Conference on Processing and Characterization of Materials (CPCM 2020)

18th-20th December 2020

Organised by
Department of Metallurgical and Materials Engineering
NIT Rourkela

About the conference

The Department of Metallurgical and Materials Engineering, National Institute of Technology Rourkela is going to organize the Conference on Processing and Characterization of Materials (CPCM-2020) during 18th-20th December 2020 through online mode after successful completion of earlier 2nd international conference/9th national conference in this series (NCPCM-2011-2019).The *Conference* on Processing and Characterization of Materials, CPCM2020 will be a forum to bring together the users, manufacturers, designers and researchers involved in structures or structural components manufactured using different materials. The forum would provide an opportunity for the exchange of the researches and insights from scientists and scholars, and promoting research in the field of Metallurgy and Materials Science. Papers dealing with design, research and development studies, experimental investigations, theoretical analysis and fabrication techniques relevant to the application of materials in various assemblies, ranging from individual components to complete structure will be presented at the conference.

About past conferences

2019

2nd International Conference on Processing and Characterization of Materials
and
9th National Conference on Processing and Characterization of Materials

Published by:
1. **Materials Today Proceedings (Elsevier)**
2. **International Journal of Materials and Product Technology Journal**

2018

1st International Conference on Processing and Characterization of Materials
and
8th National Conference on Processing and Characterization of Materials

Published by:
1) **Materials Science Forum,**
2) **Int. Journal of Materials Research**

2017

7th National Conference on Processing and Characterization of Materials

Published by: Materials Science and Engineering (IOP)

2016

6th National Conference on Processing and Characterization of Materials

Published by: Materials Science and Engineering (IOP)

2015

5th National Conference on Processing and Characterization of Materials

Published by: Materials Science and Engineering (IOP)

2014

4th National Conference on Processing and Characterization of Materials

Published by: Materials Science and Engineering (IOP)

2013

3rd National Conference on Processing and Characterization of Materials

2012

2nd National Conference on Processing and Characterization of Materials

2011

1st National Conference on Processing and Characterization of Materials

About the institute

NIT Rourkela, formerly known as Regional Engineering College, Rourkela (Estd: 1961) is one of the premier national level institutions for technical education in the country and is funded by the Government of India.

It is an Institute having excellent reputation at both undergraduate and post-graduate levels to produce quality students in the branches of Engineering, Science, Managements, and Humanities, with a strong emphasis on both basic and applied research.

The Institute is managed by the Board of Governors of National Institute of Technology (Rourkela) Society and vested with significant degree of administrative and financial autonomy. Government of India have recognized the Institute as a premier institution of repute and have developed it as a center of excellence under plan funding.

The campus of the Institute consisting of the Institute buildings, halls of residence and staff colony is situated at the eastern end of Rourkela steel city, beyond Sector-1 over an area of 262 hectares of land provided by the Government of Orissa. It is a residential campus offering accommodation to faculty, staff and students. The campus has all the amenities for developing personal, social and academic skills of the student community.

About the department

Established in 1964, the Department has emerged as a powerhouse for academics, scientific research, and cutting-edge technologies. With time, the department grew noticeably and established new areas of research and teaching in materials engineering, while retaining its strength in traditional areas of metallurgical engineering. The department is actively involved in fundamental research in diversified fields like steel technology, advanced manufacturing processes, alloy designing, nanotechnology, composites and computational materials. The alumni of the department hold strong positions in many prestigious organizations over the world. The department attracts highly qualified faculties and bright students from the entire nation. The well-developed infrastructure, diversified expertise of the faculties and incredibly talented students has placed the department in the global forum. The graduates from the department are well-placed in esteemed industries and institutions. The department has a history of producing highly ambitious students motivated for higher education in India and overseas. The department is actively involved in research activities in the front line areas of Metallurgical and Materials Engineering in collaboration with reputed R&D organizations and industries throughout the country. The research wing of the department is strongly supported by various public and private organizations. At present, various research projects are being run in the department by external sponsoring agencies like Department of Science and Technology (DST), Council of Scientific and Industrial Research (CSIR), Naval Research Board (NRB), Defence Research and Development Organisation (DRDO), Board of Research in Nuclear Sciences (BRNS), National Aluminum Company (NALCO), TATA Steels, Steel Authority of India Ltd (SAIL).

Director's Message

The Department of Metallurgical and Materials Engineering, National Institute Technology Rourkela is a pioneer in many academic activities. The annual conference on processing and characterization of materials has been a strength of the Department since 2011. The Department has accumulated a significant amount of knowledge and experience over a broad spectrum of Materials Engineering, from conventional metals and alloys to composite materials, nanomaterials and computational materials engineering.

I am happy to announce that the Department is organizing the Conference on Processing and Characterization of Materials (CPCM 2020) through online mode during 182O December 2020. It is enthralling to mention that the conference receives internationally recognized plenary, keynote speakers from globally renowned universities. I expect the audience will be motivated from such experienced faculties and scientists to pursue their career in the cutting edge research. It is my honour to welcome the participants in the online conference. I am sure that efficient knowledge sharing will lead to academic accomplishment. I also record my sincere appreciation of hard work put in by the entire team of the Department of Metallurgical and Materials Engineering to make the conference CPCM 2020, a grand success.

Animesh Biswas
(Director, NIT Rourkela)

Chairman's Message

I am happy to be a part of this Tin or Aluminium jubilee version of the "Conference on Processing and Characterization". Two years back, the department had celebrated the golden jubilee of the first graduating batch. With this legacy, the Metallurgical and Materials Engineering Department of National Institute of Technology Rourkela is known for its academic achievements and multidirectional research involving different metals-alloys, composites and non-metals. Though matured, it is still striving to improve upon, and in this adventurous path, this annual conference is an event for which we wait for the next 365 days.

The pandemic has brought us closer and closer by modern communication, and I am happy to announce that more than 80 speakers would be participating in this online conference. Many recognized achievers across the world would share their technical thoughts to inspire young researchers. I hope this conference and the publications made from this conference would help many to spread scientific findings, among others. At the same time, I also feel sorry as we could not invite you to our green campus for a physical conference.

I want to thank all speakers of this conference for their kind participation and time. I would also thank my team for making the online version of this conference lively. On behalf of the organizer, I would request for your pardon for any possible shortcomings.

Regards

Prof. Anindya Basu
(Chairman, CPCM 2020 and Head of Department)

Convener's Message

Greetings!

Being Convener, I take great pride in welcoming all the great scientists, academicians, and young researchers and students to bestow their gracious presence in the Online Conference on Processing and Characterization of Materials (CPCM 2020) organized by the Department of Metallurgical and Materials Engineering, NIT Rourkela during 18th- 20th December 2020. This conference shares an insight into the recent research of materials science and engineering as well as cutting edge technologies, which gains immense interest with the colossal and exuberant presence of adepts, young and brilliant researchers, and talented student communities. The aim of some thematic sessions is to bring together, a multi-disciplinary group of scientists and engineers from all over the world to present and exchange break-through ideas relating to the innovation in material science and technology. I feel that the conference will be effective platform for providing interaction between computational scientist/researchers and experimental scientist/researchers of materials engineering domain as a good number of computational materials science/engineering researcher paper presentation will be there. We're looking forward to an excellent meeting with great scientists from different countries around the world and sharing new and exciting results in metallurgical and materials science/engineering. I hope that this conference will help to create more intuitive minds among students and young researchers as the great scientist Albert Einstein told "The intuitive mind is a sacred gift and the rational mind is a faithful servant."

Thanking you,

With regards,

Dr. Snehanshu Pal

Convener, CPCM 2020

Assistant Professor,

Department of Metallurgical and Materials Engineering

National Institute of Technology, Rourkela

Rourkela-769008, Odisha, India.

Co- Convener's Message

Dear Participants,

Sincere Greetings!

It gives me immense pleasure to welcome you all to the Online Conference on Processing and Characterization of Materials (CPCM 2020) being held in the Department of Metallurgical and Materials Engineering, NIT Rourkela during 18th- 20th December, 2020. Material's Processing and Characterization is focused on cutting edge material's technology including designing, regulating the process parameters to achieve the tailor made microstructure, required final properties and to improve the sustainability for several specialized applications. Several eminent researchers from academia, research laboratories, Industries will deliver talks on several thematic aspects of materials in the conference. The conference provides a knowledge sharing platform and possible research collaboration for the researchers, scientists and industries.

I, thank you all for participating in the conference and hope to have great knowledge sharing.

Thanking you,
With regards,

Dr. Anshuman Patra
Co-Convener, CPCM 2020
Assistant Professor,
Department of Metallurgical and Materials Engineering
National Institute of Technology, Rourkela
Rourkela-769008, Odisha, India.

Treasurer's Message

Organizing CPCM-2020 was one of the most challenging jobs that I was involved in at NIT Rourkela. COVID-19 had put strong restrictions on crowds. The global pandemic had made it impossible to organize a physical conference like we used to do earlier and a virtual event had be organized. One of the most essential elements of a virtual conference is a fully functional website which could get the participants directly in touch with the organizers. The other was to have a video conference platform. With the help of a video conference platform this conference became a reality. The conference takes place in a virtual environment, where authors present their work and interact with attendees virtually instead of in-person. The aim was to mimic the actual conference experience as much as possible. Organizing this virtual conference required as much logistical planning as its face-to-face counterpart.

I hope all of you will appreciate the effort put forward by team CPCM-2020. We hope to come back next year with a regular ICPCM-2021 where the presenters can interact face-to-face in-person with all. I find myself very lucky to be a part of the CPCM-2020 organizing team and I thank all the team members. It was a unique experience. I hope all participants enjoy and gain from the virtual conference as much as we did in organizing the virtual conference.

Dr.Syed Nasimul Alam
Treasurer, CPCM-2020

Plenary Speakers

- **Prof. B. S. Murty** — *Director, IIT Hyderabad, Professor, IIT Madras, India.*
- **Dr. G. Padmanabham** — *Director, ARCI, India*
- **Prof. Indranil Manna** — *Vice Chancellor, BIT Mesra, Ex –Direcor IIT Kanpur and CGCRI Kolkata, Professor, IIT Kharagpur*
- **Prof. Douglas Spearot** — *Professor, University of Florida, USA*
- **Prof. Amitava De** — *Professor, IIT Bombay, India.*
- **Prof. Kantesh Balani** — *Professor, IIT Kanpur, India.*
- **Prof. Chuang Deng** — *Associate Professor University of Manitoba, Canada.*
- **Dr. Saurav Kundu** — *Chief of Process Research, Tata Steel*

Keynote Speakers

- **Mr. G.V.R. Murty** — *General Manager(Retd), Mishra Dhatu Nigam Limited (Min of Defence), Hyderabad*
- **Prof. Jatin Bhatt** — *Associate Professor, VNIT Nagpur, India*
- **Prof. S. Sen** — *Professor, NIT Rourkela*
- **Prof. Amlan Dutta** — *Assistant Professor, IIT Kharagpur, India*
- **Prof. Anish Karmakar** — *Assistant Professor, IIT Roorkee, India*
- **Prof. Snehanshu Pal** — *Assistant Professor, NIT Rourkela*
- **Prof. Anshuman Patra** — *Assistant Professor, NIT Rourkela*
- **Dr. Madhumanti Mandal** — *Researcher Engineer, Institut Jean Lamour, CNRS- Université de Lorraine Nancy, France*
- **Mr. Sujan Hazra** — *Principal Researcher, Tata Steel*

Schedule

18th-20th December, 2020					
18/12/2020		19/12/2020		20/12/2020	
09:30-10:00	Inauguration	9:00-10:00	Plenary talk 5 (PL5) Prof. B. S. Murty Director, IIT Hyderabad Professor, IIT Madras Speaker Introduction : Prof. S. N. Alam	09:00-10:00	Plenary talk 8 (PL8) Dr. Sourav Kundu (Tata Steel) Speaker Introduction : Prof. A. Mallik
10:00-11:00	Prof. Indranil Manna (PL1) Speaker Introduction : Prof. A. Patra	10:00-11:00	Plenary talk 6 (PL6) Prof. Kantesh Balani Professor, IIT Kanpur Speaker Introduction : Prof. S. N. Alam	10:00:10:30	Keynote 7 (KN7) Prof. Amlan Dutta Assistant Professor, IIT Kharagpur Speaker Introduction : Prof. A. Mallik
11:00-12:00	Plenary talk 2 (PL2) Dr. G. Padmanabham Speaker Introduction : Prof. A. Patra	11:00-11:30	Keynote 3 (KN3) Mr. G. V. R Murty General Manager (Retd.), MIDHANI, Hyderabad Speaker Introduction : Prof. S. N. Alam	10:30-11:30	Contributory talk : Session 6 Session Chair : Prof. K. K. Mehta
12:00-13:30	Contributory talk : Session 1 Session Chair : Prof. K. Dutta	11:30-12:00	Keynote 4 (KN4) Prof. Anish Karmakar Assistant Professor, IIT Roorkee Speaker Introduction : Prof. S. N. Alam	11:30-12:00	Keynote 8 (KN6) Prof. Anshuman Patra Assistant Professor, NIT Rourkela Speaker Introduction : Prof. A. Mallik
Break					
15:00-16:00	Plenary talk 3 (PL3) Prof. Amitava De Professor, IIT Bombay, India Speaker Introduction : Prof. S. Pal	12:00-13:30	Contributory talk : Session 3 Session Chair : Prof. A. Basu	12:00-13:30	Contributory talk : Session 7 Session Chair : Prof. S. N. Alam

Schedule

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Dr. Madhumanti Mandal CNRS-Univeresite de Lorraine
Speaker Introduction : Prof. S. Pal</td><td>14:30-15:00</td><td>Keynote 5 (KN5)
Prof. Sudipta Sen
Professor, NIT Rourkela
Speaker Introduction : Prof. A. Mallik</td><td>15:00-15:30</td><td>Keynote 9 (KN9)
Mr. S. Hazra (Tata Steel)
Speaker Introduction : Prof. S. Pal</td></tr>
<tr><td>18:30-19:00</td><td>Keynote talk 2 (KN2)
Prof. Jatin Bhatt
Associate Professor, VNIT Nagpur
Speaker Introduction : Prof. S. Pal</td><td>15:00-17:00</td><td>Contributory talk : Session 4
Session Chair : Prof. S. K. Sahoo</td><td>15:30-16:30</td><td>Contributory talk : Session 8
Session Chair :Prof. N. Yedla</td></tr>
<tr><td rowspan="2">19:00-20:00</td><td rowspan="2">Plenary talk 4 (PL4)
Prof. Douglas Spearot
Professor,
University of Florida, USA
Speaker Introduction : Prof. S. Pal</td><td>17:00:17:30</td><td>Keynote 6 (KN6)
Prof. Snehanshu Pal
Assistant Professor, NIT Rourkela
Speaker Introduction : Prof. A. Mallik</td><td>16:30-18:30</td><td>Contributory talk : Session 9
Session Chair : Prof. S. Pal</td></tr>
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PLENARY TALK

Modeling Plasticity in Metals at Atomistic and Mesoscopic Length Scales

Prof. Douglas E. Spearot
Department of Mechanical and Aerospace Engineering
Department of Materials Science & Engineering (affiliate), University of Florida

Abstract. Recent effor ts towards accurate modeling of plastic deformation in metals via integration of atomistic and discrete dislocation dynamics (DDD) simulations will be discussed. Following a brief introduction to atomistic simulation and DDD methods, two coupled research tasks will be discussed in detail. (1) Atomistic simulations are used to determine the dependence of the Peierls stress and dislocation mobility on dislocation segment character angle and local stress state. The Peierls stress is calculated via a change in the internal energy, which is an invariant measure of the dislocation driving force. Empirical piecewise dislocation mobility functions, which account for linear phonon damping and non-linear radiative damping mechanisms are determined from MD simulations of straight dislocations. (2) The atomistically-derived dislocation mobility laws are incorporated into the DDD model. DDD simulations of isolated dislocation loop expansion show strong agreement with MD results, validating the implementation. Then, large-scale DDD simulations are performed to elucidate the role of dislocation mobility functions on the deformation response of dislocation networks. The results demonstrate that the use of character angle and stress state dependent dislocation mobility laws, which account for changes in dislocation dynamics due to altered core structure, provides quantifiable changes to the plastic deformation path, leading to different final microstructures. This highlights the importance of using detailed descriptions of dislocation dynamics in mesoscale plasticity models.

Towards Green Steel Production

Dr. Saurabh Kundu
Tata Steel

Abstract. Steel industr y is responsible for More than 8% of the India's GHG emission. The dependency on C based fuel for generation of energy and its use as reducing agent during iron making is one of the main reasons be- hind the CO_2 emission during steel making. The Carbon based technology for steel production is responsible for emission of more than 2.5 t of CO_2 for each ton steel produced. The IPCC 1.5^{o}C target by the end of this millennium requires net emission to be brought to zero. Steel industry along with others needs to be proactive to gradually bring the emission to zero. There are three major ways to reduce the emission. Those include reduction of CO_2 emission at the source, which is possible (a) by using hydrogen based reluctant in place of C based reluctant. Apart from the re- duction at source, (b) capturing and utilising the CO_2 emitted from different processes in making useful chemicals is also a potential way to reduce harmful impact of green house gas. The third way to mitigate the GHG emission is to
(c) Capture the emitted CO_2 and sequestering the same in deep sea wells. Among these three, the last one which requires sequestering CO_2 in various geological storage locations, is difficult to achieve in India because of its specific geography. The first two are the best ways for any steel industry to attack the problem of CO_2. For both (a) and (b), production of green hydrogen is important, so the hydrogen pathways for steel industry to achieve the net zero emission has been discussed in detail. Adaption of new technologies for iron and steel making has also been discussed comparing their emission efficiencies and technology readiness levels. A brief analysis of how captured CO_2 can be utilised in making various chemicals useful in industry and in households have been presented along with challenges in terms of scale and funding required.

Nanoscale twin boundary-mediated mechanical deformation in FCC metals

Jianwei Xiao[1], Reza Rezaei[1,2], Frederic Sansoz[3] , and Chuang Deng[1]
[1]Department of Mechanical Engineering, University of Manitoba, Canada
[2]Department of Materials Science, University of Tehran, Iran
[3]Department of Mechanical Engineering, University of Vermont, USA

Abstract. Coherent twin boundaries are special planar defects in materials that are of mirror symmetry and particularly low energies. Twin boundaries in metals can form during the synthesis (i.e., the so-called growth twins) or during the mechanical deformation (i.e., the so-called deformation twinning). In the past decade, nanotwinned structures have been widely studied as an effective way to mitigate the well-known strength-ductility trade-off in metals. In this talk, the recent progress regarding nano-twinning mediated mechanical deformation in FCC metals will be reviewed with particular emphasis on the following three topics: (1) Maximum strength and Hall-Petch breakdown in nanotwinned FCC metals; (2) Strength and plasticity in nanotwinned FCC metal nanowires; and (3) Deformation-twinning mediated shape memory effects in FCC metal nanowires. While the focus of this talk will be on conventional FCC metals such as Au and Cu, the influence of twinning on the mechanical deformation of the emerging FCC high entropy alloys will also be briefly discussed.

Practical Scanning Electron Microscopy

Kantesh Balani
Professor, Department of Materials Science and Engineering, Indian Institute of Technology Kanpur, Kanpur-208016, India
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Abstract. Scanning electron microscopy (SEM) is inherent to characterizing microstructures of both conventional and fascinating nanomaterials. With meager sample preparation and its inherent high depth of field has become very attractive proposition for imaging fractured surfaces. In addition, high lateral resolution (to the tune of ~ 1-2 nm), providing surface topography (via secondary electrons) or eliciting compositional contrast (from backscattered electrons) make SEM a highly popular option for a metallurgist. SEM also enable performing energy dispersive spectroscopy (EDS) to observe elemental distribution in various phases. Nonetheless, many a times ease of operation becomes a handicap in maximizing or optimally presenting the output from the instrument. Also, the use of this data in thesis and research papers is also demanding and must be carefully performed as to retain the uncontaminated information of the material. Certain features may be either be lost or overlooked, or there may be a very high chance of reporting erroneous observations as facts. Thus, such biases must be avoided, and statistical relevance of the claims must be established without compromising the high magnification and high-resolution capability of SEM to enhance the quality of your thesis and research papers. So, this talk will cover various fascinating aspects that help providing appropriate setting to hone the instrument capability towards making a microscopist provide reliable and right information of exploring materials of tomorrow.

KEYNOTE TALK

Micro indentation studies on HPT processed $Zr_{62}Cu_{22}Al_{10}Fe_5Dy_1$ bulk metallic glass

Abhilasha Jain[a,*], Yogesh Prabhu[a], Dmitry Gunderov[b, c], Jatin Bhatt[a]
[a] Department of Metallurgical and Materials Engineering, Visvesvaraya National Institute of Technology, Nagpur, 440 010, India
[b] Ufa State Aviation Technical University,12 K. Marx str., Ufa, 450008, Russia
[c] Institute of Molecule and Crystal Physics UFRC RAS, 71 pr. Oktyabrya, Ufa 450054, Russia

Abstract. Bulk metallic glass $Zr_{62}Cu_{22}Al_{10}Fe_5Dy_1$ having high zirconium content is processed using HPT (High pressure torsion) and Acc. HPT (Accumulative high-pressure torsion) method wherein the total strain over the specimen is significantly enhanced by pressing and torsion leading to considerable change in overall structure-property relationship. In absence of grain boundaries and dislocations that are intrinsically the carriers of plastic flow, the amorphous nature of BMG plays a decisive role in altering the mechanism of deformation. The random disordered structure of bulk metallic glass when subjected to high torsional strain and compressive pressure results in discernible changes in mechanical properties due to severe plastic deformation which result in destruction of short-range order. Structural characterization of BMGs was carried out using X-ray diffraction (XRD) technique in which absence of crystalline peaks in XRD curve confirmed amorphous nature of the material before and after HPT process. Also, from XRD analysis it is concluded that HPT process did not induce any stress induced crystallization during the severe plastic deformation. Vickers micro-indentation is employed to realize the progress in deformation and associated changes in as cast, HPT and Acc. HPT specimens. The deformation behaviour around micro indented regions on BMG specimens was investigated by FE-SEM (Field emission scanning electron microscope) to decipher the origin and propagation of shear bands. Also, the mechanisms responsible for such changes are addressed in the framework of free volume.

Process optimisation in Melting and Forging of Superalloys

G.V.R. Murty

Abstract. Super alloys are heat resistance alloys of nickel, iron-nickel, and cobalt which can be used at high temperatures. Processing of superalloys in the melting and forging stages throws up several challenges which are imposed by the end applications. These challenges include the narrow chemistry, cleanliness, micro and macro segregations, reheating, narrow window of deformation temperatures, selection of forging tools etc. This paper deals briefly about the industrial melting and remelting technologies employed for overcoming the quality challenges namely the effect of variation of VAR parameters on ingot surface and defect formation, effect of reheating temperatures, selection of reheating furnaces, furnace atmospheres, design of tooling and the metallurgical aspects during thermo mechanical processing of superalloys with case studies.

Microstructure and mechanical behaviour of the heat affected zone in line pipe steels

Madhumanti Mandal, Warren J. Poole, Matthias Militzer
Department of Materials Engineering, The University of British Columbia,
Vancouver, BC, V6T 1Z4, Canada.

Abstract. Low carbon micro-alloyed steels are used for line pipe applications as they combine high strength and acceptable fracture toughness with good weldability. During welding, the strength and fracture toughness of the material in the heat affected zone (HAZ) is potentially degraded. Using a Gleeble thermomechanical simulator, bulk microstructures were produced that are representative for the HAZ in gas metal arc welding. Here, the first weld pass produces a bainitic microstructure that is characteristic of the coarse-grain heat affected zone (CGHAZ) and the second weld pass involves intercritical annealing of this region (ICCGHAZ), producing martensite films along the prior austenite grain boundaries. The effect of the intercritical austenite fraction and the resulting martensite-austenite constituents on the ductile-brittle transition temperature has been quantified. EBSD and fractography studies have been conducted to correlate the fracture behaviour with the microstructural features. Finally, the role of carbon content on crack propagation has been considered for ICCGHAZ microstructures.

Study on the formation of various dual phase structures in thermo-mechanically tailored HSLA steel

Anish Karmakar[*1], Debalay Chakrabarti[2]
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[2] Dept. of Metallurgical & Materials Engineering, IIT Kharagpur
anish.met@gmail.com, anish.karmakar@mt.iitr.ac.in

Abstract. A comparative study has been carried out on the development of ultrafine grained ferrite-carbide and ferrite-martensite dual phase (DP) structures in a low carbon microalloyed steel processed using two different thermomechanical processing routes, (i) inter-critical deformation and (ii) warm deformation and inter-critical annealing. The samples were deformed using Gleeble3800® simulator, maintaining a constant total strain ($\varepsilon = 1$) and strain rate ($\dot{\varepsilon} = 1/s$). Ultrafine grained DP structures could be formed by careful selection of deformation temperature (Tdef) for inter-critical deformation and annealing temperature (Tanneal) for warm deformation and annealing treatment. The ferrite-martensite microstructures developed in this study have ferrite grain sizes in the range of 1.5 to 4.0 μm, the sizes and fractions of fine martensitic islands ranged from 1.5 to 3.0 μm and 15 to 45 percent, respectively. Dynamic strain induced austenite to ferrite transformation followed by continuous (dynamic) recrystallization of the deformed ferrite grains dictated the grain refinement during inter-critical deformation, while, continuous (static) recrystallization by pronounced recovery dictated the grain refinement during warm deformation and inter-critical annealing. The fraction of high angle boundaries (with >15 degree misorientation) increased with the increase in Tdef or Tanneal, depending on the processing schedule. The effect of different starting microstructures, i.e. ferrite-pearlite (F+P) and ferrite martensite (F+M) with varying martensitic morphologies namely blocky martensite (F+Mb) and fibrous martensite (F+Mf) and heating rates (1 - 200 °C/s) on the formation of ultrafine DP steels after cold rolling and inter-critical annealing have been investigated. Mixed ferrite grain structures, comprised of fine and coarse grain regions and showing 'bimodal' grain size distribution along with carbide and martensite phases have also been produced by rapid inter-critical annealing of warm rolled (or cold rolled) samples. The tensile response of the ferrite-carbide and ferrite-martensite steels with unimodal (fine or coarse) and bimodal distribution of ferrite grains have been compared. Ultrafine grained dual phase structure offered the best combination of tensile strength and ductility among all the samples.

Ductile iron: the emerging engineering material

S. Sen
Department of Metallurgical and Materials Engineering, National Institute of Technology Rourkela, Odisha, India

Abstract. Ductile iron (also known as S.G.ir on or Nodular ir on) contains spher oids or nodules of graphite in various types of matrices. Ever since its discovery in 1948, its application as an engineering material is increasing day by day. It has already replaced galvanized iron as the material for water-supply pipe in the U.K. and many other European countries. The properties of the material can be improved by both addition of alloying elements and different heat-treatment processes. Recent studies have established that ductile iron can be used as the material for casks to be used for transportation of nuclear wastes as it has a very high melting point and excellent toughness can be obtained for this material by developing different types of matrices by means of appropriate heat-treatment processes. The dual matrix structure containing ferrite and martensite provides the best results in this regard. The austenitic grade of ductile iron can retain its toughness at -20C if it contains 12% of Ni.Increasing the Ni content , the toughness can be retained at even lower temperature. So it can be concluded that ductile iron can be used as a low-temperature material. So the prospect of the Ductile iron as an engineering material is very bright.

Deformation twinning in fcc metals: an atomistic perspective

Amlan Dutta
Department of Metallurgical & Materials Engineering, Indian Institute of Technology Kharagpur, West Bengal, India – 721302

Abstract. In face-centered cubic metals, deformation twinning is typically absent unless the stacking fault energy is very low. However, recent experiments have shown that even in metals with moderate and high stacking fault energies, this phenomenon is possible under some specific conditions of loading, temperature, or microstructure. Although the process of deformation twinning occupies an indispensable place in the deformation mechanism maps of fcc metals and alloys, only a few studies have attempted to reveal its fundamental mechanism in the context of these recent findings. Here an overview of our ongoing studies is presented, which aims to explore the phenomenon of deformation twinning by analyzing the behavior of twinning dislocations in fcc crystals. To this end, we resort to molecular statics and nudged -elastic-band computations for estimating the generalized planar fault energies and transition pathways. Subsequently, the atomistic information is fed to continuum models to examine the nucleation and core-structures of the twinning partial dislocations. In particular, we investigate the conventional layer-by-layer mechanism of twinning, along with the newly proposed alternate-shear route. Our methods offer a new insight into the obscure phenomenon of deformation twinning in fcc metals, and underline the potential of atomistically-informed numerical modeling in unearthing the mechanical behavior of materials.

Next Generation Ironmaking and Future Research Directions

Sujan Hazra
Tata Steel

Abstract. Global warming is the biggest threat for human life, and CO $_2$ is the responsible pollutants of recent warming trends. Commitment was made in Paris Agreement to reduce the greenhouse emission by 80 % by 2050 com- pared to 1990. Steel industry contributes 5-7 % of total CO_2 emission in the world and must have to find innovative solutions to reduce significantly. Specifically, CO_2 emission from iron making process emits 70-75 % of total steel works. As ~72 % of steel is produced using blast furnace (BF) route, BF research and technology development needs be more concentrated for CO_2 mitigation. Possibilities for mitigation of CO_2 in BF process are: 1. new technology developments and deployment such as top gas recycling, CO_2 Capture and Utilization (CCU), 2. replacing fossil fuels by renewable energy, 3. replacing BF by less CO_2 intensive ironmaking process. Japan (COURSE-50) and Major steel producers has already started research and technology deployment to mitigate CO_2 emission. Indian Steel makers should align research and development in that direction also. One of the major constraints to mitigate this CO_2 problem for Indian steelmakers is the deteriorating iron ore quality. Most importantly, increasing alumina content of iron ore significantly makes the ironmaking value chain less energy efficient and thereby increases the cost of steel production and emit higher CO_2. Tata Steel makes an effort to transform this constraint as an opportunity. More than five of decade research led to find an innovative process called, HIsarna, which has capability to produce purer hot metal using low grade ore and coal. Further this process offers environmental benefit including significant reduction of CO_2 emission. Tata Steel will make an effort to industrialize this process for sustainable growth even with deteriorating iron ore quality.

Investigation of microstructure, mechanical behavior of nano-Al2O3, Cr2O3, TiO2 dispersed Mo alloys

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Abstract. The study reports the fabr ication of 1.0 wt.% nano-Al2O3, Cr2O3, TiO2 dispersed Mo alloys by mechanical alloying for 20 h and conventional sintering at 1450 °C with 2 h of soaking period in argon atmosphere. The 20 h milled powder evidences the presence of oxide particles inside Mo particle. Intersecting Lattice fringes and distinct diffraction spots are evident from Transmission electron microscopy (TEM) and Selected area diffraction pattern (SAD) respectively. MoO2 phase formed along with the oxides phases in the sintered alloys inside Mo matrix and at the interface. The investigation reports excellent mean hardness of 11.16 GPa in Mo-TiO2 alloy. On a contrary, Mo-TiO2 exhibits enhanced wear rate against Mo-Al2O3 and Mo-Cr2O3 respectively owing to lesser fraction of MoO2 oxide precipitation. The oxides contributes in lubrication action and improves the wear resistance.

Keywords : Mo alloys, Oxide dispersion, TEM, Mechanical Alloying, Hardness, Wear

CONTRIBUTORY TALK

CPCM-0001

Induration of Indian Low Grade Iron Ore Pellets in a Pilot Heat Hardening System

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Abstract. Pellet induration is typically per for med in moving grate or grate kiln furnaces, through which pellets are sequentially dried, fired and cooled by direct contact with hot gases of varying flow rates and temperatures. Indian low grade goethite ore (FeO(OH)) comprises a significant amount of chemically bonded water (approx. 6%). During faster pellet induration, this water suddenly gets evolved out at a temperature range 350 to 450ºC. Some pellets get cracked and some of them get disintegrated during induration. In the present investigation a suitable induration cycle has been developed for pelletization of the Indian low grade goethite ore to produce the commercial grade pellets. Pellet grade concentrate was generated through beneficiation of goethite ore of Bolani mines under Steel Authority of India Limited. Green pellets with a basicity of 0.35 were prepared in a laboratory disc pelletizer and thereafter, drying, pre-heating and firing were conducted in a tailor made laboratory scale horizontal zone furnace by varying the main process parameters such as temperature and duration of soaking. Thereafter, the experimental data were validated in a pilot pelletization system of capacity 60 kg per batch i.e. a straight grate simulator. Pellets obtained by optimizing the process parameters exhibit the properties like cold compressive strength, porosity, RDI, RI etc. in line with the commercial grade pellets.
Keywords: Goethite Ore, Pellet Induration, Cold Compressive Strength

CPCM-0002

Application-specific graphene analyses, synthesis, processing, and testing of 2.45 GHz ISM band customized novel metal-free antenna

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Abstract. Graphene has shown a tremendously increasing scope for suitability and reliability in various target applications of recent times. This could be primarily ascribed to the prevalence of multiple carbon sources for processing, development of several facile synthesis procedures, ground-breaking enhancements in fundamental properties, and its customizability into nanomaterials with the number of dimensions being zero, one, two, and three. Application-based tailoring of nanomaterials, especially carbonaceous materials, is highly relevant and gaining momentum in numerous sectors as it ensures scalability, reproducibility, and flexibility. There are many stages from material to system, such as sourcing, synthesis, processing, customization, validation, and implementation. At every stage, characterizing the pertinent parameters and properties through measurement, detection, estimation, simulation, verification, and other strategies is crucial to the device functionality. Graphene antenna, the system of interest in this study, has grown in popularity over the conventional antennas due to the amalgamation of excellent material characteristics, antenna metrics, and its prospective savings in space and energy. In the present work, the realization of graphene into antenna has been discussed from the standpoint of facets in multiple modules. Parameters of an antenna are dependent on the core material, synthesis methodology, the form utilized, and related factors. In this aspect, sampling of the material behaviour and working has been done by microscopy, spectroscopy, diffraction, and analytical studies. The device characterization by radiation pattern and simulations evince that graphene antenna is apt for applicability in 2.45 GHz ISM band with high gain, optimum return loss, voltage standing wave ratio, and bandwidth.

Keywords: Graphene, Patch Antenna, Characterization, Customization, Nanomater ial

CPCM-0003

A Study on Properties & Comparison of Various Bio Diesel Production & Waste Management

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Abstract. Resear ch on the bio-mass petroleum plants has been conducted for many years. Various bio diesel plants come up with petroleum fluid. Previously, All unfamiliar biodiesel plants have been cultivated for many decades for domestic intention used as meal and living. Todays, researchers concentrated divergently on biodiesel plants used enormously on various chemical applications used as petroleum fluid, cooling agent, pollutant absorbent and medical panacea, etc. After intellectual study analysis on biodiesel plants, as a result, its beneficial properties, finding application in a wide range of petroleum fluid. This is another resource of more reliable, less noxious pollutants. This paper presented a review conducted on the Abnormal process of waste management and different biodiesel plants to juxtaposition capricious biodiesel plants properties and their waste management procedure to convert into petroleum ingredient. Studies of biodiesel plant propound to compare the rate of waste utilization management for different kind applications, this study will help to prolific scientists at the time of selection appropriate biodiesel from inconstant properties. This paper is about the Elaboration of previous detailed studies of biodiesel plants taken as juxtaposition agents and comparing pollu- tant emission rate, ignition temperature, flash point, cooling points, renewability of plant. Result shows referred form experimental and numerical analysis performs by other scientists.
Keywords: biodiesel, properties analysis, renewable sour ces, waste management process, biological specification of biodiesel plant

CPCM-0004

Relationship between surface microhardness and roughness produced by MAF process

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Abstract. Owing to the MAF process' s capabilities for its efficient sur face finishing, it is essential to under stand the parallel quality of different response parameters and their interdependency. This paper focuses on identifying a relation between surface hardening and roughness induced by the MAF process. In this research work, the influence on micro-hardness from the value of surface roughness has been studied. The different experimental conditions are applied to Ti-6Al-4V specimens treated using a pulsating DC sourced MAF set-up, and SiC-based loosely bonded magnetic abrasive media was used for material removal. The surface roughness and microhardness share significant interdependency, represented by a graph showing the best relationship between surface microhardness and roughnes.

CPCM-0005

Tribological Behaviour of Al-Si-TiB_2 In-situ Composites

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Abstract. In recent years the comprehensive need for high performance, good quality and low cost materials has caused a swing in research from monolithic to composite materials. Due to their high strength to weight ratio, cost- effectiveness and high wear resistance aluminium matrix composites are extensively manufactured and used in structural applications largely in automobile and aerospace industries. Amongst other matrix phases, Al-Si alloys are frequently used in addition of ceramic particles like Titanium Diboride (TiB_2) as it ensures substantial rise in the wear resistance, modulus and its specific strength without altering the density of the composite noticeably. In the present work, an effort has been made to study, synthesize and characterize the Al-Si alloys dispersed with varying amount of TiB_2 for several engineering applications. The reinforcement of TiB_2 particles into the Al-Si matrix was performed by a salt metal (exothermic) reaction of K_2TiF_6 and KBF_4 halide salts through stir casting route. Effect of Si together with TiB_2 particles in the newly fabricated composite has been analyzed and the results obtained signify the efficacious preparation of the required composites with confirmation of TiB_2 presence in XRD as well as SEM analysis. They also help in improving the hardness and wear properties of the metal matrix composites significantly.
Keywords: Stir Casting, Halide Salts, TiB_2, Tribological Behaviour

CPCM-0006

Effect of Heat Treatment on the Corrosion Behaviour of Plasma Processed LM6 Alloy

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Abstract. Aluminum alloys have been found always increasing uses in marine environments. In this work, the study on the corrosion behavior of LM6 alloy which prepared by plasma melting method. Some of the alloy samples were heated at temperature 350°C & 450°C for 2 hours then water quenched. All the alloy samples (both heat treated and non-heat treated) are kept in seawater for 42 days and then every 7 days the weight loss/gain was measured. A comparative study of the microstructure, hardness and corrosion behaviour of the heat treated and non-heat treated corroded samples were carried out. The morphology and composition of corrosion products were examined with the help of optical microscope, SEM and XRD. The results indicated that 450°C heat treated samples has lower corrosion rate values and higher hardness value than 350°C heat treated and non-heat treated samples. Optical micrographs shows that the size and number of surface isolated pits formed on heat treated 450°C alloy sample is less as compared heat treated at 350°C & non-heat treated alloy samples. These are increased continuously with increases number week reveal to seawater. 450°C heat treated samples exhibit more corrosion resistance than 350°C heat treated and non-heat treated samples due to effect of heat treatment on the alloy samples. The pitting corrosion mechanism is get from the experimental investigation.
Keywords: LM6 alloy, weight loss/gain, Water quenching, Corrosion rate, Pitting corrosion, Plasma technique

CPCM-0007

Investigation of Failures in Marine Propellers

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Abstract. Corrosion failure of Nickel Aluminium Bronze (NAB)(55% Cu35% Zn-2%Fe-3%Mn-2%Al-1%Ni) and Manganese Aluminium Brass (MAB)(79%Cu-1%Zn-4%Fe-3%Mn-9%Al-4%Ni) based cast marine propellers were investigated. Specimens extracted from failed propellers were characterized by Optical microscopy, scanning electron microscopy, X-ray dispersion spectroscopy. The corrosion product were extracted by filing and investigated by XRD. NAB microstructure comprises of Cu-rich alpha matrix, with Fe3Al and NiAl rich precipitates classified as κ1, κ2, κ3 and κ4 phases based on temperature of formation during cooling with κ1 forming at highest temperature and κ4 forming at lowest temperature. The corrosion layer had two distinct layers, one the corroded layer and the other partially corroded layer. The corroded oxide layers contained the precipitates which were intact. In the partially corroded layer, corrosion selectively occurred along the κ3 boundaries. It is hypothesized that the is due to Al depletion in the matrix near the κ3 precipitates which forms during solidification of the alloy and increases with faster solidification and cooling rates. The corrosive sea water sets up a galvanic couple between the Alrich and Al-depleted regions which leads to loss cohesion and strength. This along with factors like erosion and cavitation lead to failure of the propellers. The MAB which comprises of α, β and large rosette-shaped κ phases fail by dealloying corrosion evident by the color of the β phase from yellow to red. Coupon immersion experiments carried out in the real life conditions revealed that corrosion started in the form of pits though showed negligible loss of weight.
Keywords: Nickel Aluminium Bronze, Manganese Aluminium Brass, Galvanic couple, Dealloying corrosion

CPCM-0008

Microstructural Evolution and Failure Behaviour of Resistance Spot Welded Dual Phase Steel

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Abstract. Today automakers are str iving towards reducing the weight of passenger cars, leading to lesser fuel consumption, and thereby lowering of environmental pollution. Dual-phase steels are one of the most commonly used advanced high strength steel grades in the automotive industries. These steels have higher strength, good formability, and adequate weldability. The steel finds several applications in the fabrication of components such as chassis, suspensions, and body frame. Resistance spot welding (RSW) is one of the most widely used processes to join thin metal sheets. This study aims to investigate the microstructural and failure behaviour of spot-welded dual phase (DP) steel joints of 1.4 mm thickness. The findings show that microstructure of fusion zone (FZ) of the joint mostly consisting of lath martensite, while the microstructure of heat affected zone (HAZ) manifests distinct characteristics viz. heat affected zone coarse grain (HAZ-CG) with coarser martensite, heat affected zone fine grain (HAZ-FG), and heat affected zone intercritical (HAZ -IC) with some ferrite and martensite packets at grain boundaries. The base metal (BM) predominately shows ferrite with martensite islands at grain boundaries. Under tensile-shear loading, crack initiated from the base metal. While the failure of coach peel specimen takes place from HAZ-CG. The strength of the specimens increases with increasing size of the nugget. The work concludes that the structural integrity of joint is significantly controlled by microstructural variations, joint configuration, and location of failure.

Keywords: Dual phase (DP) Steel, Spot-welds, Microstructure, Martensite, Failure location

CPCM-0009

Impact of UV Illumination on the Mechanical, Optical and Thermal Properties of High Density Polyethylene -Nano TiO2 and Polypropylene -Nano TiO2 Composites

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Abstract. Photodegradation of molecules can be caused by the absorption of photons having appropriate energy. The process can be enhanced by addition of suitable catalysts which can absorb the photon depending on their band gap. In case of plastics, slow degradation of the products remains a major concern for environment. An approach has been made to study the degradation of polymers using TiO2 as photocatalyst. The present study focuses on photocatalytic degradation of polymers [high density polyethylene (HDPE) and polypropylene (PP)]-TiO2 composites. Composites have been prepared adding 1 wt% of TiO2 nanoparticles to each polymer and processing by two roll mill followed by compression molding. Samples have been subjected to UV illumination and their mechanical, optical and thermal properties have been evaluated. It has been observed that the deterioration in mechanical properties has been higher in HDPE based composite as compared to PP based composite.
Keywords: Photocatalytic degradation, HDPE, PP, TiO2, Tensile str ength

CPCM-0010

Effect of Steel Making Parameters on Nitrogen Level in Steel

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Abstract. Var ious factors affecting the nitrogen pickup in liquid steel were studied. Nitr ogen content is lowest at converter which further increases sharply from tapping to ladle furnace (LF). It continues to increase during treatment at LF. However there is slight increase in nitrogen pickup at caster. Factors affecting nitrogen content at converter includes the ratio of scrap to hot metal charge, the quantity of fluxes, re-blows and tapping duration. Higher duration of arcing at LF leads to higher nitrogen absorption. Sulphur and oxygen also contribute to nitrogen pickup. Results show that deoxidised steel has comparatively lower nitrogen pickup as compared to oxygen-bearing steel or partially killed steel. However, there is inverse relation between finished sulphur obtained at the end of LF treatment and nitrogen pickup at CC. This study will give a basic guideline to steelmakers to produce stringent quality steel with lower nitrogen level.
Keywords: Steel, Converter, Ladle Refining, Nitr ogen Pickup, Sulphur , Factors affecting Nitr ogen.

CPCM-0011

Influence of crystallographic orientation on the mechanical properties and deformation behavior of Ni nanowire using large molecular dynamics

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Abstract. The influence of crystallographic orientation on the mechanical properties and deformation behavior of Ni nanowire have been studied using large-scale molecular dynamic simulation. Embedded atomic method potential is used to model the interactions between nickel atoms. The tensile studies of Ni nanowires of [110], [201], [111] and [112] crystallographic orientations is carried out at a temperature of 10 K and at a strain rate of 108 s -1 . Periodic boundary condition is applied along the loading y-direction and non-periodic and shrink wrapped boundary conditions in the other two directions. The size of the Ni nanowire used for tensile studies is 100 Å (x-axis) × 1000 Å (y-axis) × 100 Å (z-axis) and comprises of ~925000 atoms. The simulated results show that orientation has significant effect on the mechanical properties. The stress strain curves shows an elastic-plastic behavior. The yield stress of [110], [201], [111] and [112] orientation are 9.5 GPa, 11.7 GPa, 17.2 GPa and 10.5 GPa respectively.
Keywords: Molecular dynamics, nanowire, orientation, mechanical properties

CPCM-0012

Biomass: A Source of Carbon for the Reduction of Iron-Ore Pellets in Iron and Steel Industry

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Abstract. In traditional iron making, the reduction of iron ores to metallic iron is done by coke which acts as a reductant and source of energy as well. The coal used for coke making is premium in quality and has limited reserves, so an attempt has been made to reduce the requirements of coking coal using bio-char derived from biomass waste as well through direct reduction of iron ore. Biochars can become a better option for replacing the premium quality of coking coal for reduction purposes in iron and steel industry. The work presented here comprises the comparative study for reduction of Iron ore pellets using different biochar reductants i.e. Saw Dust Char (SDC), Eucalyptus Shell Char (ESC), Sugarcane Waste Char (SWC). Iron ore were subjected to thermal reduction analysis with these biochar reductants and the iron ore was successfully reduced to predominantly metallic iron phase. Reduction commenced at approximately 900°C and was almost completed at 1050°C. The obtained result shows the highest percentage of reduction in case of Saw Dust Char (SDC). Along Saw Dust Char Eucalyptus Shell Char and Sugarcane Waste Char can also be used for iron ore reduction processes with a higher calorific value and lower activation energy.

Keywords: Biomass; Saw dust char; Reduction, Iron-ore pellets

CPCM-0013

Effect of process parameters on the electrical conductivity of friction stir welding Using ANN approach

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Abstract. The present research work investigates the influence of FSW parameters on the electrical conductivity of thick AA1350 aluminium plates. The data was taken using full factorial technique. Rotational speed of tool, welding speed, and tool tilt angle are regarded as input parameters. First, modelling of FSW effective parameters by ANNs is investigated. To train the networks, experimental test results on thirty specimens are considered, and the networks are developed based on back propagation (BP) algorithm. After ANN modelling, optimization of FSW parameters by full factorial method is also investigated. The optimum value of electrical conductivity of welded joints obtained was 52.73 IACS. The results showed that the outcomes of the ANN are in good agreement with the experimental data; this indicates that the developed neural network can be used as an alternative way for calculating electrical conductivity for given process parameters.
Keywords: Friction Stir Welding (FSW), Solid State Welding, Full factorial method, Artificial Neural Network

CPCM-0014

Investigation of heat transfer and solidification during twin-roll strip casting

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Abstract. Twin-roll casting is a process where casting and solidification occur simultaneously to produce a thin strip. It offers low capital investment, low operational cost, and the strips produce are the most probably refined microstructure, which attracts the interest of global manufacturing industries. Therefore it is necessary to understand the solidification phenomena in this process, which will help to control the process parameters. In this present research work, a comprehensive steady-state mathematical model of high-speed twin-roll strip casting of Al-33wt.% Cu alloy is developed on ANSYS 19 platform to study the heat transfer and solidification phenomena during the casting process. The model simultaneously takes into account fluid flow, heat transfer, and solidification in the molten pool and variation of physical properties with temperature. From the simulation results, it is found that the cooling rate in the strand decreases with an increase in casting length, and solidified shell thickness increases with an increase in the length of the casting strand.

Keywords: Strip casting, twin-roll, mathematical modeling, Solidification, Heat transfer

CPCM-0015

Liquid-liquid extraction of Eu (III) from chloride medium using D2EHPA in kerosene

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Abstract. Europium is a valuable lanthanide element which is mainly recognised for its use in making fluorescent lamps and TV screens. Efforts are going on to recover Eu effectively from waste where liquid-liquid extraction appears as crucial separation technique to separate an element from waste. In this paper, solvent extraction of Eu(III) from chloride medium using acidic extractant D2EHPA in kerosene has been studied. Lactic acid has been used as a complexing agent in the aqueous feed. The effect of variation of experimental parameters like lactic acid concentration, D2EHPA concentration, and temperature on percent extraction has been studied. The percent extraction of Eu(III) decreases from 75% to 60% when concentration of lactic acid is increased from 1.2M to 2M. By increasing the concentration of D2EHPA, percent extraction increased. The change in enthalpy was found to be positive which indicates the system is endothermic in nature. The effect of temperature variation experiment with 0.1M D2EHPA, highest 78.46% Eu(III) was extracted at 52°C .Extraction of 0.001M Eu (III) in 0.1M lactic acid with variation of D2EHPA concentration gives cent percent results. The optimum condition was obtained with maximum 91.42% extraction of 0.01M Eu (III) in 1M lactic acid using 0.2M DEHPA in kerosene.

Keywords: Eu (III), Lactic acid, DEHPA

CPCM-0016

Trialkyl phosphine oxide as extracting agent for Nd (III)

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Abstract. Neodymium, one of the cr itical rare earth metals is in demand nowadays due to enormous technological applications and its limited supply has enforced the metallurgists to search resources for its efficient recovery. Solvent extraction is widely used as a separation technique for rare earth extraction and separation. The present investigation represents detailed studied on solvent extraction of Nd (III) from acidic nitrate solution using Trialkyl phosphine oxide (TAPO) as extractant diluted in kerosene. The operating variables like shaking time, concentration of extractant, nitric acid, nitrate, diluents and temperature were analysed for the extraction of Nd (III).The percentage of extraction increases with increase in nitric acid concentration from 0.01M to 0.1M but as the concentration of acid increased to 1M the extraction decreased.The extraction percentage of metal decreases with increase in concentration of nitrate ions. Quantitative extraction of neodymium (III) (96%) was obtained using 0.2M TAPO in kerosene. Thermodynamic studies showed negative value of enthalpy change indicating exothermic extraction and negative entropy change confirming the formation of Nd(III)-TAPO complex. Maximum extraction of Nd(III) was achieved on using kerosene as diluent due to its lower dielectric constant value compared to other diluents under consideration.

Keywords: Solvent extraction, Nd (III), TAPO

CPCM-0017

Study the relation between granulation index and bed permeability on productivity and sinter quality at Sinter Plant-3

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Abstract. The sinter quality has become very important with its increased usage in large blast furnaces. The sinter production rate is directly proportional to the Vertical Sintering Speed (VSS) in the sinter bed from top to bottom. The movement of high temperature flame front depends upon the air flow in the sinter bed which is a function of permeability of sinter bed and the available suction under the bed. The flame front speed and gas flow through the bed governs the temperature profile through the bed. The permeability of the sinter bed is a function of granulation efficiency of the sinter mix. The objective here is to generate data and establish a co-relation between Granulation Index (GI) and permeability of sinter bed on productivity and quality of sinter. A no. of trials was conducted for sinter mix granulometry, air filtration velocity and available suction at SP-3 to determine GI and bed permeability. By data, it was found that permeability of sinter bed increases with increasing GI upto a value of 1.89 and decreases afterwards. With increasing moisture, GI increases due to reduction in amount of very fine particles in sinter mix. The bed permeability decreases with moisture exceeding 9.77%, even though granulation increases. Sintering time decreases with improved bed permeability. The best sintering time of 32.49 min was achieved with permeability of 20.62 JPU and machine speed of 2.77 m/min. VSS decreases with an increase in bulk density of material. Highest VSS of 21.54 mm/min is achieved for bulk density 1.48.

Keywords: Ver tical sinter ing speed, Granulation index, granulometry.

CPCM-0018

Development of polydopamine assisted polypyrrole-based superhydrophobic coating on Al alloy for improved salt-water corrosion

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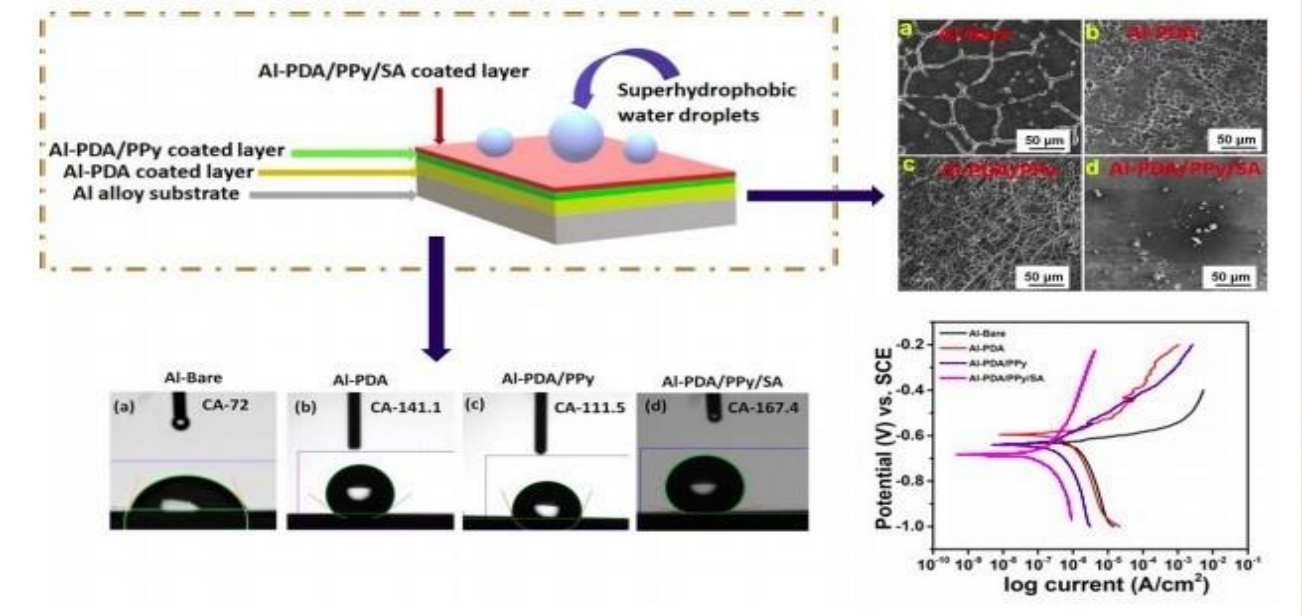
Abstract. Mussel-inspired, polydopamine (PDA) coating, which contains amine and catechol functional group has received renewed interest for improving corrosion resistance in different metal surface (Al, Mg, Ti, Cu). The proposed work highlights the development of mussel-inspired PDA assisted polypyrrole-based (PPy) superhydrophobic coating on Al-0.98 wt. % Mg- 0.68 wt. % Si- 0.29 wt. % Cu – 0.1 wt. % Mn alloy for improved salt-water corrosion. This study also laid an emphasis to on the topic that is much less addressed in the literature, i.e. the bonding of PPy films on Al alloys substrate and the role of PDA. The PDA assisted PPy coating on Al alloy was performed in three steps. In the preliminary step, samples were immersed in dopamine TRIS buffer solution for 24 h where the self-polymerization occurs. Then, the resulted PDA layer act as anchoring sites for PPy films growth. Afterwards, PDA-PPy coated Al alloy surface was treated with stearic acid (SA) for developing superhydrophobic surface. Therefore, the multilayer coating formed on the aluminum alloy substrates provide the super hydrophobic surface that improves the corrosion resistance three order of magnitudes on Al alloy surface compared to bare alloy.

Keywords: Al alloy, Polydopamine, Polypyrrole, Stearic acid, Super hydrophobic, Corrosion

Graphical abstract.



CPCM-0019

Development and Characterization of Sorbitan Monostearate Based Organogels for Topical Delivery of Miconazole Nitrate

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Abstract. In the present study, our effor ts have been devoted to develop and characterize the organogel consisting miconazole nitrate as pure drug by using sorbitan monostearate as base for topical delivery of Miconazole Nitrate. Different compositions of miconazole organogel were prepared by changing the concentration of the organogelator Span 60. Tween 20 was added to improve the stability of organogel.The developed formulations were subjected for evaluation by using different parameters such as visual inspection, pH, FTIR study to determine the drug-polymer compatibility, microscopic analysis, gel-sol transition studies, drug content analysis, rheology, spreadibility and in-vitro drug release study and in-vitro anti-fungal activity etc. The results of FTIR study indicated no drug-polymer interactions observed. The gel-sol transition study indicated that, as the concentration of the gelator was increased, there was subsequent increase in the transition temperature. As the concentration of Span 60 increased, there was proportionate decrease in drug release drug pattern. Thus the formulated organogel had a distinct advantage over existing conventional dosage form. The result of in-vitro anti-fungal activity suggested that,the mean zone of inhibition for optimized formulation was found to be 23.5mm comparing with Miconazole cream 18mm.Based on the results, the developed organogel can be used as an efficient drug carrier for the topical delivery of Miconazole.

Keywords: Organogel, Sor bitan monostearate, Miconazole, Topical delivery

CPCM-0020

Impact of Brick Powder on Tensile and Flexural Properties of a Hemp Fiber

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Abstract. Natur al fiber s, it was the word attracted by the entire world and replaces the most of materials because of its properties improvement, easy of availability, low cost and renewable nature. By using these fibers along with matrix and reinforcements, advanced fiber reinforced composite materials was developed. These properties may vary due to the conditions like type and size of fiber, place of growth and their environmental conditions, chemical method and their time period, water absorption nature, fiber orientation and type of filler material and their particle size. Now a day's most of the researchers focused on composite materials prepared by using the various powders as a filler materials. As a part of it for the first time this paper focused to study the impact of different percentages of brick powder on natural hemp fiber. While among them10wt% and 40wt% of brick powder composite materials were received the highest ultimate tensile strength and flexural strength properties than the remaining materials.

Keywords: Brick powder, filler material, Hemp fiber

CPCM-0021

Photocatalytic Application of SnS2/Bi4Ti3O12 heterostructure system for degradation of herbicides under visible light irradiation

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Abstract. In this study, the SnS_2 /$Bi_4Ti_3O_{12}$ material was prepared by a two-step process and studied as photocatalyst for degradation of potentially harmful herbicides under visible light irradiation. The $Bi_4Ti_3O_{12}$ was initially synthesized by combustion route which was subsequently modified with SnS2 by a modified hydrothermal route. The heterostructure materials were characterized using XRD, XPS, UV-Vis-DRS, FTIR, Raman, PL, FESEM and TEM analytical techniques. XRD study indicated the presence of orthorhombic crystalline phase of $Bi_4Ti_3O_{12}$ in the heterostructure system. The heterojunctions materials exhibited better optical absorption property and enhanced charge carrier separation characteristics. Microscopic studies indicated the presence of well dispersed SnS2 nanoparticles in a continuous $Bi_4Ti_3O_{12}$ matrix. The calculated band positions of both components suggested facile migration of excitons leading to the formation of a Z-scheme heterostructure. The SnS_2 / $Bi_4Ti_3O_{12}$ materials show excellent photocatalytic activity for aqueous phase degradation of herbicides under visible light. The generation of $^{\cdot}OH$ and $O_2^{\cdot-}$ radicals over the photocatalyst surface has been observed by spectrometric method. These active transient species have been found to be responsible for the photocatalytic activity. The SnS_2 / $Bi_4Ti_3O_{12}$ materials exhibited remarkable stability and recyclability during the photocatalytic tests. The detail study of the characterization and photocatalytic activity of the SnS_2 / $Bi_4Ti_3O_{12}$ materials will be presented in the conference.

Keywords: Photocatalysis, visible light, SnS^2 , bismuth titanate, herbicide

CPCM-0022

Prediction of de-lamination of Tapered Composite Laminate with Single Step Ply-Drop

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Abstract. Morden aeronautical str ucture is being made of laminated composite in which plies are dropped at discrete position to provide taperness. In present study two different ply drop configuration are considered in which plies are dropped at single step for tensile loading. CFRP ply material and epoxy as a resin is considered. A commercial Finite Element Software ANSYS 14.0 APDL was used to construct laminate with a 20 node solid three-dimensional layer element. Tsai-Wu criterion is considered to find failure factor for tapered composite laminate with single step ply-drop .The delamination sites were found by considering the inter-laminar stress. High stress concentrations were occurred at near to the tip of epoxy region. In different fibre orientation for dropped plies, the 90^0-90^0 orientation gives minimum value of longitudinal stress.

Keywords: ply drop, inter-laminar stress, de-lamination, finite element method, composite structure

CPCM-0023

Low Cycle Fatigue Behavior of Microalloyed Steel

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Abstract. The Nb-microalloyed steel under investigation is a low carbon microalloyed grade steel produced by thermomechanical treatment. Low cycle fatigue (LCF) tests were conducted to evaluate its response under cyclic loading to verify its suitability for automobile application. Cyclic hardening in the initial stage followed by prolonging softening till failure was observed at higher applied strain amplitudes (≥ 0.75%) whereas; throughout softening was observed at lower applied strain amplitudes (≤ 0.5%). The material is found to exhibit non-Masing behavior i.e. absence of any strain range effect. Post LCF hardness measurements reveal a considerable increase in the hardness where, the magnitude increases with the increase in applied strain amplitude. Coffin-Manson and Basquin relationships were used to formulate the strain life equation for the material. The fracture surface reveals that the fatigue crack seemingly initiates from the surface when observed under scanning electron microscope. Striation marks in the fracture surface confirm the typical fatigue failure. The presence of dimples shows a fast fracture due to the last loading cycle.

Keywords: Low cycle fatigue, Str ain life, Failure mechanism

CPCM-0024

Seismic Performance Assessment of a TMT Rebar

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Abstract. In this current work, str ain-controlled low cycle fatigue behavior of thermo-mechanically treated Fe 500S grade steel rebar has been examined to assess its response to seismic conditions. The total axial strain-controlled LCF tests have been carried out on the specimen until failure at room temperature at five different strain amplitudes (±0.3 to ±1.0) by keeping a constant true strain rate of 1×10-3 s -1 and a fixed strain ratio of -1. Assessment of fatigue properties has been supplemented by microstructural characterizations in addition to tensile measurement. Decrease in cyclic yield stress indicates cyclic softening of rebar till failure in all applied strain amplitudes resulting in deterioration of seismic resistance property. The strain life equation has been formulated for the rebar using Coffin-Manson and Basquin relationships. The fracture surface reveals that the fatigue crack seemingly initiates from the transverse rib root and propagates along the rim region when observed under scanning electron microscope.

Keywords: Low cycle fatigue, Str ain life, Failure mechanism, TMT rebar.

CPCM-0025

Thermoexperimental optimization of effect of process parameters on weld strength during Ultrasonic welding

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Abstract: Ultr asonic welding is one of the most advanced solid state joining technique used for welding of similar and dissimilar materials at only 30% of its melting point temperature. It can be implemented for joining of metals or non-metals rapidly and securely owing to a high-pressure vibration. The widespread application of the process can be found in electrical, automotive, aerospace, medical and packaging industry. In the present research work, Response surface methodology (RSM) with Box-Behnken design has been implemented to design the experimental setup and optimize the effect of process parameters viz. pressure, amplitude and welding time on the tensile strength. RSM is coupled with desirability function is utilized to optimize the parameters for a desired tensile strength of the joint. Experimental design is equipped with the thermocouple to predicted the heat generated at the interface during ultrasonic welding.
Keywords: Ultr asonic welding; RSM; Desir ability function; thermocouple

CPCM-0026

An assessment of hardness measurement on high temperature conditionedglass/ epoxy composites modified with CNT and MLG

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Abstract. As the commercialization of fiber -reinforced polymer (FRP) composites is gaining momentum, new investigations for understanding their behavior are constantly being undertaken by researchers worldwide. Exhaustive studies are being conducted to interpret the behavior of FRP composites modified with nanoparticles like multi-walled carbon nanotubes (MWCNTs) and multi-layered graphene (MLG). The response of these modified composites to temperature conditioning is of interest for specific applications. In this study, MWCNTs (0.2wt%, 0.4wt% and 0.6wt% of epoxy) were incorporated into epoxy and used to fabricate glass fiber reinforced MWCNT epoxy composite (MWCNT-GE) laminates; another set of laminates (MLG-GE) were fabricated in which epoxy matrix was modified with multi-layered graphene (MLG) of concentrations 0.2wt%, 0.4wt% and 0.6wt% of epoxy. The prepared samples were conditioned for 30 minutes at different temperatures: 30°C, 70°C and 110°C. Durometer hardness testing was performed to measure the hardness of neat as well as modified samples. The hardness values obtained for different conditioning temperatures and different nanoparticle concentrations were compared and analyzed. Fractographic analysis using Scanning Electron Microscope (SEM) was done to observe the distribution of nanoparticles in the samples, and significant conclusions on how they may affect hardness were drawn.

Keywords: FRP composite, Multi-walled carbon nanotubes, Multi-layered graphene, High temperature conditioning, Hardness test, Fractography

CPCM-0027

Preparation and Optical Characterization of LaMnO3 Thin Films by SolGel Technique

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Abstract: Sear ching for chemically stable solar -absorbing materials having earth-rich elements is the key factor for nextgeneration photovoltaic techniques. Many theoretical studies proposed that Mott insulators have potential as photovoltaic materials. In this paper, we report the results of structural, microstructural, and optical properties of Mott insulator LaMnO3 (LMO) thin films. LMO thin films were deposited on glass substrates by the sol-gel deposition technique. Structural characterization was performed by X-ray diffraction (XRD) and Raman spectroscopy. The surface morphology of thin films was studied using FESEM and average grain size was found in nanometer range. Retention of stoichiometry in thin films was confirmed by EDX analysis. Optical property of LMO thin films was studied with the help of UV-Vis spectrometer. LMO thin films show an indirect bandgap as well as strong light absorption over a wide wavelength range in the solar spectrum. These results strongly indicate that the LMO can be a promising candidate as a light absorber for next-generation solar cells.

Keywords: Mott Insulator s, Photovoltaic, Bandgap.

CPCM-0028

Influence of TiO_2 Particle on the Friction Stir Welding of 7075 Al Alloy

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Abstract. In this work, the influence of TiO_2 particles on the mechanical and corrosion properties of the friction stirred welded 7075 aluminium alloys were studied. Surface characterization was carried out with a scanning electron microscope (SEM). Energy dispersive spectroscopy (EDS) was performed to analyze the presence of TiO_2 particles in the weld. The tensile strength of the base metal was compared with the reinforced and unreinforced weld. The yield strength of the base metal is high as compared to weld alloy. The drastic decrease in tensile strength of the welded sample may be attributed to the dynamic recrystallization which is the consequence of heat generated due to the friction between the tool and weld material. Residual stresses generated during welding also affect the strength of the weld. However, the tensile strength of the reinforced alloy is found to be more in contrast to the unreinforced 7075 aluminium alloy. It can be interrelated to the presence of TiO_2 particles in the matrix. The fracture surface was examined through SEM. Overall it shows ductile fracture with a dimple surface. However, in the presence of TiO_2 particle, there is evidence of both intergranular and transgranular fracture. The corrosion test was conducted with 3.5 wt% NaCl solution. The base metal shows more corrosion resistance than the unreinforced and reinforced weld.

CPCM-0029

Correlation of Corrosion resistance of Hot Rolled UHSS with its microstructure

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Abstract: Usage of Ultr a High Str ength Steel (UHSS) is found to be increasing in automobile application for enabling vehicle weight reduction with higher safety. This steel is mostly used for long & cross member of vehicle and exposed to contact of corrosive material while vehicle is running. Corrosion test of Hot rolled UHSS coil conforming to EN 10149-2-S700MC & S650MC are done by Potentiodynamics Polarization Test Method in Potentiometer with 3.5 % aqueous NaCl solution as electrolyte. Although both the coils are rolled from same heat (Chemistry), but exhibited significantly different corrosion rate, such as 1.427 mm / year for S700MC and 0.287 mm / year for S650MC. Detail microstructure study under optical microscope, SEM, TEM & XRD shows that S700MC is having much higher dislocation density, grain boundary area, precipitate interface than that of S650MC. Hence strengthening mechanisms such as precipitation, dislocation, grain refinement – which have contributed to higher strength in S700MC, are the reason for higher corrosion rate also.
Keywords: UHSS, Steel, S700MC, S650MC, Corrosion, Microstructure.

CPCM-0030

An attempt to synthesize to graphene through electrochemical route using a basic solution for anti-corrosive coatings

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Abstract: Carbon is predominant material of use in our world and its elemental footpr ints are found in many are- as. One such highlighted member of carbon family, which has amassed attention in the last decade is graphene. Revolutionary research has taken place since its discovery in the field of electronics and materials. Yet, this prodigy has a lot to contribute in future. The idea of utilising graphene as a "corrosion protector" has started few years back and has yielded interesting results. The present work focusses on synthesis of FLGPs (few layered graphene particles) via electrochemical exfoliation of pyrolytic graphite in a basic solution (NaOH). Characterization techniques were employed to confirm the presence of graphene and to observe the morphology of the graphene layers. Coating of FLGPs on copper was exhibited through electrophoretic deposition (EPD). The corrosion behaviour and coating stability of the coated sample was analysed by means of LSV tests. Furthermore, AFM, FESEM and Profilometer give glimpses about the surface roughness and morphology of the coated samples.

Keywords: FLGPs, EPD, AFM, SEM, Tafel Plot

CPCM-0031

Utilization and geopolymerization of fly ash for concrete preparation and soil stabilization: A review

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Abstract: Geopolymer binders are green composite materials that can develop binding characteristics formed by the alkali activation of an aluminosilicate precursor such as fly ash. Over the last 30 years, different applications of geopolymer binders, that includes production of green concrete, coating material, bricks and as a method of stabilization of soil have been studied. This review paper primarily focuses on use of fly ash for concrete preparation and soil stabilization through this novel geopolymer technology. Therefore, the first part of the paper highlights the advantages, properties of fly ash based geopolymer while the second part describes its utilization as method of soil stabilization for geotechnical applications. In fly ash based geopolymer concrete, the precursor fly ash, is chemically activated by a high-alkaline solution to form a paste that binds the coarse and fine aggregates, and other unreacted materials to form concrete. The findings of the past research studies have been highlighted in this paper, which show that fly ash-based geopolymer exhibits higher compressive strength, better durability properties and lower water absorption and porosity when compared to traditional cement-based concrete. Further, in the context of geotechnical engineering, soil stabilization is the moderation of soil properties in order to obtain a type of soil that remains in an unchanged condition throughout its serviceable life. Utilization of alkali activated fly ash as a method of soil stabilization, includes mixing a geopolymer paste i.e. fly ash with an alkaline activator, then adding it with varying percent to the soil. As a result of geopolymeric reactions, the soil becomes chemically stable, which increases the coherence of the soil particles. Past literature demonstrates that soils may be stabilized to increase its strength and durability and to reduce plasticity, prevent erosion and dust generation. The paper finally concludes that fly ash, through geopolymerization, can be successfully used as a binder for concrete preparation and soil stabilization.

Keywords: fly ash; geopolymerization; geopolymer concrete; soil stabilization; waste utilization

CPCM-0032

Vibration analysis of thick and thin beams using finite element method

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Abstract: In this paper mainly investigated the fr ee vibration analysis of the Euler -Bernoulli beam and Timoshenko beams using isogeometric approach. The uses of both the types of beams are very significant in almost all mechanical com- ponents such as aerospace, automobile and nuclear power plant etc. To determine natural frequencies of beams, a thick beam element is developed by using iso-geometric approach based on Timoshenko beam theory which allows the transverse shear deformation and rotatory inertia effect. The Timoshenko beam generally encountered the shear locking and to identify such effect three refinement schemes such as h-, p- and k- refinement are used in the analysis. The natural frequency and mode shape of both structure can be determined for design purpose. In addition to this the bending stiffness and bending stresses are also determined using soft computing techniques. The higher order basis functions having no shear locking phenomenon in very thin beam situations. The design and analysis of both types of beams are still a challenging task for researchers and engineers.
Keywords: Timoshenko beam, natural fr equency, iso-geometric approach, h-,p- and k-refinement etc.

CPCM-0033

Influence of Nb5+ doping on microstructure and electrical properties of NBT ceramics

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Abstract. Na0.5Bi0.5TiO3 (NBT), Nb5+ doped (Na0.5Bi0.5)1-x/2 Ti1-xNbxO3 and N0.5B0.5Ti1-xNbxO3 ceramics for x=0.01 were synthesized by microwave assisted conventional solid state reaction route. Influence of Nb5+ doping on microstructure, electrical properties of NBT ceramics were studied. Microwave processing technique is chosen for sintering of ceramics, as it is a powerful method, which enables sintering in a short time and its fast heating rate avoid grain growth in the ceramics. X-ray diffraction pattern showed the formation of single phase perovskite structure with rhombohedral symmetry of pure and doped NBT sintered at 1000oC for 30 minutes in a microwave furnace matches with JCPDS No. 36-0340. Microstructure of all the ceramics was investigated by field emission scanning electron microscopy (FESEM) and observed that grain size decreases with doping. Frequency dependent and temperature dependent dielectric study were carried out for all the samples in the frequency range of 1 kHz to 1MHz.All ceramic shows diffused phase transition around temperature Tmwith diffusivity in the range of 1.5-2 and Nb doping shifts the Tm toward lower temperature.Room temperature polarization-electric field (P-E) hysteresis loop confirms the ferroelectric behavior of all the ceramics.

Keywords: Perovskite, Hysteresis loop, Diffusivity.

CPCM-0034

Comparative Study of Hydroxyapatite Synthesized by High Energy Ball Milling in Wet and Dry Condition

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Abstract: Mechanochemical method/ high energy ball milling (HEBM) was per for med to produce nano hydroxyapatite/HA powder both in wet and dry condition by taking $CaCO_3$ and $(NH_4)H_2(PO_4)$ as starting precursors. Nanoparticles of HA were produced by high energy ball milling in wet condition with rotation speed 600 rpm for 10 hours by taking ethanol as grinding liquid and zirconia balls as grinding media. From EDX analysis, an additional peak of aluminium was observed for wet milling but not for dry milling. Occurred Al contamination may be related to various factors like: the chamber that is used for milling contains aluminium, grinding liquid, high rotation speed, and more milling time. To avoid Al contamination, dry milling is preferred in which rotation speed is taken as 300 rpm and milling time (5 hours). Average particle size of HA was found to be in the range from 27nm to 80nm from FESEM analysis. XRD study confirmed the evolution of pure HA phase. Optimized calcination and sintering temperature of HA system was at 8000C and 10000C respectively, synthesized by using microwave assisted high energy ball milling technique.

Keywords: Hydroxyapatite, Mechanochemical, EDX

CPCM-0035

Corrosion behavior of indigenous CRLA steel in a simulated pipe line environment consisting of coke oven, blast furnace and LD gases

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Abstract: Potentiodynamic polarization behavior of AISI type corrosion resistive low alloy (CRLA) in borate buffer solution without NaCl and with NaCl solution with different molar quantity as well as in the simulated in operation environment has been tested in the present report. The corrosion potential and pitting potential are found at different pH and at different molar quantity of NaCl. The pitting corrosion observed in metallic materials, focusing on events associated with nucleation of pits, i.e. passivity breakdown, initiation of pits and their propagation stage. Passivity breakdown including the role of the inter-granular boundaries of the barrier oxide layer on the redistribution of the potential at the metal/oxide/electrolyte interfaces in the passive state is presented. This oxide layer may break due to different types of environmental effects leading to rapid corrosion. Hence the study on breakdown of passivity should permit one for the interpretation of process parameter and environmental restriction for long time of serviceable of the metal. The corrosion resistive low alloy is having the higher percentage of copper and manganese making it corrosion proof literally. In this work the corrosion study is based on passivity breakdown and corrosion point in borate buffer solution as a function of pH and Cl ions. The pitting corrosion studies of CRLA is carried out in borate buffer solution at varying pH (8.3,9.3,10.3) in the presence of 3.5% chloride ions. Corrosion studies were performed by potentiodynamic scans, microscopy techniques, SEM, Raman spectroscopy and X- ray diffraction. As increasing the pH of borate buffer solution, the breakdown potential increases i.e. the pitting tendency decreases whereas it got decreased with increasing chloride ion concentration.
The value of breakdown potential was also found to increase with the potential scan rate. After obtaining the potentiodynamic curve pitting studies of the surface is done by optical microscope.

Keywords: CRLA, Passivity, Potentiodynamic

CPCM-0036

Synthesizing and Characterization of Sugarcane Reinforced Epoxy Composites

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Abstract. A composite is fabricated of Epoxy polymer as matrix with sugar cane fibre as reinforced material . It is fabricated to different samples of varying fibre loading and chemically treated and untreated. During the making process certain chemical treatments were done at room temperature for better properties of the composite. After moulding and casting into composites, these samples are tested through certain physical tests such as impact test, fractography, hardness test, surface roughness etc. which signifies its moisture penetration, hardness, voids, water absorptivity etc. in different compositions of the fibre. A fine result came out which shows the comparison between the properties of different samples, and the use of fibre shows an encouraging effect on the mechanical properties of the composite and it can be a better substitute for transportation, building & construction, furniture & chair, suitcase & helmets and many more products.
Keywords: -Fibre Matrix Interface,scanning electron microscopy,impact energy, surface morphology of composites, absorptivity

CPCM-0037

Aluminum-Lithium Alloys for Aerospace Applications

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Abstract. In present days there is a need for alternate materials for aerospace application as weight is consider ed as a main factor in order to overcome this problem. Here In this paper, a detail study on aluminum-lithium alloy (Al-Li 2099 alloy) a new innovative material used for aerospace application and even equilibrium phase diagram of aluminum-lithium alloy is discussed. To increase the strength to weight ratio of Al-Li 2099 alloy is mixed with max 2% of lithium. Lithium is added because it reduces alloy density and increases the strength and elastic modulus of the material. Even the mechanical properties of Al-Li 2099 alloy are compared with the conventional alloy. The manufacturing process and testing of this material is also explained in this paper.

Selection of materials for aerospace industry has to be done carefully based on their properties and its applications. Factors such as metallurgical, manufacturing and environmental considerations should be considered while choosing materials for aerospace industry, Strength and other properties are concerned while designing the adequate material. Aluminium is used for aerospace vehicle's structure due to its properties of light weight, corrosion resistant. Alloying is a process which strengthens the alloy depending on the composition and properties of its alloying elements. To attain certain properties the material under goes heat treatment / cold treatment process. In this paper a study on Aluminum – Lithium alloys is done with emphasis on 2099 and 2199 for aerospace applications. This paper gives an overview of the alloying elements, and their thermal-mechanical properties. 2024 and 7075 aluminum alloys are compared. Aluminum alloys are used in many international companies such as Alcoa and Bombardier due to their optimized properties in aircraft applications.

Keywords: Aluminum-lithium alloy (Al-Li 2099 alloy), Equilibrium phase diagram, Strength to weight ratio, elastic modulus.

CPCM-0038

Corrosion behaviour of abradable Aluminium based coating used in aero engines

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Abstract. In aero engine manufactur ing industr y coating plays an important role for providing sur face protection against corrosion, erosion, friction and wear, as it is confronted with harse conditions like high temperature and corrosive environment during service period. The present investigation explores the corrosion potential of abradable Aluminium based coating used for aero engine components (for sealing and clearance control in compressor of aero engines) by subjecting it sea water for different length of time. The coating deposition is done using thermal plasma spray method. It is found that coating possessed good adhesive strength, required hardness and surface roughness. Porosity is high at CPSP (critical plasma spray parameter). Also certain phase transformation and interlayer oxide formation, during plasma spraying coating characteristics are observed. Untreated coating sample and sea water treated samples were characterised to evaluate their corrosion resistance potential by Micro structural characterisation, composition and phase analysis of coating samples as well as sea water treated samples have been carried out using scanning electron microscopy, X-ray diffraction and Energy Dispersive Scanning . Present investigation indicates that there is sharp weight gain in initial weeks followed by decrease is weight of coating samples after sea water treatment up to ten weeks of immersion. The weight gain of sample may be due to increase in oxide component formation. The decreasing trend of weight with time may be concluded that the deposited grains formed due to corrosion may be washed out by prolonged time of treatment.

Key words: CPSP, plasma spraying, saline water corrosion.

CPCM-0039

A Taguchi Based Grey Relational Analysis to Determine Optimum Machining parameter for Facing Operation of Ti6Al4V Metal Matrix Composite

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Abstract. This paper shows the novel approach of Taguchi Based Grey Relational Analysis of Ti6Al4V Machining parameter. Here, all the components of machining forces, including longitudinal force (Fx), radial force (Fy), tangential force (Fz), surface roughness and material removal rate (MRR) are measured during the TI6Al4V metal matrix composite facing operation. The effect of three process parameter, such as cutting speed, tool feed and cutting depth; is being studied on the matching responses. During the machining operation, it is advisable to determine the most suitable combination of these machining parameters on the process performance parameter. Orthogonal design of experiment (Taguchi L9) has been adopted to execute the process parameters in each level. To validate the process output parameters, the Gray Relational Analysis (GRA) optimization approach was applied. The percentage contribution of machining parameters to the parameter of response performance was interpreted through variance analysis (ANOVA). Through the GRA process, the emphasis was on the fact that for TI6Al4V metal matrix composite among all machining parameters, tool feed serves as the highest contribution to the output responses accompanied by the cutting depth with the cutting speed in addition.

Keyword: Ti6Al4V, Facing Operation, Taguchi Method, Grey Relational Analysis, ANOVA, Optimization.

CPCM-0040

Investigation of Elastic Properties of Titanium Dioxide from first principles

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Abstract. In the recent years Titanium Dioxide (TiO_2) has played a significant role in the materials science and technology world due to its elastic properties and extensive use in vast ranging sphere of applications. In previous time there have been significant studies experimentally and theoretically for calculation of elastic property of TiO_2. There have been studies based on addition of TiO_2 to polymers to improve the mechanical property when both the materials combine. However, there is less structured analysis of the elastic findings of the TiO_2 structure. In the paper the main aim is to calculate the elastic properties of the TiO_2 using first principle calculation with the support of Quantum Espresso software and compare it with the results already present in literature. The Quantum Espresso based as a software suite emphasizing on first principle calculation to obtain the electronic structure of the material for modeling. Quantum Espresso is an open source software based on the density functional theory (DFT) calculations. Parameter such as total energies are estimated for TiO_2 using QE. Thus using the total energies, the elastic properties for TiO_2 are evaluated using a further processing package ElaStic that is able to compute the full stiffness tensor of second-order elastic constant for any crystal structure from first principle calculation of total-energy or stress evaluation.
Keywords: Titanium Dioxide, Elastic, fir st principles, ab initio, density functional theory, Elastic.

CPCM-0041

Molecular dynamics simulation-based investigation of Mechanical Behavior of CNT Embedded Nanocrystalline Al at Cryogenic Temperature

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Abstract. A molecular dynamics simulation based study has been performed to investigate the mechanical behavior of nanocrystalline (NC) aluminum (Al) and NC Al embedded with Carbon nanotube (CNT) composite under uniaxial tensile loading for cryogenic temperature (77 K) through hybrid potentials for interatomic interactions of Al-CNT at 10^{10} s^{-1} strain rate. Armchair type CNTs ((5, 5), (15, 15) and (30, 30)) are preferred as reinforcing material in this study. The structural variation and defects evolution are also examined during the deformation of NC Al and NC Al embedded with CNT composite. NC Al embedded with CNT composites has exhibited higher ultimate tensile strengths in contrast to NC Al without CNT. It is also found that the matrix (NC Al) has fractured first along the grain boundaries (i.e. intergranular fracture) then CNT has fractured through Stone-Wales defect. Shockley partial dislocations are driving factor for the crack initiation leading to fracture of NC Al without CNT and CNT embedded NC Al composites.

Keywords: Molecular dynamics, Nanocrystalline material, Carbon nanotube, Aluminum, Dislocation.

CPCM-0042

Stability of Transition Metal Dopants Implanted in Rock-salt Oxides

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Abstract. Implanting metallic ions in semiconductor oxides have attracted immense attention owing to their applications in various devices. As the ‘state’ of the dopant is very important in deciding the properties of the host oxide, we intend to propose a simple way in predicting the same within the framework of density functional theory (DFT). Using MgO as a stable host and transition metal (TM) atoms as dopants, this study aims at predicting the preferred site and charge states of the implanted TM atoms in the oxide. We show that, contrary to the popular notion that TM dopants will invariably substitute the host cations, some TM atoms can be stabilized as interstitial in the oxide depending on their ionic radii and oxygen affinity. Our dopant formation energy calculations revealed that, the overall thermodynamic stability of an implanted ion in the host is related to their preferred charge state in the oxide. We explain this relation with Fe, which can be stabilized as interstitial in MgO in 3+ or 2+ charge states. However, neutral Fe is not stable in MgO and precipitates out at the grain boundaries. Based on DFT and calculating the transition barriers associated with interstitial hopping and diffusion coefficients, this study provides a new prescription to predict whether an implanted TM dopant in rock-salt structured oxides will remain stable and embedded in the host or it will precipitate out. Our work paves a way for a better understanding of dopants in oxides, necessary for altering oxides’ properties for device applications.

Keywords: Transition metal dopants in oxides, Thermodynamic stability, Density functional theory

CPCM-0043

A comparative nanoindentation study on HEA coated FCC metals and stacking fault tetrahedra evolution in HEA coated single crystal Al: A MD simulation study

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Abstract. In the present study, the nanoindentation test has done on Mo20W20Co20Ta20Zr 20 (HEA) film -coated single crystal (SC) Cu and Al by replacing the substrate SC Ni in the earlier reported study [1] to compare the underlying deformation activities and mechanical properties using molecular dynamics (MD) simulation. In addition, the development mechanism of stacking fault tetrahedra (SFT) in Mo20W20Co20Ta20Zr20 coated SC Al has also been investigated. The comparative study suggests the appearance of different distorted structures at higher indentation depth are effectively influence the plastic deformation in HEASC FCC specimens such as in HEA-SC Ni, the evolution in prismatic loops and interface distorted dislocation structures, in HEA-SC Cu, the evolution in long lengthed Hirth partials, Lomer-Cottrell (LC) barriers, closed stair-rod partial dislocation steps, multi-dislocation loops, and complex distorted interface structures; and, in HEA-SC Al, the evolution in SFT, LC barriers, closed stair-rod partial dislocation steps and loops, etc. The critical analysis of SFT development in Mo20W20Co20Ta20Zr20 coated SC Al reveal the development mechanism is dislocation-based, which has predominately governed by stacking fault (SF) planes' interaction and dislocation gliding. The shear strain and displacement vector plots confirm the growth of distorted dislocation structure below the indenter tip in HEA coated SC Ni is relatively more symmetric and significant than others due to its high stiffness. Moreover, in HEA coated SC Cu, the appearance of complex distorted dislocation structures at the interface restricts the plastic deformation to a greater extent in the interface layer.

Keywords: HEA, MD Simulation, Nanoindentation, Stacking Fault Tetrahedra, Lomer -Cottrell Barrier

CPCM-0044

Microstructural Evolution During Pancake Forging of Ni-Cr-W-Mo-TiAl Nickel Base Superalloy: Experimental and Simulation

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Abstract. Ni-Cr-W-Mo-Ti-Al is precipitation hardened superalloy with high-temperature oxidation resistance and strength, and excellent resistance to the oxygen-rich environment. The microstructural changes during hot working depend on essential parameters such as strain, strain rate, temperature, and holding time. It is crucial to control hot working parameters to achieve the required microstructure and mechanical properties. Hot compression tests were conducted in the temperature and strain rate range of 1100-1200°C and 0.1-5 s-1 , respectively to investigate the microstructural evolution. The flow curves were analyzed to determine the critical stress and strain for initiation of dynamic recrystallization (drx). Relationship was formulated between the dynamically recrystallized grain size (Ddrx) and Zener-Holloman parameter (Z). These results were applied to pancake forging of Ni-Cr-W-Mo-Ti-Al superalloy at 1150 and 1200°C. A total strain of ≈ 1 was imparted in a single step followed by air cooling. Finite element simulation was carried out using FORGE® software to predict the distribution of state variables in the pancakes. Johnson-Mehl-Avrami-Kolmogorov (JMAK) type model was employed to estimate the dynamically recrystallized grain size. There was close match between the predicted values and actual measurements.

Keywords: Nickel based superalloy, Microstructure, Pancake for ging, and Simulation

CPCM-0045

Parametric Investigation on Drilling Behavior of 3D Printed CFRP Composites

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Abstract. CFRP composites are widely used in manufacturing industr ies since it offer s attractive mechanical and physical properties like high strength, high modulus, and low density. Conventional drilling is an inevitable machining operation which is mostly performed for making hole in composites. In this study, CFRP composite was fabricated by using 3D printing machine. Composite plate of 4 mm in thickness was fabricated to investigate the drilling behavior. The drilling behavior of the composite was experimentally investigated by varying different drilling parameters. The effect of different drilling parameters namely axial feed (45, 63, and 90 mm/min), spindle speed (250, 710, and 2000RPM), and geometry of the drill bit (8-facet, dagger, and slot) on the drilling-induced forces (thrust force and torque) and the maximum temperature-induced during drilling of CFRP composites was experimentally investigated. The drilling parameters were also optimized through Taguchi analysis. The relative significance of the drilling parameters was obtained by analysis of variance (ANOVA).

Keywords: 3D Printing, CFRP, Drilling, Thrust Force, Torque, and Temperature

CPCM-0046

Investigating the Selectivity, Interferences and Adsorption Mechanism of Cr(VI) using Lanthanum Phosphate Polyaniline Nanocomposite

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Abstract. A novel lanthanum phosphate-polyaniline (LaPO4 -PANI) nanocomposite was synthesised by simple sol-gel technique. The nanocomposite synthesized with 1:1 ratio showed the highest ion exchange capacity and selective adsorption performance of Cr(VI). The phase and morphology of the as-prepared material was confirmed from XRD, FESEM, and TEM analyses. The FTIR, Raman, and TGA data inferred the definite chemical interaction between the organic and inorganic counterparts in the formation of LaPO4 -PANI. The selective adsorption of Cr(VI) was estimated by evaluating the distribution coefficient, electrical double layer theory as well as valency and Pauling's ionic radii of interfering ions (phosphate, iodide, sulfate, chloride, sulfide). The high tolerance capability of LaPO4 -PANI against the interfering ions made it appropriate for selective and efficient removal of Cr(VI). The nanocomposite showed highest removal percentage of 98.6% towards Cr(VI) in a wide pH range of 2-6 at room temperature, as compared to sole lanthanum phosphate (56%) and polyaniline (75%). XPS analysis demonstrated the adsorption mechanism due to combined effect of the partial reduction of Cr(VI) to Cr(III) and chemisorption through electrostatic interactions, co-ordination interaction and ion exchange. The procured results make the LaPO4 -PANI nanocomposite a promising and selective adsorbent for the abatement of Cr(VI) from aqueous solution.

Keywords: LaPO4 -PANI; distribution coefficient; interfering Ions; Cr(VI); selective adsorption

CPCM-0047

Oxidation of 2.25 Cr-1Mo Steel in a continuous water vapour environment

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Abstract. Boiler materials are made up of alloys which can operate at high temperature range normally up to 600°C. 2.25Cr-1Mo Steel is extensively used for super heater and reheater tube, header pipe in large-scale thermal and nuclear power plant where high temperature oxidation could be an inevitable phenomenon. Hence oxidation tests for 2.25Cr-1Mo steel were carried out at different temperatures and different steam flow rates by using Lenseis TGA machine at 800°C and 900°C with different steam flow rates of 6.42, 3.21 and 1.6 µ.lit/min. It was observed that oxidation of 2.25Cr-1Mo ferritic steel was dependent on time, temperature and steam flow rate. Higher steam flow rate and higher temperature resulted in a higher oxidation. The oxide layer thickness was greater at higher steam flow rate. Two layers of oxide were investigated at 800°C. The Oxidation rate was initially parabolic during heating and finally linear during cooling. The activation energy was greater in lower steam flow rates.

Keywords: 2.25Cr-1Mo steel, Oxidation, Activation energy

CPCM-0048

Prediction of the Fatigue Life of lass-Vinyl-Ester-Polyurethane Sandwich Structure using a Mathematical Model

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Abstract. Predicting the fatigue life of a Polymer Composite Sandwich Str uctures (PCSS) is always a great deal of challenge to composite design engineers. Various factors like fundamental constituting elements and their properties, type of manufacturing process, working conditions such as type of loading, maximum or minimum loading and frequency of application of load as well as the environmental surroundings influence the fatigue life of PCSS. For the present experimental study, GVE-PU (Glass-Vinyl-EsterPolyurethane) a polymer composite sandwich structure is selected. It is widely used in manufacturing components like wind turbine blades, ship casings and surfing planks which are majorly subjected to cyclic loadings. Initially GVE-PU composite laminates having foam density ranging from 100 – 300 Kg/m3 were developed through hand-lay-up process. These sandwich laminated were subjected to flexural and fatigue testing under 60 – 80% of ultimate flexural loading with 6-9 Hz frequency. Furthermore, the test results were analyzed in the form of 2D & 3D surface plots to compare GVE-PU with GVE (Glass- VinylEster) composite. Both laminate results were compared and S-N curves were drawn to identify the distinctive stress dominated and cycle dominated zones to draw conclusions. Finally a mathematical expression was developed to predict the fatigue life of PCSS laminate.

Keywords: Fatigue life, PCSS, GVE-PU sandwich, GVE laminate, Flexural and Fatigue testing, S-N curve, 3D surface plots.

CPCM-0049

Diverse morphological tuning of ZnO nanostructures and their characterization

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Abstract. In the present work, for mation of ZnO nanostructures was discussed via a single step wet chemical route without the involvement of any surfactants and seed layer. Varied morphological tuning was observed with progress in the reaction period. The morphologies observed with proper chronological order were nanosheets, sheet embedded nanorods, proper nanorods and petal like nanorods. The structural, optical and electrochemical studies were limited to ZnO nanorods only. Focus of XRD peaks on (100), (002) and (101) planes suggested sharper peaks signifying higher order of crystallinity. The average crystallite size via Debye and Scherrer equation was found out to be 23 nm (shape factor k= 0.93). A well- defined excitonic band was noticed at around 360 nm; also photosorption seemed to be taking place in both UV as well as visible wavelength ranges suggesting the presence of defect carriers within the bandgap of the material. The n- type conduc- tivity of ZnO nanostructures was confirmed by Mott- Schottky (M-S) studies. A characteristic cathodic peak was observed with anodic sweeping suggesting the presence of n-type doping influence of nitrogen on the conductivity of ZnO nanorods. Upon increasing the cathodic potential, a prominent enhancement in the photocurrent values suggested better collection of electrons. Noticing an upward curve in the M-S plot indicated the presence of n-type doping influence of nitrogen on the conductivity of ZnO nanorods. Although nitrogen was expected to be a p-type dopant, however n-type behavior was dis- played owing to due to insufficient concentration of nitrogen and oxygen as suggested from EDAX studies. First indication of nitrogen doping through Raman spectral analysis was observed through the displacement of the peak position initially obtained at 660 cm−1 in case of pure ZnO nanorods, which shifted to 680 cm−1 in-case of nitrogen doped ZnO nanorods. We observed that the ZnO nanostructures that were doped with nitrogen exhibited superior optical response to ultraviolet light compared to undoped ZnO nanostructures.
Keywords: ZnO, Nitr ogen Doping, PEC studies and M-S plot, Raman Spectroscopy.

CPCM-0050

Enhancement in reliability of Lime Kilns through several innovations at Calcining Plant-II in Rourkela Steel Plant plant for higher productivity and better quality of lime

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Abstract. Calcined Lime and Dolomite are one of the most important ingredients in both primary and secondary steel making. Optimum usage of good quality calcined lime and dolomite is essential to remove Phosphorus (P) and Sulphur (S) from steel, in addition to Alumina and Silica. Calcined Lime and Dolomite are one of the most important ingredients in both primary and secondary steel making. Optimum usage of good quality calcined lime and dolomite is essential to remove Phosphorus (P) and Sulphur(S) from steel in addition to Alumina and Silica to form proper slag. Calcination of limestone is a thermal decomposition process of raw limestone through an endothermic reaction, carried out in the solid state. In Calcin- ing Plant-II, RSP, the calcination takes place, primarily through Oil fired in Kiln 5 & 6 and Gas fired in Kilns 1 to 4, which are Parallel Flow Regenerative (PRF) kilns. Refractory performance of lime kilns plays crucial role in enhancing the relia- bility and availability of lime kilns. After the capacity expansion of hot metal production from 1.9 to 4.2MT in RSP, 2 new vertical shaft lime kilns 5 & 6, supplied by M/s. Cimprogetti, Italy, were introduced in 2012-13. However, maintaining quantity and quality of produced lime remained a challenge due to frequent maintenance issues of these kilns. Refractory Engineering (Services) department, RSP employed several innovative repair methodologies and introduced design changes to substantially improve the life of these kilns, in addition to the old kilns 1 to 4. These interventions resulted in reducing overall down time of kilns, thereby improving calcined lime quality and productivity, for steel making. In addition to the design modification done, frequent thermal imaging and daily shell temperature monitoring were also carried out to detect potential threat areas in kilns. The above innovative measures play crucial role in CP II Kilns for consistently better life of more than two years and production of not only good quality calcined lime having LOI less than 5.2 and Reactivity more than 320, but also the quantity required for enhanced steel production of SMS-II.
Keywords: Lime kiln, refr actory, maintenance practices, capital repair.

CPCM-0051

Fly-ash derived Zeolite as a versatile novel material in Civil Engineering

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Abstract. Increasing energy demand and dependence on coal as a fuel to satisfy demand of energy sector in many countries resulted in increasing production of Fly ash (FA). Most part of the fly ash has been utilized for construction. Nearly 30 percent of fly ash is discarded on landfill spots, which poses a great threat to the environment. To achieve a goal of 100 percent utilization of fly ash in sustainable way, alternative technology is very much required to convert fly ash to useful materials. Synthesis of zeolites from fly ash is an emerging approach to utilize fly ash. Numerous experimental researches confirms that zeolite has superb mechanical properties and thermal stability which can be used in building materials. Also due to its superior molecular sieving and ion-exchange capabilities, zeolites have a wide range of applications in civil engineering. This chapter will discuss on zeolite synthesis and its application in field of construction.
Keywords: Fly ash, Zeolite, Constr uction

CPCM-0052

Ethanol extract of waste potato peels for corrosion inhibition of low carbon steel in chloride medium

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Abstract. Corrosion of low carbon steels is a big constraint in their smooth use for engineering applications. Corrosion not only destroys their designed properties but also harms their physical appearance. Several researchers are working to minimize the effect of corrosion on low carbon steel. In this regard, they have consumed a lot of synthetic and natural materials till date. Nowadays, researchers are showing their trust on natural materials for corrosion inhibition application due to their easy availability, negligible toxicity and easy synthesis process as well as eco-friendly nature. It is an established fact that waste natural materials (WNMs) like banana peels have very high potential for being used in corrosion inhibition application due to their bioactive contents. However, WNMs have not been explored frequently by the researches despite their supreme technical and economical importance in corrosion inhibition. In this work, ethanol extract of waste potato peels is used for corrosion inhibition of low carbon steel in 0.5 M NaCl. The inhibition properties of the extract are determined by weight loss measurements, open circuit potential (OCP) curves, electrochemical impedance spectroscopy (EIS), Tafel polarization curves and linear polarization resistance (LPR) techniques. Results show that maximum corrosion inhibition efficiency of 70% has been achieved using 1000 mg L^{-1} of the extract. Scanning electron microscopy (SEM) and energy dispersive X-RD Spectroscopy (EDX) has also shown that the extract has successfully protected low carbon steel in 0.5 NaCl.
Keywords: Corrosion; Inhibition; Waste Natur al Material; Potato Peels; OCP; EIS; SEM.

CPCM-0053

Investigation on the stress distribution during hard turning of AISI 52100 steel using Al2O3/TiCN cutting tool coated with mono-layered AlCrN and multi-layered AlTiN/TiN coating

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Abstract. The str ess distribution in the tool and workpiece materials play a significant role in defining the usability of the machining process which is of serious concern during hard turning operation. Thus, the present work focuses on studying the stress distribution in the workpiece (AISI 52100 steel at 63 HRC hardness) and the cutting tool (Al2O3/TiCN) numerically. The mixed ceramic cutting tool is coated with mono-layer AlCrN and multi-layer AlTiN based coatings deposited by using cathodic arc evaporation process and the experiments were performed under dry cutting environment. The experimental data has been used to validate the numerical model so that the stress distribution can be predicted. The finite element analysis apparently indicated the reduction of stress in the workpiece material while machining with coated cutting tools with AlTiN coating exhibiting superior performance at the highest feed rate and AlCrN coating outperforming at the highest cutting speed. This peculiar behaviour is closely associated with the oxidation resistance and thermal stability of AlCrN and AlTiN coatings. Further, the stress distribution in the cutting tools at adverse cutting conditions clearly specify superiority of coated tools over uncoated cutting tool.

Keywords: Hard machining, Coated tool, Stress distribution.

CPCM-0054

Increase in productivity of Old Continuous Slab Caster through enhancement of sequence size by preventing rise in mould water inlet temperature above 42 Deg C, in CCM-I:SMS-I of Rourkela Steel Plant

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Abstract. Copper mould is an important and integral component of any Conventional Slab Caster for steel to initiate the initial solidification. In case of SMS-I, Rourkela Steel Plant, the slab caster was a “Brown field project” and was commissioned in 1996.This project faced severe space constraints, as it was built in the old SMS area, which was originally commissioned during late fifties, with ingot teeming. In this slab caster the copper mould is a “Constant cooling water volume” design and the water flow could not be altered, as per casting speed. Therefore, the strand shell formed in the mould is thicker in case of lower casting speed and thinner in case of higher casting speed. As per the Detailed Project Report(DPR), the designed sequence size was only 2(Two), with a total production capacity of 0.305 MT per annum. Further, Ladle Heating Furnace(LHF) was not envisaged during commissioning of slab caster. Though, several attempts were made to cast more than 2 heats in the caster, it was not possible, primarily due to logistic issues, in absence of LHF. Subsequently, the (LHF) was commissioned, adjacent to the slab caster in 1998. However, even after LHF was commissioned, the maximum sequence that could be cast was only 5(Five), with a heat size of 66 Tons. Due to higher production demand, for increasing the sequence size, it was analysed that the major constraint was “Inlet water temperature to the Copper Mould”, which was crossing the threshold limit of 42 Deg. Centigrade. In the present study, in depth analysis of mould inlet water temperature was carried out and the problem was eradicated. This resulted in casting more than 5(Five) heat sequence to increase the productivity, with minimum revenue expenditure.

Keywords: Steel, Continuous slab caster, Copper mould, Mould inlet water, Water temperature.

CPCM-0055

Performance Evaluation of Uncoated and Coated Carbide Tools during Hard Machining of AISI 4340 Steel

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Abstract. The present paper highlights a comparative assessment of the effect of cutting speed on tool performance in hard turning of AISI 4340 steel with uncoated and coated carbide inserts. For hard machining of the workpiece, one uncoated and two multi-layer coated TiC/TiCN/TiN and TiCN/TiC/Al_2O_3inserts were utilized. A series of experiments were carried out at four different cutting speeds viz. 100, 150, 200, and 250 m/min whereas the feed rate and depth of cut were maintained at 0.12 mm/rev and 1 mm respectively. The influence of variable cutting speed on two vital machinability aspects such as surface roughness and tool wear was analyzed. The outcomes of the investigation revealed that both the aforementioned machining characteristics were potentially influenced by the cutting speed. It was found that the high cutting speed was responsible for curtailing tool performance as well as the surface quality of the machined part. Besides, in contrast to its coated equivalent, uncoated instruments struggled to perform effectively at higher cutting speeds. However, in the context of declining tool wear at preeminent cutting speeds, the difference in the efficiencies of both the selected coated tools was not significant.
Keyword: Flank Wear; Surface Roughness; Hard Machining; Tool coating; Carbide inserts

CPCM-0056

Simulation of fatigue crack growth and fracture toughness of 2024 aluminum alloy under constant/variable amplitude loading conditions

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Abstract. 7024-T3 Aluminum alloys are widely used in engineering components and aircraft structural material. Therefore prediction of fatigue crack propagation of such aluminum alloy is important for designing an engineering structure and its components. In the present investigation, a mathematical simulation was done to determine the crack growth rate of the 2024-T3 aluminum alloy under constant/variable amplitude loading conditions from experimental crack length and number of cycle data. The nature of samples under investigation was single edge notch specimens and all the experiments were done in air and at room temperature. The simulation performance was evaluated using percent deviation, prediction ratio and error bands scattered of predicted and the experimental results. The simulated outputs were found to agree with the experimental results. However, it was observed that in comparison to fatigue crack growth rate, the simulation to predict fracture toughness was conservative in nature.
Keywords: crack length, fatigue crack growth, str ess intensity, crack driving forces

CPCM-0057

Effect of post-weld heat treatment on microstructure evolution and CORROSION resistance of electron beam-welded duplex stainless steel

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Abstract. The effects of electron beam welding and succeeding post-weld heat treatment at different temperatures on the microstructure evolution and pitting corrosion resistance of duplex stainless steel were investigated. The as-welded joint exhibited poor galvanic corrosion resistance, and pitting corrosion accordingly occurred in the ferrite grain in the

weld. Heat treatment promoted austenite formation, Cr2N dissolution, and eliminated dendritic segregation, as a result im- proving the corrosion resistance of the welded joint. The development of different phases upon welding without any post heat-treatment – especially in the heat affected zone (HAZ) – and their consequent different corrosion resistance were in- vestigated through optical microscopy, scanning electron microscopy (SEM), X-ray diffraction (XRD) method and poten- tiodynamic polarization, EIS in 3.5% NaCl solution. In this work selected welded samples were aged at different tempera- tures (650 °C, 850 °C, 950 °C and 1050 °C), in order to simulate heat exposure during processing or service stages. The results showed that the pitting corrosion rate increased in chloride environments with increasing aging temperature till 850°C; afterward pitting corrosion rate started to decrease and the joints restored their original pitting resistance at 1050 °C; and after that increasing the aging to above 1050 °C, pitting resistance was believed to decrease again, as a result from de- creasing γ/δ. A correlation between different welding processes and aging times was also conducted

Keywords: Duplex stainless steel, Laser welding, aging, Potentiodynamic polarization, EIS, SEM.

CPCM-0058

Catalytic performance of carbon materials for the sustainable conversion of lignocellulosic biomass to platform chemicals

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Abstract. The increasing demand for chemicals and drop-in fuels produced from renewable resources has boosted the interest in biomass upgrading. Cellulose is the main polymeric constituent of lignocellulosic biomass, with a highly crystalline polymer structure, consisting of thousands of d-glucose molecules. This polymer can be hydrolyzed to glucose sugars and further to 5-Hydroxymethylfurfural (5-HMF) which can be transformed to a huge variety of valuable chemicals. 5-HMF with many interesting valorization routes as building block for the production of polymers, fuel additives. 5-HMF production from biomass requires two major steps, (i) hydrolysis of cellulose towards glucose; and (ii) glucose dehydration to produce 5-HMF and both the steps require suitable acidic environment. Isomerization of glucose into fructose, reduces humin formation and allowing higher temperatures, resulting in an increased reaction rate. This isomerization can be enhanced with the co-presence of Brønsted acid and a Lewis acid in the form of carbon catalyst. Also, this process, from biomass to 5-HMF, was performed in a one-pot configuration, the mechanism and mass transfer limitations would be difficult to control. This study concludes that carbon based catalyst improve 5-HMF yield and the prepared catalyst is cost effective and readily available. This easy and low cost process developed can address the issue of managing lignocellulosic waste to recover the pure cellulose, hemi-cellulose and lignin components, each being a rich source for conversion to an array of value added chemicals, presently obtained from the petroleum feedstock in an economical and environment friendly approach and for setting up of bio-refineries.

Keywords: Lignocellulosic biomass, Depolymer ization, Carbon materials, Value added products

CPCM-0059

Microstructural and Spectroscopic Studies of Aluminium/Graphene Nanocomposites Synthesized by Solid State Reaction

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Abstract. Super nanocomposites of aluminium/graphene (0.5, 0.7 and 1.0 wt%) have been successfully synthe- sized with improved density by solid state reaction technique. For developing homogenous mixture of compositions an innovatively designed planetary ball mill was employed. 8 hrs of ball milling under argon atmosphere was carried out to prevent oxidation of composites. Sintering of well compacted pellets were carried out at 550-600 ^{0}C. XRD, XPS, FESEM, EDS, micro Raman, electrical conductivity and microhardness analysis of composites were carried out to pro- duce an optimized product. The aluminum-graphene (1 wt%) composite sintered at 600 ^{0}C exhibits significantly higher electrical ($7.5x10^6$ S/m) and microhardness (178 ± 6 VHN) values than that of pure aluminum.

Keywords: Nanocomposite; XPS; Graphene; Aluminum

CPCM-0060

Characterization of AA7075 alloy foam using calcium and magnesium carbonate as foaming agent

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Abstract. In this work new composite aluminium foam AA7075 with 3 % silicon carbide reinforcement was fabricated by stir casting method using calcium carbonate (CaCo3) as a foaming agent. In order to examine the compressive deformation and bending strength, the experiments were tested. Quasi- static compression behaviour and bending properties (three-point bending test) were examined by universal testing machine for aluminium metal foam (AA7075 foam) with and without metal panel. The thickness of panel was 1 mm and 1.5 mm. As the result of the experiment, the compressive strength was measured maximum at 1.5 mm but the stiffness was better at 1 mm thickness panel. The metal panel thickness is also a significant function in the compressive strength and the deformation for the metal foam.
Keywords: Aluminium foam, compressive str ength, powder metallurgy, stir casting

CPCM-0061

Fused Tungsten Carbide Synthesis by Thermal Arc Melt Cast Method

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Abstract. Fused tungsten carbide (WC–W_2C) was synthesized successfully form WC+W (0, 5 and 32%Wt.%) by thermal arc plasma melt-cast method within only 10 min. The products were found almost fully dense with grown of different constituent phases. X-ray diffraction, X-ray photoelectron spectroscopy, transmission electron microscopy and field emission scanning electron microscopy show clear evidence of formation of fused tungsten carbide. Energy dispersive spectroscopy (of X-ray) confirms the purity of the typical composite WC+W (32% wt.%). X-ray micro computed tomography clearly evident about the absent of any porous network in the composite (WC+W (32% wt.%)). Fused tungsten carbide with 32 wt. % shows improved microhardness and Young's modulus values in comparison to that of pure tungsten carbide.
Keywords: Fused tungsten carbide, Thermal arc plasma method, X-ray diffraction, Microstructure

CPCM-0062

Study of Physio-mechanical behaviour of alkali treated date palm petiole/ epoxy composites

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Abstract. Currently there has been a speedy development in research and modernization of natural fiber reinforced composites (NFC) over synthesis fiber composites (SFC).This may be due to its various advantages such as environmental friendly, cost effective and easy availability. Various industries like constructions, automotive and packaging show there keen interest for development of new natural fiber composites (NFC) by considering various parts of natural fiber such as leaf, fruit, stem, trunk etc. The current research was planned to fabricated four numbers of new composites with varying the fiber concentrations (8%,16%,24% and 32%) and evaluate the significance of fiber concentration on physical characteristics such as absorption of water, density, void content and mechanical characteristics such as tensile strength, compressive strength, flexural strength , impact energy of alkali treated date-palm petiole fiber reinforced epoxy composites. The outcome depicted that the composite with fiber concentration (16%) have better mechanical properties then the other alternatives. The maximum tensile strength, and impact energy is obtained for composites with 16 wt.% fiber content is found to be 53.56 MPa and of 15.9 Joule. However the compressive strength and flexural strength of composite increases with increase in fiber loading upto 24 wt.% fiber content and was found to be 62.79MPa and 52.26MPa respectively. Failure analysis of fractured surface is carried out using SEM which is occurred as a result of matrix cracking, void content and fiber pullout .
Keywords: Date palm , petiole ,r achis, epoxy, sur face modification ,NaOH, SEM

CPCM-0063

Development of patient specific 3D model of ceramic femur implant and comparative study on the stress generated on Alumina and Zirconia implant material

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Abstract. The motive of this study is to model a 3D model of femur structure from CT scan and to explore the best applicable material for ceramic implant which has excellent mechanical properties for compressive load and are biocompatible in nature. Commercial ceramic materials selected for this study are widely used for the hip and knee joint implants. This investigation provides simple understanding of the complex mechanical phenomenon by using the concepts of biomechanics and helps in predicting the chance of failure. Alumina and Zirconia are implant materials which are consisted for this study. Implants materials have to resist deformation under different load conditions on long term for the suitability of the purpose. In order to perform this investigation numerical analysis is performed on femur modelled implant by simulating different load conditions exhibited while performing different actions. The implant materials exhibiting biomechanical behaviour under different loading and condition are comparatively studied.
Keywords: biomechanics, femur , static analysis, ceramic implant, finite element analysis (FEA)

CPCM-0064

Solanum melongena steam extract for corrosion inhibition of mild steel in 1 M NaCl.

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Abstract. Corrosion of metals is a serious problem for the economy and human lives of any country. Several researchers have been working to minimize the loss of corrosion damage. Green corrosion inhibitors (GCI) are a simple solution of the corrosion problem since GCI is nontoxic, efficient in corrosion inhibition, biodegradable and available at low cost. In this regard waste natural materials (WNM) have attracted a great attention of the scientists since their use as corrosion inhibitors is economic, safe and eco-friendly (recycling of the waste). In this work, Solanum melongena steam (brinjal cap) aqueous extract (SMSAE) is used for corrosion inhibition of mild steel in 1 M NaCl. The extract is characterized by Uv-visible and FTIR spectroscopy, which suggest that the extract is electrochemical active. The corrosion inhibition properties of the extract was determined by weight loss measurements, electrochemical impedance spectroscopy (EIS), open circuit potential (OCP) curves and Tafel polarization curves (TPC). The results show that the extract is giving inhibition efficiency >70% at 500 mg L-1 of the extract. Surface and compositional analysis was performed by Scanning electron microscopy (SEM) and energy dispersive X-ray (EDX) spectroscopy, which evidently illustrate that the extract is successfully inhibiting corrosion of mild steel in 1 M NaCl. It can be said based on results that SMSAE (WNM) is providing good inhibition efficiency and can be used in different applications.
Keywords: Mild Steel, Brinjal, Waste Natur al Material, Corrosion, EIS, SEM.

CPCM-0065

Effect of crack orientation on vibration characteristics of partially cracked isotropic micro-plate with bi-directional linearly varying thickness: An Analytical Approach

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Abstract. In the present work, a non-linear analytical model for a cracked isotropic micro-plate with nonuniform thickness as affected by the crack orientation and length scale parameter have been studied analytically. Linear variation in two direction of the plate thickness is assumed. The partial crack is located at the centre and an arbitrary orientation is considered in an isotropic micro-plate. Based on classical plate theory, equilibrium principle is applied and the governing equation of tapered isotropic plate is derived. Additionally, the effect of the microstructure has been included in the governing equation using the non-classical modified couple stress theory (MCST). Using the simplified line spring model, the effect of partial crack on the plate dynamics is incorporated in the form of in-plane forces and bending moments. The introduction of Berger's formulation brings the nonlinearity in the model in terms of in-plane forces. Here, Galerkin's method has been chosen for converting the derived governing equation into time dependent modal coordinates which uses an approximate solution technique to solve the nonlinear Duffing equation. Results are presented for an isotropic cracked microplate with non-uniform thickness. The effects of the variations of crack orientation, taper constant, crack length and length scale parameter are obtained for two different boundary conditions. It has been found that vibration characteristics are affected by the taper parameters, crack length, length scale parameter and crack directions for a cracked isotropic plate.

CPCM-0066

Free vibration analysis of a thin rectangular orthotropic plate

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Abstract. This study aims to the free vibration analysis of a thin rectangular orthotropic plate. In the free vibration analysis, the natural frequency of a thin rectangular orthotropic plate is calculated using ANSYS. The orthotropic plate is a crucial structural member in various fields like aerospace, automobile, and marine, so accurate vibration analysis is essential to avoid damage or failure. Free vibration analysis of a thin rectangular orthotropic plate is performed, and the effects of different factors like aspect ratio and boundary conditions on the natural frequency are studied. Few results obtained are compared and validated with existing results available in the literature.

CPCM-0067

A comparative nanoindentation study on HEA coated FCC metals and stacking fault tetrahedra evolution in HEA coated single crystal Al: A MD simulation study

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Abstract. In the present study, the nanoindentation test has done on Mo20W20Co20Ta20Zr20 (HEA) filmcoated single crystal (SC) Cu and Al by replacing the substrate SC Ni in the earlier reported study [1] to compare the underlying deformation activities and mechanical properties using molecular dynamics (MD) simulation. In addition, the development mechanism of stacking fault tetrahedra (SFT) in Mo20W20Co20Ta20Zr20 coated SC Al has also been investigated. The comparative study suggests the appearance of different distorted structures at higher indentation depth are effectively influence the plastic deformation in HEA-SC FCC specimens such as in HEA-SC Ni, the evolution in prismatic loops and interface distorted dislocation structures, in HEA-SC Cu, the evolution in long lengthed Hirth partials, Lomer-Cottrell (LC) barriers, closed stair-rod partial dislocation steps, multi-dislocation loops, and complex distorted interface structures; and, in HEA-SC Al, the evolution in SFT, LC barriers, closed stair-rod partial dislocation steps and loops, etc. The critical analysis of SFT development in Mo20W20Co20Ta20Zr20 coated SC Al reveal the development mechanism is dislocation-based, which has predominately governed by stacking fault (SF) planes' interaction and dislocation gliding. The shear strain and displacement vector plots confirm the growth of distorted dislocation structure below the indenter tip in HEA coated SC Ni is relatively more symmetric and significant than others due to its high stiffness. Moreover, in HEA coated SC Cu, the appearance of complex distorted dislocation structures at the interface restricts the plastic deformation to a greater extent in the interface layer.

Keywords: HEA; MD simulation; Nanoindentation; Stacking fault tetrahedra; Lomer -Cottrell barrier; Dislocation loops

CPCM-0068

Synthesis, modification and characterization of biochar for sustainable agricultural and environmental applications

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Abstract. The present study aims to evaluate the physiochemical properties of biochar from different feedstock produced by slow pyrolysis followed by acid treatment. Based on the biochar characteristics, the utilization of the biochar for sustainable agro-economy and environment have been delineated.

Keywords: Agro-economy; Biochar; Characteristics; Environment; Pyrolysis

CPCM-0069

Prediction of yield strength of friction stir welding process: A machine learning approach

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Abstract. In this study, we developed machine learning predictive models for friction stir welding process. FSW process has widely used in joining industry. FSW process is a solid state joining process and have many advantages over fusion welding. The strength of FSW processed material vary with the rotation rate and traverse speed. The predictive FSW strength model was developed using available experimental data. In the model, the strength was taken function of rotation rate and traverse speed. There is not exact relation available between strength with rotation rate and traverse speed.vThree different machine learning approaches namely multi-linear regression (MLR), Gaussian process regression (GPR) and support vector method (SVM) were applied. GPR and SVM approaches were applied with PUK and RBF kernel functions. The kernel functions were optimized using correlation parameters, correlation coefficient (CC) and root mean square error (RMSE) values. The developed predictive model matches well with the experimental values.

Keywords: Friction stir welding, Machine learning, Kernel functions

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