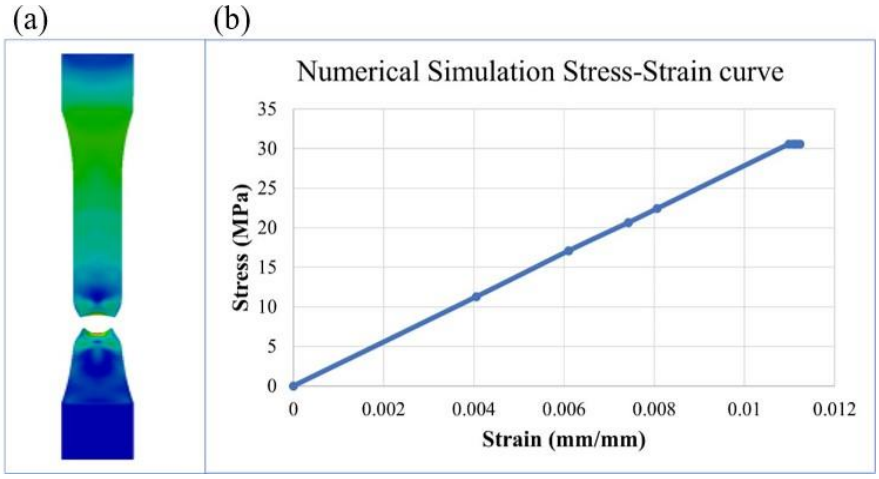

Figure 1 (a) FEM contours of tensile specimen after uniaxial testing (b) Stress-strain data from the numerical simulation

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Finite Element Analysis on the Biomechanical Stability of TPMS Based Scaffolds for Large Segmental Femur Bone Defect

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Abstract

Treating segmental bone anomalies in orthopedic surgery, particularly in highly stressed regions caused by fracture, malignancy, or infection, is a difficult procedure. The use of an artificial scaffold in Tissue Engineering has had considerable influence on tissue healing. In the formation of bones, scaffolding should offer mechanical stability, allow cells to grow freely, and encourage cell proliferation. The stiffness and strength of a structure must be carefully constructed in order to manage stress concentration and reduce stress generation in the structure. Simultaneously, appropriate porosity, surface-to-volume ratio and permeability are essential for biological activities such as bone formation and nutrient supply. The construction of a functional bone scaffold necessitates a careful balancing of all of these characteristics. To attain specified porosity and strength, the traditional method was to analyze each of these factors separately without taking into account their interaction. The objective of this research is to conduct a comprehensive analysis on strength, surface-to-volume ratio, porosity and design of the Triply Periodic Minimal Surface (TPMS) based scaffold for femur bone defect. The TPMS architecture-based scaffold was built with a porosity range of 60 to 80 percent to imitate the original bone characteristics. The Finite Element Method (FEM) was used to simulate uniaxial compression in the structure. With the Polylactic acid (PLA) biomaterial, the maximum stress and displacement of the scaffold were investigated for different unit cells and for different porosity levels (ranging from 60 to 80%). The result shows that the design and porosity influence strength and displacement.

Keywords: FEM, Scaffold, TPMS, Biomedical, 3D printing

Simulation of Metal-Oxide Nanostructured CFRP Composites

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Abstract

CFRP composites are used extensively in various sectors like aerospace, automotive, and marine due to their high stiffness strength, corrosion resistance, and lightweight. It is found from the literature that metal oxide nanostructured CFRP composites can have more strength as compared to CFRP composites. Therefore this paper proposes making a 3D model of a metal oxide nanostructured CFRP composite specimen for simulation by using ABAQUS software. To make the 3D model of the composite, a nanowire of metal oxide is to be made, which needs to be connected to a wire of carbon fiber. The carbon fiber and metal oxide nanofiber are to be connected to the matrix, for metal oxide ZnO and CuO are considered. Different percentages of both the metal oxides are to be taken while making the specimens. Simulation of tensile test is to be performed for the various specimens, and the results are to be analyzed.

Analysis on the Machinability of Ti6Al4V During Dry Turning Process

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Abstract

Titanium and its alloys are most commonly utilized in aeronautics, chemical industry, automotive and bio-medical products. In comparison with other grades of titanium, Ti6Al4V posess high strength to weight ratio, improved corrosion resistance and better bio-compatibility [1,2]. The majority of cutting tool materials used to machine titanium alloys have a short tool life and react with titanium as a workpiece material. This disadvantage is due to the generation of heat temperature closer to the cutting edge of tool. While machining titanium alloys, this phenomenon causes rapid tool wear. Ti-6Al-4V is the most widely used titanium grade alloy in various engineering components due to its outstanding inherent qualities such as high strength to weight ratio, high corrosion resistance, high temperature resistance, etc. However, machining this alloy is difficult due to its lower heat conductivity, high chemical sensitivity, increased sensitivity in work hardening, and low young's modulus. In this study, the surface integrity generated and the machined chip characteristics when machining Ti-6Al-4V alloy with Titanium carbo nitride (TiC0.51N0.12) coated carbide tools under dry condition was investigated. Full factorial experiments were conducted to study the influence of spindle rotation, feed and depth of cut on surface roughness, material removal rate and tool wear rate were examined. The process parameters levels are presented in Table 1. The surface roughness values recorded when machining Ti-6Al-4V with coated carbide tools was higher at higher feed rate. The skewness values increased with increasing machining speed. When the machined material chips were examined using EDS, carbide deposits were found to cover the chip surface, indicating that there was significant tool removal during dry machining of Ti-6Al-4V alloy with carbide cutting tool.
Table 1: Machining conditions

Parameters	Level 1	Level 2	Level 3
Spindle rotation (rpm)	1000	2000	3000
Feed (mm/rev)	0.10	0.20	0.30
Depth of cut (mm)	0.6	1.2	1.8

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Design and flow analysis of injection Mould for Car Indoor Bezel using Simulation software

Kartikey Mishra

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Abstract

Injection molding is a manufacturing process used to produce a wide range of plastic parts and products. A complex shape and size, over 30% of plastic component is fabricated by injection moulding process. It involves injecting molten plastic material into a mold cavity, allowing it to cool and solidify, and then ejecting the finished product from the mold. Injection molding is a complex process, and variations in different parameters can lead to various defects in the final molded product. The optimization of these defects depends on several parameters injection pressure, injection speed, gate location, melt temperature, mould wall temperature etc. The location and design of the gate, which is the entry point for the molten plastic into the mold, can impact the flow pattern and potential gate-related defects. In this paper, we performed a flow analysis at different gate locations using SOLIDWORKS Software. In this firstly we process reverse engineering on car bezel to generate surface model and then design an injection mould with the core and cavity for car indoor bezel at two different gate locations. After analysis, the result shows that at mid-position of the gate location gives a better result for the final product.

Keywords- Plastic injection moulding, ABS thermoplastic, Flow analysis, Gate Location

Mechanical Behaviour of Fruit Waste Fillers Based Epoxy Composites

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Abstract

The development of lightweight materials has found its way after the second world war. Polymer composites, owing to its high strength to weight raio, low thermal expansion, high stifness, high fatigue resistance found its uses in automobile, aviation, sports, etc.[1]. Off late, natural fillers are used to reinforce various polymer matrices for development of biocomposites [2]. Off late, the ill effects of using natural fibres have also been reported [3]. Hence in the present decade the focus has shifted on trying the naturally found fillers for developing polymer composites. In the present work, citrus fruit shell waste has been used in three different sizes i.e. (i) 100-250 µm, (ii) 500-710 µm and (iii) 710 µm-1 mm in three varying percentages viz 5 %, 10 % and 15 % in epoxy matrix to develop biocomposites using casting method. The developed composites have been tested for physical, mechanical and morphological behaviour to under stand the failure mechanism. The physical properties were studied in terms of void content and moisture absorption behaviour. The mechanical properties were studied in terms of tensile strength, tensile modulus, flexural strength, flexural modulus and impact strength. The results indicated that the composites developed with 100-250 µm sized fillers showed better mechanical properties when compared to biocomposites developed with 500-710 µm and 710 µm-1 mm sized fillers. The tensile properties kept on decreasing on increasing the size and percentage of the filler whereas, the tensile modulus showed reverse trend. The moistute retaining behaviour of the developed composites was found maximum for biocomposites developed with 710 µm-1 mm sized fillers. The fracture lines, pores,filler pull out were evident from the SEM micrographs. Overall, it was established that the developed biocomposites have potential to be utilized in particle board industry and other non-structural applications.

Keywords: Citrus Sinesis; Epoxy; Biocomposite; Mechanical properties; SEM

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Mechanical and Tribological Characterisation of Used Jute Fibre and SiC Hybrid Composite Material

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Abstract

In this study, the investigation of tribological properties of epoxy-based composites was conducted experimentally. The matrix material used in the research work was epoxy resin. Attempt made to upcycle the used jute bags by converting it as reinforcement with proper treatments and used as the reinforcement material and Silicone Carbide used as filler for the preparation of the hybrid composite. Composite materials are prepared by varying the percentage of filler material from 3% to 12% with the step size of 3%. Tensile test, Flexural test and wear test were performed to investigate the mechanical properties and machinability of the composite material. Tests were carried out according to the ASTM standards. Tensile test and Flexural test were performed in universal testing machine and wear test was performed on pin-on-disc wear testing machine. Abrasion test is carried at normal loads of 9.81 N, 19.62N and 29.43N for abrasion durations of 5 min, 10 min and 15 min. It was observed that the significant improvement in tensile strength is observed up to 6% by weight of the SiC content and with the further addition of SiC the strength begins to decrease. the flexural strength and modulus of the composite material increase with a fiber load of 9% by weight, but by the further addition of fiber in the matrix decreases the flexural properties. Wear Factor and Wear volume of hybrid composite materials as per research work analysed. further morphology studies were conducted for Interfacial analysis using scanning electron microscope.

Investigation of Die sinking EDM on SS316 material with Various Tool Electrode for Enhanced Machining Performance-A Review

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Abstract

EDM is a widely used unconventional machining process employed to create intricate shapes in conducting materials. This study explores the application of Electro Discharge Machining (EDM) on SS316 using various electrode materials. EDM enables the machining of challenging hard materials, bypassing the limitations of conventional methods. The selection of suitable electrodes is essential to achieve a good material erosion rate and surface finish. Electric parameters such as current, Pon (Pulse-on), and Poff Pulse-off) time are used in combination with other parameters like gap voltage, dielectric, and cutting depth. The primary objective is focus on evaluating the material removal rate (MRR), tool wear rate (TWR), and surface roughness as observations to quantify the effectiveness of EDM. This study aims to enhance EDM performance by optimizing machining parameters for improved MRR, TWR, and surface roughness.

Keywords: SS316, EDM, MRR, TWR.

Slurry Erosive Wear Behavior of TiO2-Inconel718 Composite Coatings Plasma Sprayed on Mild Steel Substrate

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Abstract

The surface characteristics of engineering materials decide the serviceability and life of a component. Engineering components must perform their functions effectively though they are subjected to aggressive and complex environments in which chemical and physical degradation of surfaces is accompanied with loads. Surface engineering plays a pivotal role in developing tailor made surfaces to withstand and perform under such conditions. In the field of surface modification, thermal spraying has come to the fore and has niched out its own place due to its versatility. Thermal spraying is primarily used for improved wear resistance, improved thermal barrier protection, electrical conductivity, resistance to corrosion and oxidation and dimensional restoration. Thermal spraying improves the life of in-service components through surface coatings. Among the different thermal spray methods available commercially, Plasma Spraying is one of the most sophisticated and versatile method. Plasma Spray Technique was used to apply TiO2 – Inconel 718 composite coatings on Mild Steel substate. Three different combinations of the TiO2-Inconel718 composite coatings were developed and studied for slurry erosive wear behavior. It was found that TiO2-30wt% INCONEL718 was the most effective among the three coatings in enhancing the slurry erosion resistance of Mild Steel.

Keywords: Plasma spray Coating, TiO2- Inconel718 composite coatings, Slurry Erosive test

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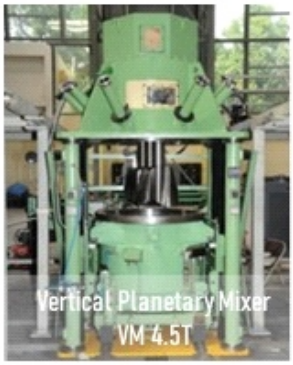

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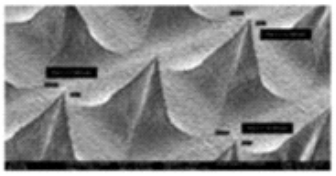

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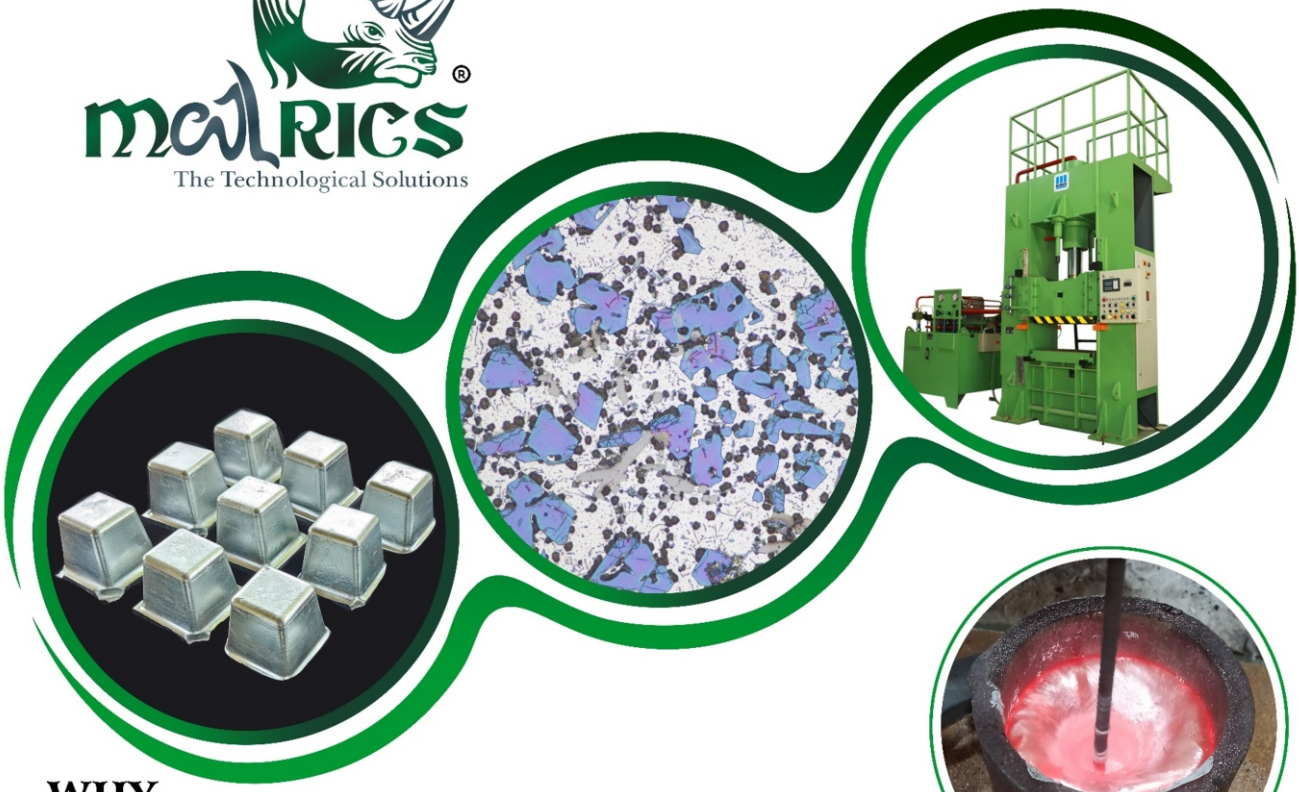

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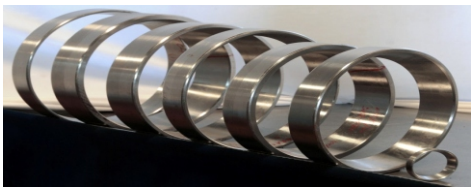

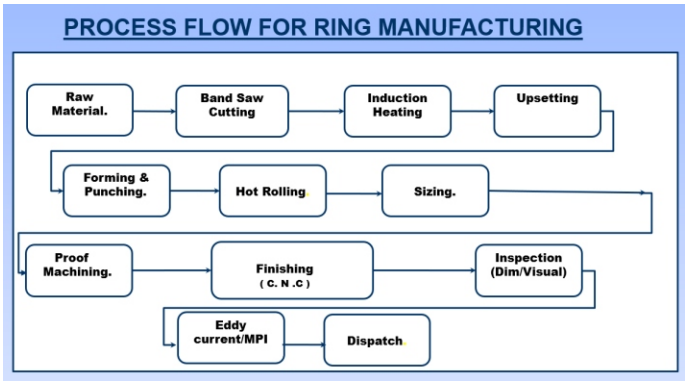

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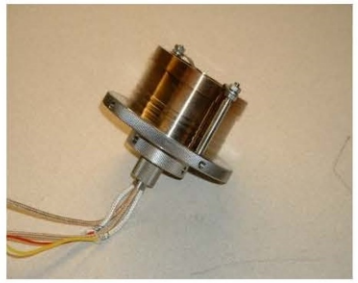

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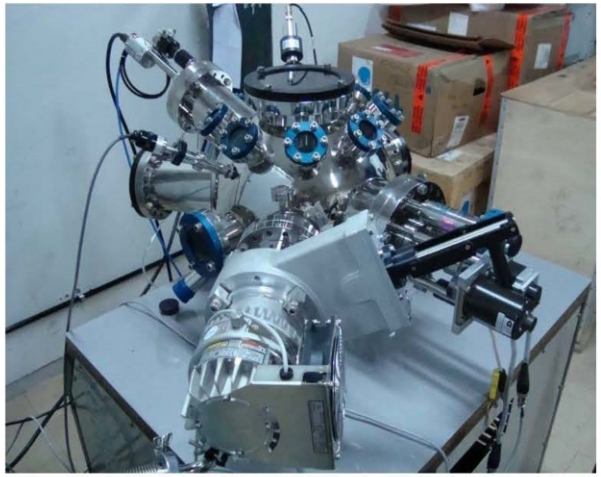

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