Department of

Metallurgical Engineering & Materials Science (MEMS)

IIT BOMBAY

Processing | Characterization | Structure | Properties | Performance

BROCHURE 2024

Metallurgical Engineering and Materials Science

Vision

Excel in research and teaching in metallurgical engineering and materials science and strive for technological innovations.

Mission

The department's mission is to further strengthen the academic curriculum with regular revision and enhance our research efforts so that the scientific and technological output of the department becomes a reflection of synergistic participation of students, faculty and staff to the best of their ability. We will strive towards creating a scientific environment which will be conducive to cater to the needs of the curious minds of our students and faculty so that technological innovations pour out which will improve the quality of living for the

The Cover Page Designed by: *Ms. Palak Soni, Rajastan*

The figure on the cover page depicts the "Material Tetrahedron" which defines the Metallurgical Engineering and Materials Science Discipline. At the center is an icon of a microstructure depicting characterization. The four sidearms have icons of 1) the iron blast furnace depicting processing 2) structure 3) tensile samples depicting properties and 4) gear, electricity and thermometer depicting performance

The brochure designed by: *Mr. Khushalsingh Rajput, Korel Graphics*

MEMS-THE DEPARTMENT IN BRIEF

The Department of Metallurgical Engineering and Materials Science (MEMS) is one of the largest departments of the Institute. The department started as Metallurgical Engineering in 1958 with the inception of the IIT Bombay. In 1993, the erstwhile Interdisciplinary Centre for Materials Science merged with the Department, which was then renamed as Metallurgical Engineering and Materials Science. In 2009 the interdisciplinary Centre for Corrosion Science and Engineering also merged with the department. As per QS world ranking based on discipline, the department stands just above 100. There are 36 full time faculty members (with 25% being women) in the Department, one Professor of Practice, 11 emeritus/visiting/adjunct faculty members, 17 staff members and more than 35 post doctoral fellows. The department offers academic programs towards doctoral (PhD), post graduate (M Tech) and undergraduate (B Tech) degrees. Currently 231 doctoral students, 113 M Tech students and 482 B Tech students are registered for the academic program.

In research, the department continues to excel in a wide variety of research areas, ranging from classical metallurgy to non-metallic materials in various forms and dimensional scales for applications ranging from advanced structural components to electronic, optical, sensing, health-care and energy harvesting/conversion/storage devices. The department works on a wide variety of materials (metals & alloys, ceramics, semiconductors, polymers and composites) and the complete life cycle of these materials (production, processing, characterization, performance and degradation). The work carried out in the department consists of theory, experiments and modelling.

Every year the department publishes more than 130 publications in highly rated international journals. The department enjoys an all-time Hindex of 84. The department also has focussed research programs through the Centre of Excellence in Steel Technology (CoEST), Water Innovation Centre : Technology, Research and Education (WICTRE) and recently established JSW Technology Hub for Steel Manufacturing. Keeping in sync with the national priorities and faculty expertise, the department is working towards more focussed academic programs in the area of computational materials, semiconductors, energy materials etc. The department has state of the art facilities both for teaching and research. In the last two years, more than Rs. 2.0 Cr has been spent on modernizing the teaching laboratories.

In addition to B.Tech in Metallurgical Engineering and Materials Science, the department offers M Tech in Materials Science, Process Engineering, Steel Technology and Corrosion Science and Engineering. Many of these academic programs attract a good number of people (both at the Master and Doctoral levels) sponsored by industries and other R&D organizations. Almost all the graduates from the department get placed through our placement cell.

In the coming 23 years, with the support from the institute and JSW, growing infrastructural needs of the department will be met by expanding to one more building with a floor space of approximately 50% of the current floor space.

This department brochure gives a one-page description of the teaching and research activities of the individual full-time faculty members and also highlights the expertise of the Emeritus /Visiting / Adjunct Faculty and staff members.

Assistant Professor

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Education:

- PhD - Materials Science, University of Cambridge, 2016
- (B.Tech. + M.Tech.) Dual degree - Metl. Engg. & Matls. Sci. IIT Bombay, 2011

RESEARCH INTERESTS

- Thin films of functional materials
- Pulsed Laser Deposition and Sputter Deposition
- Self-assembled vertically aligned nanocomposite (VAN) thin films
- Ferroelectrics, piezoelectrics, photoelectrochemical green hydrogen generation, thermoelectrics, non-volatile memories

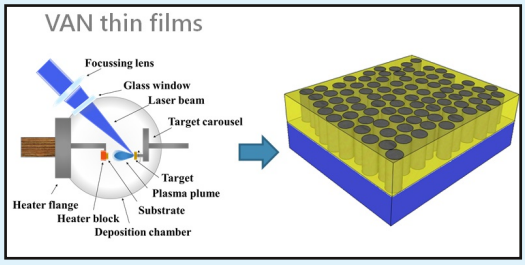
Abhijeet L. Sangle

▶TEACHING

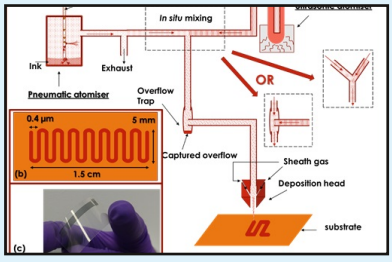
Abhijeet is interested in pedagogy of structure-property relationships and functional materials in general.
UG courses: Structure of Materials (Autumn semester), Materials Processing Laboratory (Spring semester)
PG courses: Principles and Applications of Ferroelectric and Piezoelectric materials (proposed, starting Spring semester 2024)

▶RESEARCH PROFILE

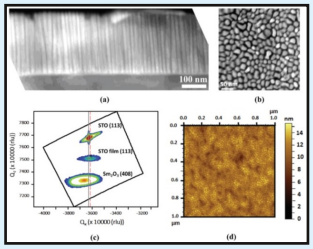
Abhijeet works in the broad area of thin films of functional materials for various applications. He is particularly interested in employing nanostructuring to enhance various properties of thin films of functional materials. One of the main themes of his research is self-assembled vertically aligned nanocomposite (VAN) films incorporating functional materials such as piezoelectrics, ferroelectrics, thermoelectrics and photoactive materials for applications in the areas of tunable high frequency devices[1], sensors and actuators; energy harvesting[2] and storage; non-volatile memories[3], etc. Abhijeet leverages the pulsed laser deposition facilities available in the department to grow these films. Besides, he is also working towards building a multi-target co-sputter deposition facility equipped with advanced in situ diagnostics. Drawing inspiration from his prior work in aerosol-jet printing technology[4], Abhijeet is also working on developing bespoke inks of functional materials for various printed electronic devices.
In the past, Abhijeet was a part of the corporate R & D division of Applied Materials India, where he worked on large area deposition of thin films of various piezoelectric materials. Given his background in industry, Abhijeet is highly passionate about translational research, taking lab-scale ideas to working prototypes/scaling up studies.



Schematic of PLD and VAN th in films



Schematic of Aerosol-jet printing process showing implementation of in situ mixing to print composite materials



SrTiO3-Sm2O3 (30-70 wt%) VAN films, 250nm thick (a) Cross-sectional STEM, (b) Plan-view STEM, (c) reciprocal space map, (d) AFM image showing topography. Source: Sangle, A. L., et al., Nanoscale (2018); STEM image credits: H. Wang group, TAMU (now at Purdue)

References:-

1. Sangle, A. L. et al. Very high commutation quality factor and dielectric tunability in nanocomposite SrTiO3 thin films with Tc enhanced to >300 °C. Nanoscale 10, 3460–3468 (2018).
2. Sangle, A. L. et al. Very High Surface Area Mesoporous Thin Films of SrTiO3 Grown by Pulsed Laser Deposition and Application to Efficient Photoelectrochemical Water Splitting. Nano Lett 16, 7338–7345 (2016).
3. Lee, S. et al. Novel electroforming-free nanoscaffold memristor with very high uniformity, tunability, and density. Advanced Materials 26, 6284–6289 (2014).
4. Ou, C. et al. Enhanced thermoelectric properties of flexible aerosol-jet printed carbon nanotube-based nanocomposites. APL Mater 6, 096101 (2018).

Assistant Professor

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Education:

- PhD - Materials Sc & Engg, Arizona State Univ, USA
- MTech - Metallurgical Engg & Materials Sc, IIT Bombay, India
- BE - Metallurgy & Materials, IIEST Shibpur, India

RESEARCH INTERESTS

- Thin films of functional materials
- Pulsed Laser Deposition and Sputter Deposition

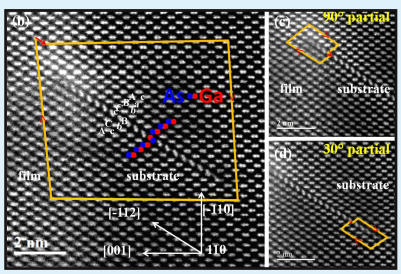
Abhinandan Gangopadhyay

▶TEACHING

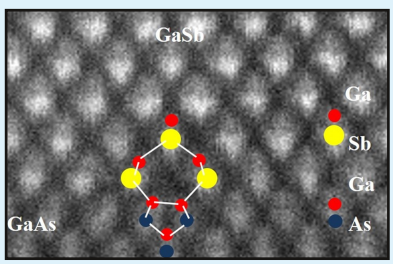
Prof. Gangopadhyay has taught undergraduate course on Mechanical Behaviour of Materials. He will be offering a comprehensive graduate level course on Transmission Electron microscopy.

▶RESEARCH PROFILE

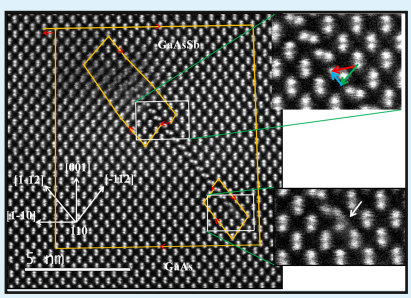
Prof. Abhinandan Gangopadhyay is interested in applying advanced electron microscopy techniques to study defects and interfaces in advanced functional and structural materials. He has previously studied the core structure of various interfacial defects such as dissociated 60° dislocation [1], Lomer dislocation [2], dissociated 90° dislocation [3] in GaAs(001)-based heterostructures using high-angle annular-dark-field (HAADF) mode of aberration-corrected scanning transmission electron microscopy (AC-STEM). Prof. Gangopadhyay has also worked on STEM-EDX characterization of grain boundary segregation in novel polycrystalline GaInP solar cells. As part of his recent industrial work experience, he has worked on nanometer-scale characterization of state-of-the-art semiconductor devices using focused ion beam (FIB) technique in conjunction with AC-STEM. His current research interests include segregation studies using STEM spectrum images and strain mapping using geometric phase analysis (GPA) and 4D STEM in advanced materials.



Aberration-corrected HAADF-STEM images of dissociated 60 degree dislocation and its bounding partials located at GaAsSb/GaAs interface [1]



Aberration-corrected HAADF-STEM image of a Lomer dislocation located at GaSb/GaAs interface [2]



Aberration-corrected HAADF-STEM image of a dissociated 90 degree dislocation located at GaAsSb/GaAs interface [3]

References:-

1. Gangopadhyay A, Maros A, Faleev N & Smith DJ. Atomic structure of dissociated 60° dislocations in GaAs/GaAs0.92Sb0.08/GaAs heterostructures. Scripta Materialia 2018;153:77–80.
2. Gangopadhyay A, Rotter TJ, Balakrishnan G, Smith DJ. Atomic-scale Structural Imaging of Interfacial Defects in GaAs(001)-based Heterostructures. Microscopy and Microanalysis. 2021;27(S1):2356-2357.
3. Gangopadhyay A, Zhang C, Maros A, Faleev, N, King RR, Honsberg CB & Smith, DJ Extended defects in GaAs/GaAs1-xSbx/GaAs (001) heterostructures. Scripta Materialia 2023;225:115150.

Ajay Singh Panwar

Professor

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Education:

- Ph.D. - Materials Science and Engineering, University of Minnesota, 2005
- B.Tech. - Metallurgical Engineering and Materials Science, Indian Institute of Technology Bombay, 2000

RESEARCH INTERESTS

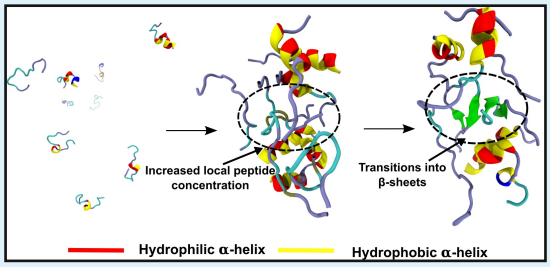
- Molecular Simulations of Soft Materials
- Simulation of Biophysical Processes
- Polymer Physics
- Colloid Assembly

▶TEACHING

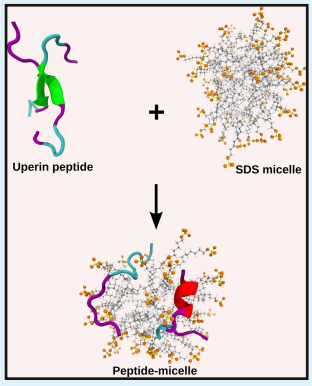
In his teaching, Prof Panwar emphasizes concepts of interfacial phenomena, soft matter physics and diffusion in materials.
Some courses taught are:
Undergraduate courses: Colloids and Interfacial Science, Kinetics of Processes
Postgraduate courses: Diffusion and Kinetics, Molecular Simulations of Materials

▶RESEARCH PROFILE

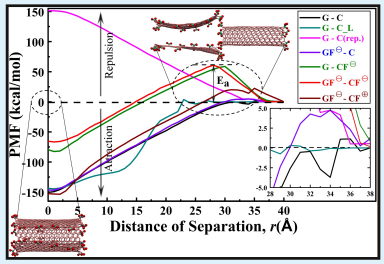
Prof Panwar's research focusses on utilizing large-scale molecular simulation methods to discover fundamental phenomena at the interface of biology and soft matter physics. He uses multi-scale molecular simulation techniques and free energy calculation methods to understand how molecular interactions lead to diverse assemblies and phenomena in biology and materials science. In the area of biophysics, his research group explores self-assembly of peptides into amyloid fibrils in neurodegenerative diseases, nano-scale transport between the cell nucleus and cytoplasm and enzymatic processes. Based on the simulations, new pathways for amyloid formation were proposed, which have important implications on the understanding of neurodegenerative diseases. Such insight can accelerate development of novel inhibition and therapeutic strategies for neurodegenerative diseases. In the area of soft materials, his research activities include, examining the role of electrostatic effects in the self-assembly of hybrid nano-materials and early-stage polymer dynamics in heterogeneous polymer crystallization.



MD simulations show that helical intermediates are critical for formation of beta-sheets in amyloids [1]



Disintegration of an amyloid dimer near an SDS micelle [2]



Tunable energy barrier for intercalation of a carbon nanotube into graphene nanosheets [3]

References:-

1. A. K. Prasad, L. L. Martin, A. S. Panwar, "Helical intermediate formation and its role in amyloids of an amphibian antimicrobial peptide", Physical Chemistry Chemical Physics 25, 12134 (2023) DOI:10.1039/D3CP00104K
2. A. K. Prasad, C. Tiwari, S. Ray, S. Holden, D. A. Armstrong, K. J. Rosengren, A. Rodger, A. S. Panwar, L. L. Martin "Secondary Structure Transitions for a Family of Amyloidogenic, Antimicrobial Uperin 3 Peptides in Contact with Sodium Dodecyl Sulfate", ChemPlusChem 87, e202100408 (2022) DOI:10.1002/cplu.202100408
3. P. Rama, A. R. Bhattacharyya, R. Bandyopadhyaya, A. S. Panwar, "Tunable energy barrier for intercalation of a carbon nanotube into graphene nanosheets: A molecular dynamics study of a hybrid self-assembly", Journal of Physical Chemistry C 123, 1974 (2019) DOI:10.1021/acs.jpcc.8b10958

Professor

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Education:

- PhD - Materials Science, University of Oxford - 2009
- M Tech - Matls. & Met. Engg, IIT Kanpur - 2006
- B E - Met, Engg. NIT Durgapur - 2003

RESEARCH INTERESTS

- Electrode Materials and Electrode/ Electrolyte Interfaces for Li-/Na-/K-ion Batteries
- Electro-chemo-mechanical Responses of Electrode Materials
- Solid Electrolytes and All-Solid-State Li and Na Metal Batteries
- Electrochemical Energy Storage Devices (from materials → electrodes → cell development)
- Engineering Ceramics and
- Ceramic Composites/Alloys

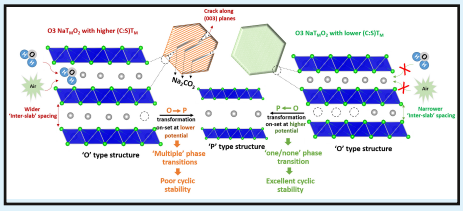
Amartya Mukhopadhyay

▶TEACHING

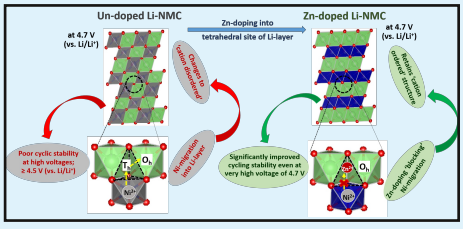
Teaches undergraduate courses on 'Electrochemistry of Materials and its Applications', 'Advanced Ceramics', 'Advanced Composites', post-graduate course on 'Structural Characterization of Materials'; have designed an elective course on 'Electrochemical and Materials Perspectives in Energy Storage'

▶RESEARCH PROFILE

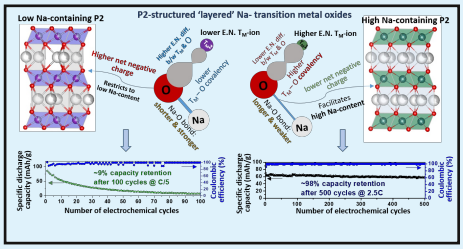
Prof Amartya Mukhopadhyay completed his Doctoral in Materials Research from the University of Oxford, UK, in 2009. He did his post-doctoral Research at Brown University, USA, for a couple of years. He is a Young Associate of the Indian National Academy of Engineering (INAE) and served as the Honorary Secretary of Mumbai Chapter of the Indian Institute of Metals (IIM). His research interests include materials for electrochemical energy storage (focusing on alkali metal-ion batteries) and engineering ceramics. Among his major accomplishments, he has been awarded with the 'SwarnaJayanti Fellowship 2020-21', recognized by the Royal Society of Chemistry (UK) journals as one of the '2019 Emerging Investigators', awarded with the 'IIT Bombay Research Dissemination Award 2018', 'INAE Young Engineer Award 2016', 'ASM-IIM North America Visiting Lectureship 2016', 'IIT Bombay Young Investigator Award 2014' and 'Dr. R. L. Thakur Memorial Award' by the 'Indian Ceramic Society' in 2013.



Revealing the dominant factors/parameters towards addressing air/water-instability and structural-cum- electrochemical instability of 'layered' Na-tran sition metal oxide based cathode materials for Na-ion



Addressing High Voltage Structural and Electrochemical Instability of Ni-containing Layered Transition Metal (TM) Oxide cathodes by 'blocking' the 'TM-migration' pathway in the Lattice [2]



Designing high Na-containing P2-structured 'layered' Na- transition metal oxides as high-performance cathode materials for Na-ion batteries [3]

References:

[1] B. [1] B. S. Kumar, A. Pradeep, V. Srihari, H. K. Poswal, R. Kumar, A. Amardeep, A. Chatterjee and A. Mukhopadhyay: Cation-oxygen bond covalency: A common thread and a major influence towards air/water-stability and electro-chemical behavior of 'layered' Na- transition metal oxide based cathode materials. Adv. Energy Mater. 13 [19] (2023) 2204407: 1-15 (https://doi.org/10.1002/aenm.202204407)

[2] A. Sharma, A. Rajkamal, S. Kobi, B. S. Kumar, A. K. Paidi, A. Chatterjee and A. Mukhopadhyay: Addressing the High Voltage Structural and Electrochemical Instability of Ni-containing Layered Transition Metal (TM) Oxide cathodes by blocking the TM-migration pathway in the Lattice; ACS Appl. Mater. Interfaces 13 [22] (2021) 25836–25849

[3] B. S. Kumar, R. Kumar, A. Pradeep, A. Amardeep, V. Srihari, H. K. Poswal, A. Chatterjee and A. Mukhopadhyay: Fundamental principles toward designing high Na-containing P2-structured "layered" Na- transition metal oxides as high-performance cathode materials for Na-ion batteries; Chem. Mater. 34 [23] (2022) 10470–10483

Amrita Bhattacharya

Associate Professor

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(+91) (022) 2576 7620

Education:

- BSc - Phy. - Burdwan University, 2004
- MSc - Phy.-, Burdwan University, 2006
- PhD - Matls. Sci., Indian Asso. for the Cultivation of Sci., 2012

▶TEACHING

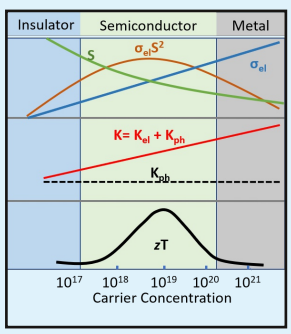
Prof. Amrita Bhattacharya has interest in the various topics of materials science related to condensed matter physics. Over the last five years, she has taught the following courses in the department;
Undergraduate courses: MM318, Electronic properties of materials
Postgraduate courses: MM747, First principles approach to materials science

▶RESEARCH PROFILE

Prof. Amrita Bhattacharya leads the Ab initio Computational Materials Simulation laboratory in the MEMS department. Her works involve understanding and predicting the microscopic phenomena behind the electronic, magnetic, and transport properties of emerging materials using the state-of-the-art quantum mechanical density functional theory based methods. In addition, she has also set up an experimental laboratory for the solid-state synthesis of alloys and for the analysis of their electronic transport properties. She also has an interest in data driven machine learning based methods.

RESEARCH INTERESTS

- Computational Materials Science,
- Density functional theory based methods,
- Electronic structure theory,
- Charge and heat transport,
- Machine learning

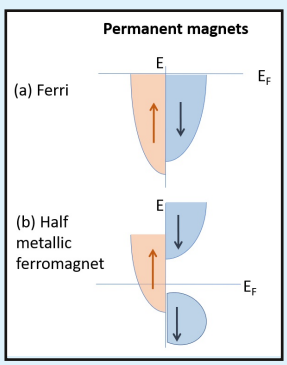


Unravelling the charge and heat transport in thermo-electric materials through theory and experiments ;

(1) Strain driven anomalous anisotropic enhancement in the thermoelectric performance of monolayer MoS2, S Chaudhuri, A Bhattacharya*, AK Das, GP Das, BN Dev Applied Surface Science 626, 157139 (2023).

(2) Self-Doping for Synergistically Tuning the Electronic and Thermal Transport Coefficients in n-Type Half-Heuslers, P R Raghuvanshi, D Bhattacharjee, A Bhattacharya*, ACS Applied Materials & Interfaces 13 (46), 55060 (2021)

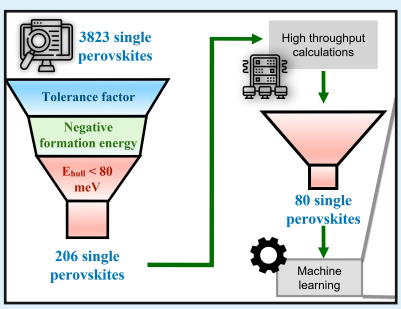
(3) A high throughput search for efficient thermoelectric half-Heusler compounds, P R Raghuvanshi, S Mondal, A BhattacharyaJournal of Materials Chemistry A 8, 25187 (2020)



Exploring the physics of correlated magnetic oxides and other magnetic metallic phases.

(1) First-principles investigation of the structure, stability, and magnetic properties of the Heusler alloy J Jami, R Pathak, N Venkataramani, KG Suresh, Amrita Bhattacharya*, Physical Review B 108 (5), 054431 (2023)

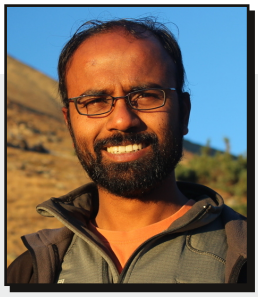
(2) A strategic high throughput search for identifying stable Li based half Heusler alloys for spintronics applications, R Pathak, PR Raghuvanshi, A Bhattacharya*, Journal of Magnetism and Magnetic Materials 553, 169244 (2022).



High throughput calculations and machine learning the physical properties of materials

(1) Machine learning the vibrational free energy of perovskites, K Kundavu, S Mondal, A Bhattacharya, Materials Advances (2023).

(2) Thorough Descriptor Search to Machine Learn the Lattice Thermal Conductivity of Half-Heusler Compounds, D Bhattacharjee, K Kundavu, D Saraswat, PR Raghuvanshi, Amrita Bhattacharya*, ACS Applied Energy Materials 5 (7), 8913 (2022).



Associate Professor

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Education:

- B.Tech., Met.l & Mtls. Engg,, IIT Kharagpur - 2009
- Ph.D., Matls. Sci. & Engg, Georgia Institute of Technology - 2013

RESEARCH INTERESTS

- Computational mechanics
- Crystal plasticity
- Constitutive modeling

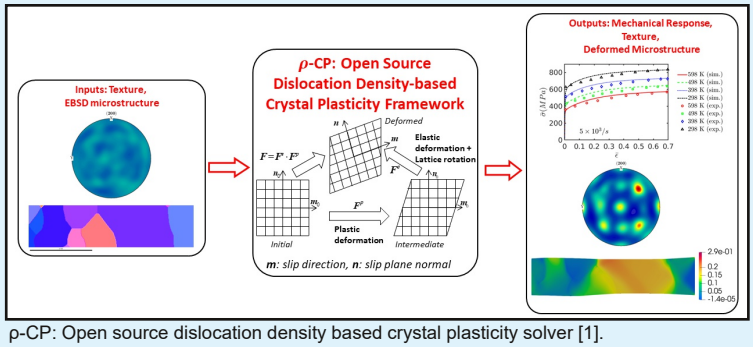
Anirban Patra

▶TEACHING

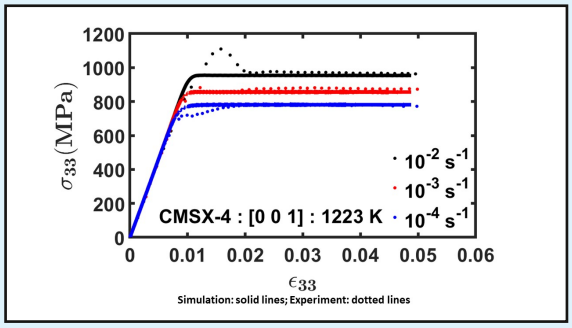
Prof. Patra emphasizes on introducing mathematical and computational aspects into materials science concepts in his teaching. He has taught an undergraduate course on the mechanical behavior of materials, as well as advanced courses on continuum plasticity of metals, and numerical solutions of partial differential equations for continuum transport modeling.

▶RESEARCH PROFILE

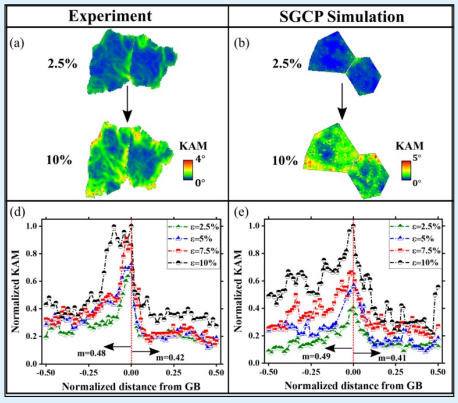
Prof. Patra's research interests are in the prediction of microstructure-mechanical property correlations using physically-based crystal plasticity constitutive equations. These tools have been used for simulating deformation in nuclear, aerospace and automotive alloys. A key emphasis of his research is also on the development of computational methods, including open source tools, for such applications.



ρ-CP: Open source dislocation density based crystal plasticity solver [1].



Crystal plasticity prediction of mechanical properties of Ni-base superalloy single crystals [2].



Prediction of misorientation development using strain gradient crystal plasticity modeling [3].

References:-

[1] Patra, A., Chaudhary, S., Pai, N., Ramgopal, T., Khandelwal, S., Rao, A., McDowell, D.L., "ρ-CP: Open source dislocation density based crystal plasticity framework for simulating temperature- and strain rate-dependent deformation", Computational Materials Science, Vol. 224, 2023, 112182.

[2] Chaudhary, S., Guruprasad, P.J., Patra, A., "Crystal plasticity constitutive modeling of tensile, creep and cyclic deformation in single crystal Ni-based superalloys", Mechanics of Materials, Vol. 174, 2022, 104474.

[3] Pai, N., Prakash, A., Samajdar, I., Patra, A., "Study of grain boundary orientation gradients through combined experiments and strain gradient crystal plasticity modeling", International Journal of Plasticity, Vol. 156, 2022, 103360.

Aparna Singh

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Education:

- BTech in Mtls. & Met.l Engg.
  IIT Kanpur, 2007
- PhD in Mtls. Sci. & Engg.
  MIT Cambridge, 2011

RESEARCH INTERESTS

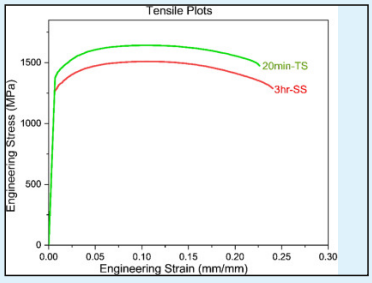
- Rails and wheels Fracture and fatigue
- Physical and mechanical metallurgy of steels Polymer composites
- Reliability of PV modules

▶TEACHING

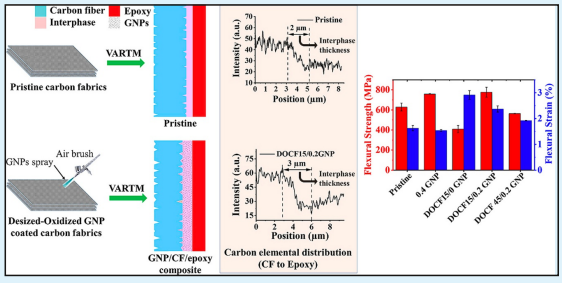
Undergraduate Courses: Mechanics of Materials
Postgraduate Courses: Fatigue of Materials, Tribology of Materials, Physical metallurgy and mechanical properties of steels

▶RESEARCH PROFILE

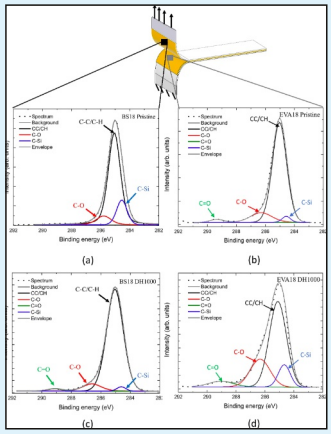
Prof. Aparna Singh's interest is in the development of novel materials with a combination of high strength, toughness and fatigue crack growth life. She is also interested in understanding processing-microstructure- processing links in steels and polymer composites. Her rigorous experimental work has shown many interesting deformation phenomena in epoxies and steels. She also has significant experience in probing causes of failures in rails and wheels. Multiple novel grades of steels have been developed in her group that have the potential to be used as rail/wheel materials. Novel varieties of hierarchical carbon-fiber epoxy composites have also been developed in her lab that can find use in prosthetics , wind turbine blades and aeroplanes. She has also worked with industries like Renewsys and Shapoorji Pallonji.



Enhanced tensile response in low carbon carbide free nano-bainitic steel



Enhancement of mechanical properties of carbon-fiber epoxy composites using graphene nano-platelets



High resolution XPS spectra for peeled (a) BS18 in pristine condition, (b) EVA18 in pristine condition, (c) BS18 after DH aging and (d) EVA18 after DH aging

References:-

1. A. Kumar, B. Blessto, A. Singh*, "Development of a low-carbon carbide-free nanostructured bainitic steel with extremely high strength and toughness." Materials Science and Engineering A, 2023.
2. K. Mishra, A. Singh*, "Time-dependent degradation of highly cross-linked epoxy due to hygrothermal aging at three different temperatures." Polymer Degradation and Stability, 2023
3. U. Desai, B. K. Sharma, A. Singh, A. Singh*, "A comparison of evolution of adhesion mechanisms and strength post damp-heat aging for a range of VA content in EVA encapsulant with photovoltaic backsheet." Solar Energy, 2022.
4. S. Rathore, W. Leong, A. Singh*, "Mechanical properties estimation of 2D–3D mixed organic-inorganic perovskites based on methylammonium and phenylethyl-ammonium system using a combined experimental and first-principles approach." Journal of Alloys and Compounds, 2023.
5. A. Srivastava, V. Gupta, C. Yerramali, A. Singh*, "Flexural strength enhancement in carbon-fiber epoxy composites through graphene nano-platelets coating on fibers." Composites B: engineering, 2019.
6. K. Singh, A. Kumar, A. Singh*," Effect of prior austenite grain size on the morphology of nano-bainitic steels." Metallurgical and Materials Transactions A, 2018.

Arup R. Bhattacharyya

Professor

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Education:

- PhD: Polymer Blends, IIT Delhi, 2000
- M.Sc: Org. Chem., Bhopal University, 1994

RESEARCH INTERESTS

- Polymer Blends
- Polymer Nanocomposites
- Piezoelectric and Triboelectric Polymer Nanocomposites

TEACHING

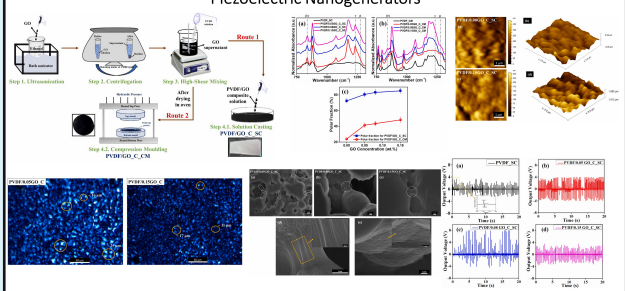
Some of the courses taught are:

1. Engineering Polymers and Composites of the Materials
2. Polymer Blends and Composites
3. Advanced Composites

RESEARCH PROFILE

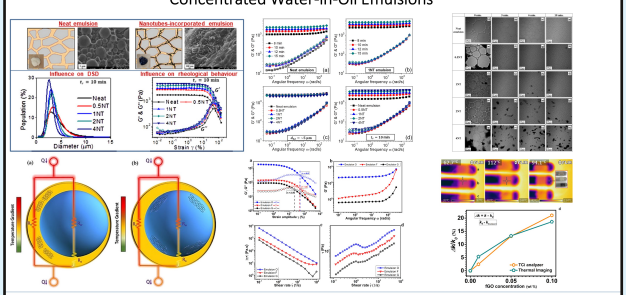
Prof. Bhattacharyya's research interests are in the area of 'Processing-Structure-Property' relationship studies in carbon nanotubes (CNTs) and graphene based polymer nanocomposites, wherein he has addressed the challenge of nanomaterial dispersion in polymer matrix. In this context, he has developed a novel organic dispersant to disperse agglomerate free nanomaterials in various polymer matrices, which could establish an adequate interfacial interaction between the polymer matrix and the nanomaterials. The method was extremely innovative and was adopted to commercially viable polymer processing technique viz. melt-mixing to prepare electrically conducting polymer nanocomposites of very high strength, modulus and thermal stability. Currently, he is working extensively on graphene, CNTs, h-BN, MoS2 based PVDF nanocomposites for piezoelectric applications. Prof. Bhattacharyya has collaborated with DMSRDE, Kanpur (DRDO laboratory) to develop melt-spun CNTs based polypropylene nanocomposite fibers. Further, he has also collaborated with Reliance Industries Ltd., Mumbai to develop electrically conducting nanocomposites for electronic packaging applications. Moreover, he has collaborated with Gharda Chemicals, Mumbai to develop MWCNTs incorporated poly (aryl ether ketone) nanocomposites and their blends with ABPBI to achieve electrically conducting nanocomposites, which showed extremely high heat distortion temperature. He has also collaborated with Orica Pvt. Ltd., Australia to develop MWCNTs and graphene oxide based high internal phase emulsion of high thermal conductivity at ultra-low volume fraction of the nanomaterials.

Graphene Oxide Based Poly(vinylidene fluoride) Nanocomposites As Flexible Piezoelectric Nanogenerators



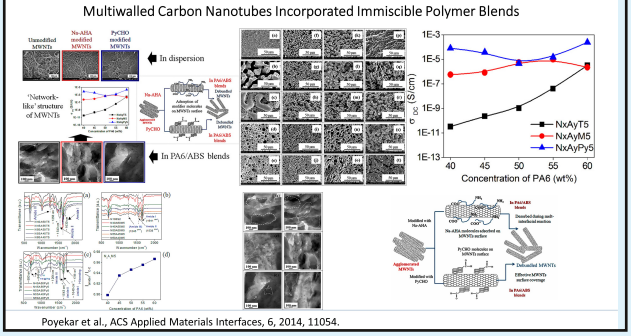
Adaval et al., Polymer, 256, 2022, 125239.

Multiwalled Carbon Nanotubes/Graphene Oxide Incorporated Highly Concentrated Water-in-Oil Emulsions



Sharu et al., ACS Omega, 3, 2018, 13584; Gamot et al., Langmuir, 35, 2019, 2738.

Multiwalled Carbon Nanotubes Incorporated Immiscible Polymer Blends



Poyekar et al., ACS Applied Materials Interfaces, 6, 2014, 11054.

Ashutosh Suresh Gandhi

Professor

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Education:

- Phd - Metallurgy, IISc Bangalore, 2001
- ME - Metallurgy, IISc Bangalore, 1994

RESEARCH INTERESTS

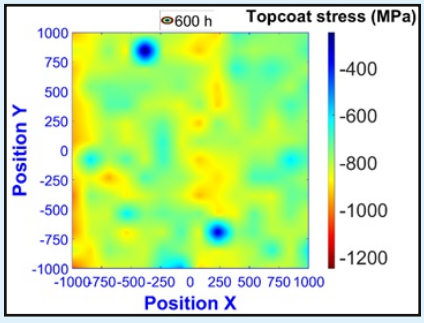
- Science of Ceramics,
- High Temperature Protective Coatings (TBCs and EBCs),
- Multicomponent Equimolar (High Entropy) Ceramics,
- Phase Transformations,
- Metastable and Amorphous Materials

TEACHING

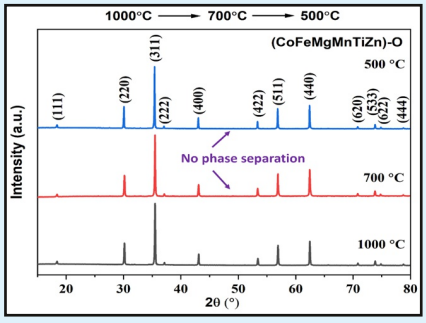
- Departmental Excellence in Teaching Award, IIT Bombay 2021 Structural Characterisation of Materials (MM732), M.Tech. Core High Temperature Corrosion (MM 695), M.Tech. Core
- Physical Metallurgy (MM737), M.Tech. Core
- Mechanical Characterisation of Materials (MM733), M.Tech. Restricted Elective Topics in Mechanical Behaviour of Materials (MM730), M.Tech. Restricted Elective Ceramics and Powder Metallurgy (MM357), B.Tech. Core
- Manufacturing Processes Laboratory (MM323), B.Tech. Core

RESEARCH PROFILE

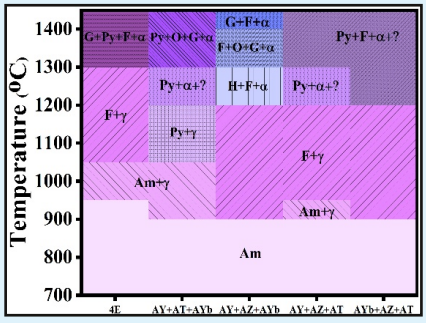
1) High temperature protective coatings:
a) Thermal barrier coatings (TBCs) - i) New thermal barrier materials based on 'high entropy' ceramics. Indian Patent #381163 (Nov 2021), Application No. 201921032434 (Aug 2019). ii) Condition monitoring of TBC system by spectroscopic sensing iii) Phase transformations and property evolution in zirconia TBCs. Mater. Sci. Eng. A, 556, 927-935 (2012). b)Environmental barrier coatings (EBCs) - i) Thermodynamic explanation of multiple phase formation in rare earth silicate EBCs ii) Slurry spray deposited, in-situ reaction sintered, multilayered EBCs
2) Multicomponent equimolar 'high entropy' oxides - a) Spinel, perovskite, pyrochlore/fluorite structured 'high entropy' oxides. Materialia (20) 101259 (2021) b) Advanced structural characterisation of 'high entropy' oxides c) Interesting properties: Thermal, optical, dielectric, and mechanical
3) Alumina based glasses a) Rare-earth and transition metal oxide additives to stabilise glassy phase b) Low temperature sintering of alumina glasses c) Advanced structural characterisation of alumina glasses



Residual stress in thermal barrier coating measured by Raman spectroscopy.



Thermally stable multicomponent equimolar 'high entropy' spinel.



Enhanced thermal stability of alumina glasses by composition design.

Associate Professor

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(+91) (022) 2576 7619

Education:

- Ph.D. - Johannes Gutenberg University, Mainz, Germany, 2010
- M.Sc- University of Hyderabad-2005

RESEARCH INTERESTS

- Semiconductor Devices,
- Low cost photovoltaic devices,
- Photoelectrochemical cells

Aswani Yella

TEACHING

Courses taught are

UG courses: Thermodynamics of materials

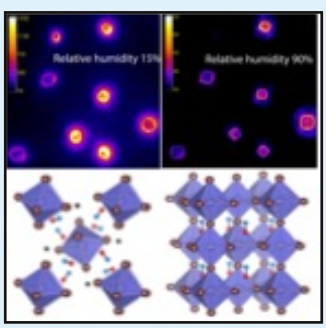
PG courses: Semiconductor photo electrochemistry and photocatalysis, Electrical and magnetic materials

RESEARCH PROFILE

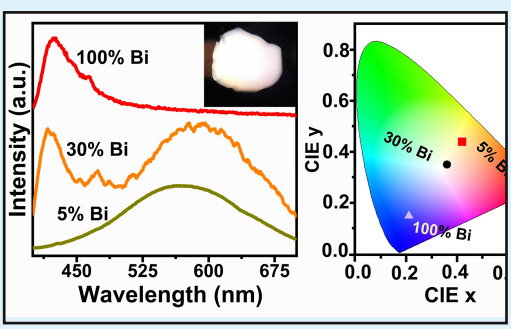
The group of optoelectronic materials and devices are interested in developing semiconductor materials for optoelectronic devices, in particular halide perovskite materials. Halide perovskites have many interesting properties like high absorption coefficient, large charge carrier diffusion lengths, ease of synthesis, etc. However their real life applications are hindered due to the moisture instability and the lead toxicity. The group found zero- dimensional perovskites to transform to 3D perovskites in the presence of moisture and remain to be stable under moist conditions, which lead to the stable perovskite solar cells. Since the transformation takes place in the presence of humidity, these were found to be useful in making self powered humidity sensors. To address the lead toxicity, the group is focussed on developing lead free perovskites and found that Cs2AgInCl6 doped with Bi3+ to be emitting a broad range with white light emission, making it a single source white light emitter.

Recent Publications:

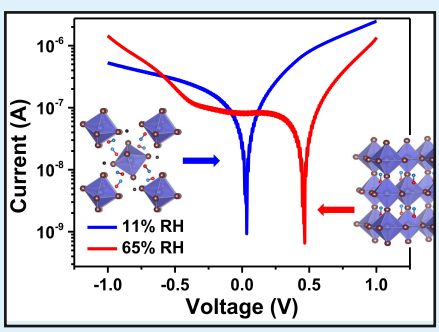
1. Moisture-Induced Ionovoltaic Electricity Generation by Manipulating Organic–Inorganic Hybrid Halide Perovskites
   Sumit Kumar Sharma, Monika Salesh, Mohanraj Subramaniam, Burhanuddin Attarwala, Aswani Yella ACS Energy Letters, 2023, 8,2259-2266
2. High performance acidic water electrooxidation catalysed by manganese–antimony oxides promoted by secondary metals
   Sibimol Luke, Manjunath Chatti, Douglas Mc Farlane, Aswani Yella, Rosalie Hocking, Alexandr Simonov EES Catalysis, 2023, 1, 730-741
3. Lead-Free Potassium Alloyed Cs2AgBiBr6: Tunable Optoelectronic Properties and Carrier-Lattice Interaction
   Vipinraj Sugathan, Jiban Kangsabnik, Aftab Alam, Aswani Yella Energy & Fuels, 2022, 36, 11100- 11107



Zero dimensional perovskites to 3D perovskite transformation in the presence of moisture



Single source white light emitting Bismuth doped Cs2AgInCl6



Moisture to electricity conversion using halide perovskites

Associate Professor

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(+91) (022) 2576 7629

Education:

- PhD - Materials Science, University of Cambridge, 2014
- M. Tech - Materials Science, IIT Bombay, 2010
- B. Tech - Metallurgy and Materials Science, 2006

RESEARCH INTERESTS

- Superconducting devices,
- Josephson effect,
- Superconducting spintronics

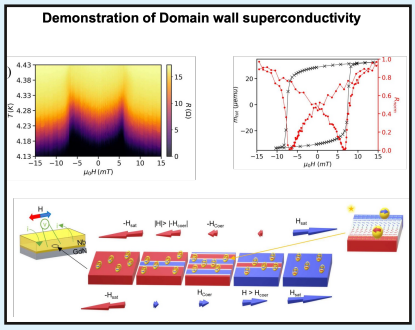
Avradeep Pal

▶TEACHING

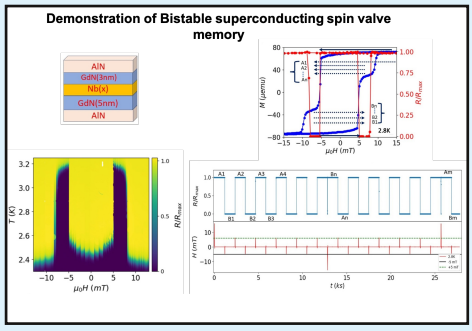
In his teaching, Avradeep focuses primarily on conceptual understanding of origin of physical phenomena, with a special attention to stay clear of rote memorisation as much as possible.
Courses taught:
Undergraduate - Structure of Materials
Post Graduate - Advanced Ceramics (Piezoelectrics, Ferromagnets, Superconductors)

▶RESEARCH PROFILE

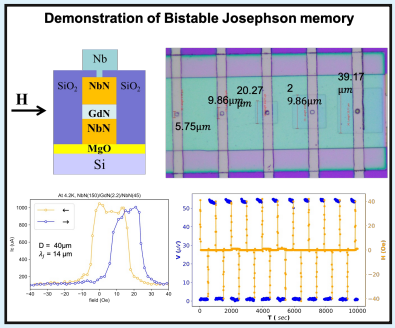
Avradeep's interests lie in the sphere of development, understanding and utilisation of novel phenomena that arises at hybrid material interfaces, and development of several novel quantum devices. The major focus is on the interface of thin film superconductors and ferromagnets. His work therefore spans from controlled Ultra High Vacuum growth of ultra thin film (2nm and lower) multi-layers, to nano-fabrication of these layers into devices like tunnel junctions, spin valves, Jospehson junctions; and subsequent low temperature electronic transport measurements of such devices. For achieving the same, he has developed several highly customised UHV thin film deposition and fabrication systems, and has standardised a industry level niobium based junction fabrication process. This has led to the discovery of novel cryogenic memory devices and other cryogenic components such as Josephson diodes that are crucial for upcoming era of quantum technologies.



Domain wall superconductivity in GdN/Nb bilayers



Superconducting exchange coupling driven memory device



High frequency Josephson memory device at 4.2K

Assistant Professor

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(+91) (022) 2576 7647

Education:

- PhD - Matls. Sci. & Engg., Carnegie Mellon University, 2018
- MS - Matls. Sci. & Engg., Carnegie Mellon University, 2016
- BTech & MTech - Met.l Engg. & Matls. Sci., IIT Bombay, 2013

RESEARCH INTERESTS

- High temperature metal processing
- Thermodynamics and kinetics
- Sustainability

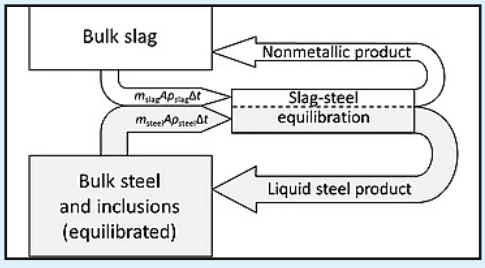
Deepoo Kumar

▶TEACHING

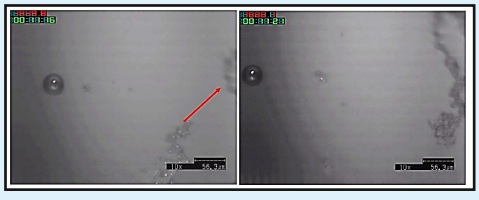
Prof. Deepoo Kumar likes to reinforce theoretical understanding by including interesting conceptual problems and computational examples in his teaching. In-class problem solving is considered integral to the learning process. Some of the courses taught are as follows:
UG level: Transport Phenomena and Kinetics, Heat Treatment Laboratory **PG level:** Advanced Concepts in Steelmaking, Kinetics of High Temperature Processes.

▶RESEARCH PROFILE

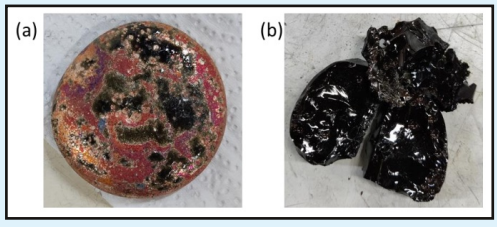
Prof. Deepoo Kumar's research interests are in the experimental and computational studies related to extraction and processing of metals. His experimental work includes reduction of hematite pellets using hydrogen, steel refining, steel-slag and slag-refractory interactions, inclusion characterization, processing of electronic waste[4] and quenching of steel. Laboratory and characterization facilities include atmosphere-controlled induction furnace, high temperature confocal laser scanning microscope[2] and SEM-based automated inclusion analysis. He has developed kinetic models for ladle refining[1], RH-degassing and BOF process using FactSage macro. These models can predict changes in steel and slag composition during steel production. In addition, ladle refining and RH-degassing models can calculate changes in inclusion composition and amount with time as well. He works in close collaboration with major steel producers of the country on experimental, modeling and characterization related problems. Some examples are as follows: heat transfer model for a bell annealing furnace for Theis Precision Steel[3], static models for BOF and EAF to perform sustainability studies for Tata Steel. He is currently working with JSW on developing ASPEN+ model for iron and steelmaking plant to find a balance between cost and CO_2 emission. He has conducted workshops on FactSage and clean steel production.



Modeling strategy for mass transfer controlled reactions e.g. steel-slag reaction



High temperature confocal laser scanning images showing in-situ agglomeration of solid inclusions (red arrow) floating on liquid steel surface at 1600°C.



Cu-Ag-Sn alloy (a) recovered from electronic waste using high FeO slag (b); experiment performed under argon atmosphere using induction furnace

References:-

[1] D. Kumar: Development of a reliable kinetic model for ladle refining, PhD thesis (2018), Carnegie Mellon University

[2] S.P.T. Piva, D. Kumar, P. C. Pistorius, Modeling manganese silicate inclusion composition changes during ladle treatment using FactSage macros, Metall. Mater. Trans. B Process Metall. Mater. Process. Sci. 48B(2017) 37–45

[3] Kumar, D., Viswanathan, N.N., Sarkar, P.S. (2022). Heat Transfer Model of Coil in a Bell Annealing Furnace. In: Dave, H.K., Dixit, U.S., Nedelcu, D. (eds) Recent Advances in Manufacturing Processes and Systems. Lecture Notes in Mechanical Engineering. Springer, Singapore

[4] B. Durgapraveen: Slag Design for Selective Metal Recovery from Electroni Waste, MTech thesis (2023), IIT Bombay

Dipti Gupta

Professor

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(+91) (022) 2576 7608

Education:

- PhD - 2007, Mats. & Met. Engg., IIT Kanpur, India
- M-Tech - 2002 - Mats. & Met. Engg., IIT Kanpur, India.
- B-Tech - 2000 Mats. & Met. Engg., IIT Kanpur, India.

RESEARCH INTERESTS

- Flexible/Stretchable/Printed/Wearable electronics
- Sensors and systems for healthcare applications
- Energy harvesting and storage Devices
- Structural electronics, 3D printing

▶TEACHING

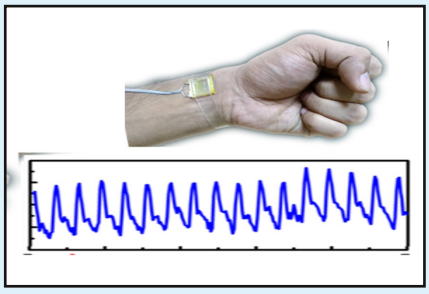
In her teaching, Prof. Dipti Gupta has taken inter-disciplinary approaches where she covers a wide range of topics from physics, chemistry, materials, electronics, and electrical engineering to equip students with basic concepts, device physics and fabrication aspects of traditional silicon based semiconductors and organic semiconductors. **UG courses**: Semiconductor Devices and Processing, Materials and Technology **PG Courses:** Organic Semiconductor and Devices

▶RESEARCH PROFILE

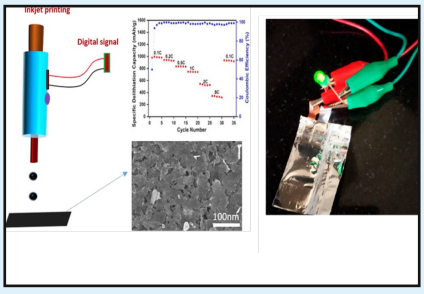
Prof. Dipti Gupta's research interests are in the area of 'Flexible/ Stretchable/Printed Electronics' for the energy and bio-medical applications. She has focused on technology/product development and has conducted application- oriented research that has resulted in several patents and publications in internationally reputed journals. She has been instrumental in establishing Technology Innovation Hub on IoT and IoE at IIT Bombay and serves as Executive member. She serves in Center Policy Committe of recently established Center for Semiconductor technologies at IITB. Further, she is associated with Koita Center for Digital Health (KCDH), Wadhwani Research Center for Bioengineering (WRCB), etc. Her group has developed Soft, light-weight flexible printed sensors that flex, stretch, bent, twist, conform and can comfortably be worn on the body are very important for health diagnosis and treatment as they enable real time monitoring of human health status. Her group has developed technologies for printed batteries, triboelectric nanogenerators, vibrations sensors for structural health monitoring, sub-zero temperature sensors, organic thin film transistor based biosensors etc.

Publications:

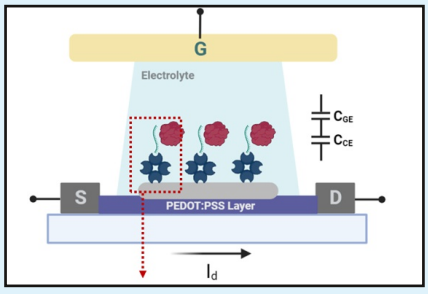
1. Tania Mukherjee and Dipti Gupta, "Cognitive gripping with flexible graphene printed multi-sensor array", Nature Communications Engineering, 2, 27, (2023)
2. Ashok Kushwaha, Ankur Sharma, Bharat Bhushan Bhatt, Amartya Mukhopadhyay, Dipti Gupta, "Inkjet-Printed Graphene-Modified Aluminum Current Collector for High-Voltage Lithium-Ion Battery", ACS Applied Energy Materials, (2023)



Wearable Sensor for pulse waveform monitoring



TENG and Inkjet printed battery



Organic thin film transistor based Biosensor

References:-

1. Ravinder Reddy, G. Srinivas, Dipti Gupta, "Smart electronic sensor for physiological monitoring", Indian Patent Application no. 201821019280, Granted, Patent No. 370588
2. D. Gupta, R. Anand, L. Kumar, S. Sahu, "Organic Electrochemical Transistor Based Biosensor for Wearable Sensor for pulse waveform monitoring

Assistant Professor

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(+91) (022) 2576 5606

Education:

- PhD - Matls. Engg., KU Leuven, Belgium, 2015
- BTech - Met. & Matls. Engg., IIT Madras, 2009

RESEARCH INTERESTS

- Computational Thermodynamics
- Metal Additive Manufacturing Phase
- Transformations Microstructure
- Evolution Mesoscale Modelling

Durga A

▶TEACHING

Prof. Durga uses a variety of teaching methods including in-class short questions, group activities and project- based assessment. There is a strong emphasis on process-structure-property correlations and modelling approaches in all her courses.

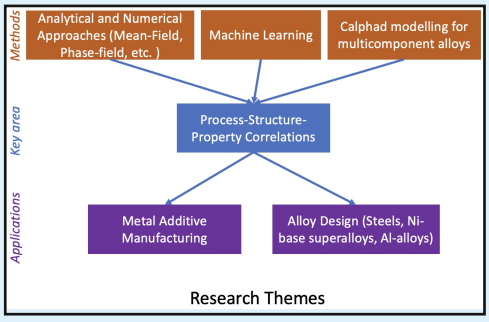
She has taught the following courses:

Undergraduate Courses - Casting and Joining, Thermodynamics of Materials

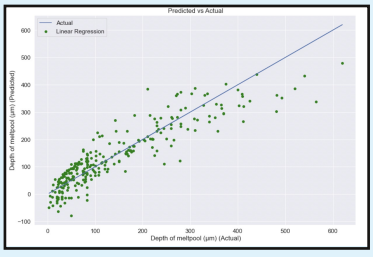
Postgraduate Course - Additive Manufacturing with Metals

▶RESEARCH PROFILE

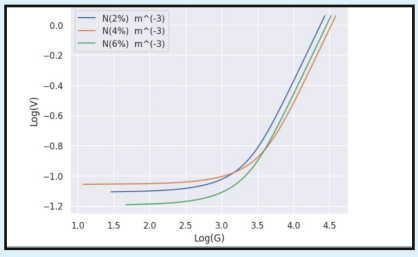
Prof. Durga's key research interest lies in modelling microstructure evolution when an alloy is subjected to different processes, be it casting, additive manufacturing (AM), or heat treatment. She has worked extensively on different approaches such as phase-field modelling, cellular automata and other numerical and analytical models. Through coupling such models with multicomponent Calphad thermodynamic and mobility databases, she has ensured that the models can be applied to technical alloys. In her research career thus far, she has worked on different projects collaborating with both industry and academia. Her research group is currently working on microstructure modelling during fusion-based metal AM [1,2] and solid-state phase transformations during AM. She is the PI of a project funded by the Science and Engineering Research Board on modelling microsegregation during metal AM and a co- PI on a project within the JSW Technology Hub for Steel Manufacturing on alloy design.



The key research themes of Prof. A. Durga's group



Comparison between the actual melt pool depths and those predicted using a linear regression model of additively manufactured Ti-6Al-4V alloy [1]



Temperature gradient G versus solidification growth front velocity V representing Columnar-to-Equiaxed Transition in grain structure [2]

References:-

[1] Nitesh Kumar Sachan, Optimizing parameters for 3D printing of defect free parts using ML algorithms, M.Tech. Thesis, IIT Bombay, 2023.

[2] Loveneesh Lawaniya, Effect of heterogeneous nucleating sites on the as-built grain structure of additively manufactured steels, B.Tech. Project - I, IIT Bombay, 2023.

Gururajan Mogadalai P

Professor

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Education:

- PhD - Metallurgy, IISc, Bangalore 2006,
- M Sc Engg, Metallurgy, IISc, Bangalore 1999,
- MSc Materials Science, Anna University, Madras, 1996,
- B Sc Physics, Madras University, 1994

RESEARCH INTERESTS

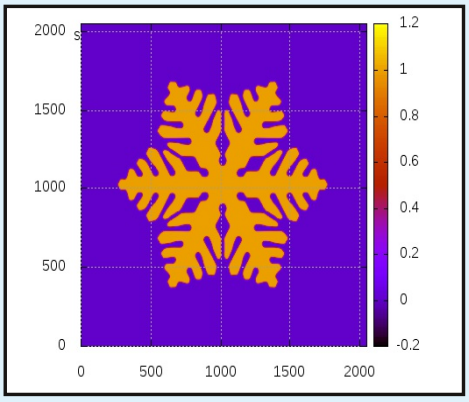
Phase field modelling, mechanics and thermodynamics of materials, atomistic simulations, modelling of microstrcutural evolution (physics based)

TEACHING

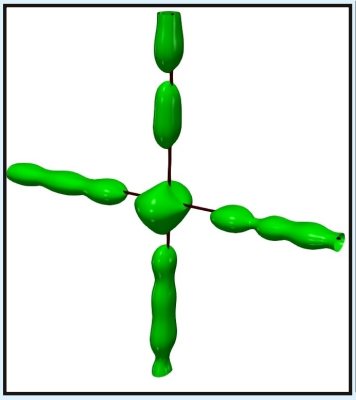
Professor Gururajan's teaching interests include physical metallurgy, diffusion and kinetics, modelling and analysis, simulation and optimization, AI and data science, and computational laboratory. He has also introduced and taught courses on modelling of microstructure evolution and mathematical methods at the post-graduate level. He has taught a few NPTEL / Swayamprabha courses and co-taught three GIAN courses -- all of which are available in YouTube.

RESEARCH PROFILE

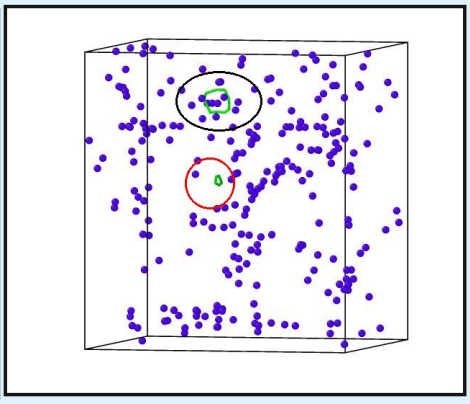
Professor Gururajan's research interests include modelling of microstructural evolution. He has close collaborations with experimentalists and enjoys working with them. The work carried out in his group includes phase field and atomistic modelling for phase transformation and deformation induced microstructural evolution. His research group is involved in developing and implementing new formulations of phase field models, and, more importantly, in developing open source code suites for phase field modelling. His research group consists of several undergraduates (from all over the country), masters students, phd students and post-docs who use cellular automaton, molecular dynamics, Monte Carlo and phase field models. The research carried out in the group is funded by projects from the Government of India as well as industries (Indian as well as International).



Implementation of a phase field model (using cuFFT) which incorporates hexagonal aniostropy in interfacial energy using sixth order tensor terms in the extended Cahn Hilliard model (the formulation of which also was developed in the group).



Phase field dislocation dynamics simulation results showing concurrent spinodal and nucleation and growth due to the presence of dislocations in a phase separating system. We have shown the crucial role of pipe diffusion in selecting the phase transformation mechanism.



Homogeneous and heterogeneous nucleation in Cu-Al alloys using MD simulations carried out using LAMMPS. We have shown the solid solution softening in these alloys as a result of reduction in stacking fault energy with alloying addition.

Prof. T.R.R. Mohan Chair Professor

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(+91) (022) 2576 7621

Education:

- Ph.D. : Drexel University, USA, 1994.
- MS: University of Texas at El Paso, USA, 1991.
- B.E.: Jadvpur University, India, 1987

RESEARCH INTERESTS

- Crystallographic Texture
- Microstructural Engineering
- Thermomechanical Processing

Indradev Samajdar

▶TEACHING

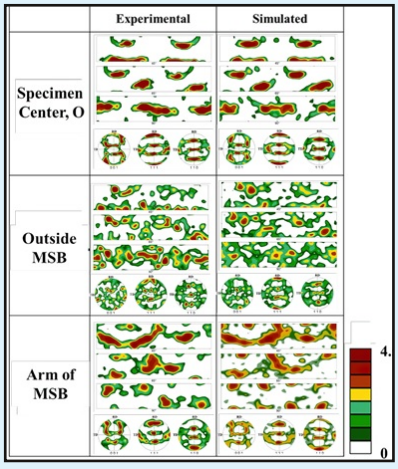
Advanced Physical Mechanical Metallurgy Electron Microscopy
Mechanical Working of Metals
Laboratory: Metallography and Processing-Structure-Property of Steel

▶RESEARCH PROFILE

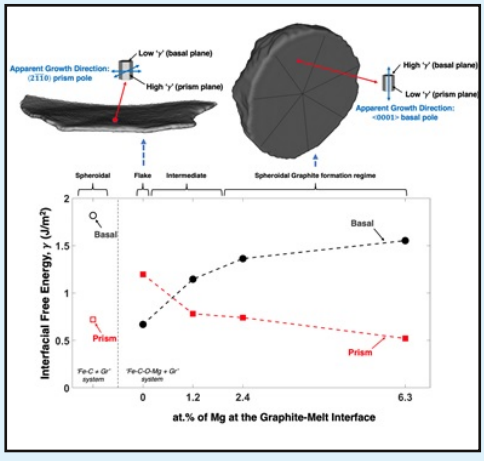
Texture Laboratory +
National Facility of OIM and Texture

Key Achievements:
1 Text Book + 247 papers in Intl Peer Reviewed J.,
3 Patents; 35 PhDs graduated, 7 Ongoing (IITB), 1 – Monash, 1 -HBNI

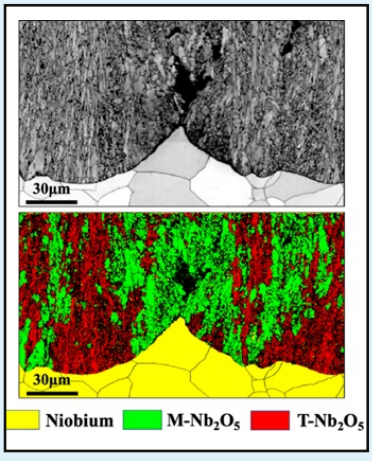
Awards:
1. H.H. Mathur Award of Research Excellence, IIT Bombay, 2016.
2. Institute Chair Professor (2014-2017, 2017-2020), TRRM Chair (2021-Cont.)
3. Adjunct Professor: Monash University.
3. Fellow of INAE and EMSI.
4. Metallurgist of the year: IIM-NMD, 2011.
5. MRSI (Materials Research Society of India) Medal Lecture



Formation of Macroscopic Shear Band. Reference: Prakash et at., IJP, (2023), 166, 103632.



Origin of Graphite Morphology in Cast Iron. Reference: Tewary et at., Acta Mater., (2022), 226,11760.



Oxidation Mechanism in Niobium. Reference: Dhole et at., Acta Mater., (2022), 229, 117793.

Jayasree Biswas

Assistant Professor

biswasj@iitb.ac.in

(+91) (022) 2576 7623

Education:

- B.E. (Metallurgical and Materials Engineering) - Jadavpur University, 2013.
- M.Tech. (Metallurgical Engineering and Materials Science) – IIT Bombay, 2015.
- Ph.D. (Materials Science and Engineering) – McMaster University, 2021.

RESEARCH INTERESTS

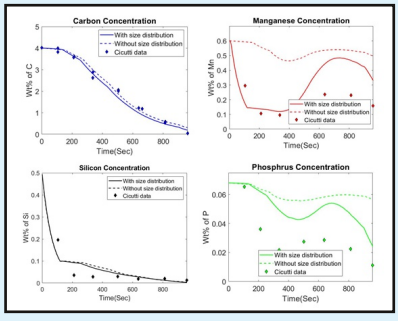
- High temperature kinetic studies in ferrous and nonferrous systems
- Process Modeling
- Metal recycling from secondary sources (such as spent PCB, batteries, solar cells)
- Green metal processing (Green steelmaking)

▶TEACHING

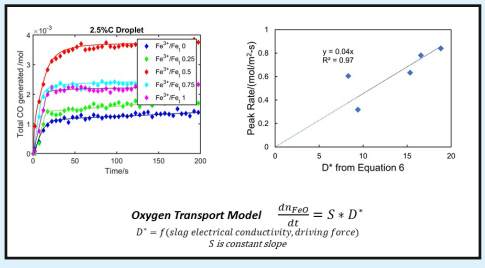
In her teaching, she has started teaching Transport Phenomena course (PG course). She will also be teaching Advanced Concepts in Steel making Course (PG course).

▶RESEARCH PROFILE

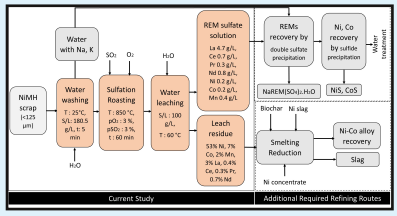
Prof. Jayasree Biswas's research interests are mainly in the area of high-temperature kinetic studies for both ferrous and nonferrous systems (both experimental and mathematical modelling) and metal recycling. During her Masters, she worked on developing dynamic model for BOF steelmaking process, where she developed a dephosphorization model based on the thermodynamics and reaction kinetic principles[1]. The model was able to capture the P reversion phenomenon with blowing time in the steelmaking. During her Ph.D., she worked on decarburization kinetics of liquid Fe-C droplets in oxidizing slag, of various electrical conductivities. Her experimental work was mainly focused on capturing the compositions relevant to HISARNA process(Tata Steel Europe). She identified the enhancement of decarburization kinetics with increasing slag electrical conductivity, due to faster oxygen transport. She also developed a kinetic model to predict the oxygen transport kinetics[2]. Her studies also revealed the influence of competitive adsorption (O,S) on refining reaction kinetics at slag/metal interface. During her post-doctoral research, she explored the area of battery recycling and investigated the sulfation roasting-water leaching route for selective extraction of metals from various battery scraps and successfully extracted 99% Li from LIB (LCO) black mass and 65% REEs from NiMH scrap[3]. Apart from that, she also explored the molten oxide electrolyte route for ferrochrome production from chromite pellets and briefly worked on carburization of HDRI pellets. Currently, at IIT Bombay, she is continuing working in both the areas of metal refining and metal recycling.



Evolution of metal bath composition as predicted from model [1]



Total CO gas generation with time for liquid Fe-C droplet reacting with various electrical conductivity slag (by varying ferric fraction) at 1505 _deg_C and prediction of oxygen transport from the kinetic model [2]



Proposed route for NiMH battery scrap recycling [3]

References:-

[1] Biswas et al. A Dynamic Mixed-Control Model for BOF Metal–Slag–Gas Reactions, MMTB 2021

[2] Biswas & Coley, Decarburization of Iron Carbon Droplets with Oxidizing Slag : An Experimental Study to Understand the Effect of Ionic and Electronic Conductivity on Decarburization Kinetics, MMTB 2022

[3] Biswas et al, Extraction of Rare Earth Metals from NiMH Battery Scrap via Selective Sulfation Roasting. J Sustain Metall., 2024

Associate Professor

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(+91) (022) 2576 7609

Education:

- PhD - Met. Engg. - KU Leuven, Belgium
- M Tech - Met. Engg. & Matls. Sci. - IIT Bombay
- BE - Met. Engg. - VRCE (now VNIT) Nagpur

RESEARCH INTERESTS

- Thermodynamics of steel refining reactions
- Clean steel production
- Process metallurgy
- Metallic foams

Manish M Pande

▶TEACHING

Prof. Pande has been teaching following undergraduate and post-graduate courses/labs.

Courses: Iron and steel making, Advanced concepts in steel making

Labs: Joining and casting lab, Processing and characterization of steel

▶RESEARCH PROFILE

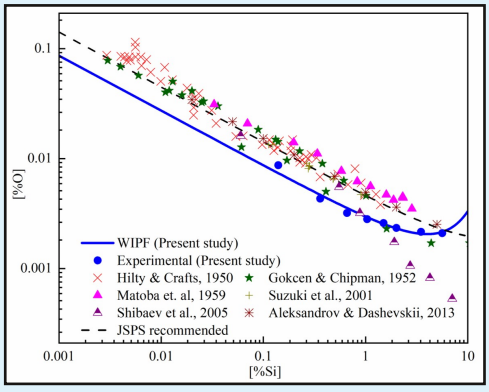
Prof. Manish M Pande's research interests include secondary steelmaking, clean steel production (steels containing low non-metallic inclusions), thermodynamics of steel refining reactions and simulating high temperature equilibrium experiments at a laboratory scale.

He has set-up a clean steel laboratory, at Metallurgical Engineering and Materials Science department (MEMS), IIT Bombay. Before joining MEMS, IIT Bombay, Prof. Pande has worked full-time in research and development departments of steel industries in India (Essar Steel Ltd.) and (Tata steel Europe/MPI) UK. His total industrial experience is nearly 7 years. During his doctoral (KU Leuven, Belgium) and post-doctoral (MU Leoben, Austria) studies, he worked in collaboration with ArcelorMittal Gent and voestalpine, Linz respectively, on the steelmaking projects.

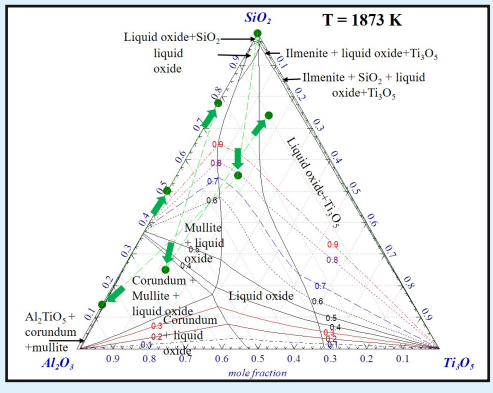
At present, his research group has been working on the experimental and thermodynamic analysis of high alloy steels. Prof. Pande is also interested in developing new alloy steels and new materials such as metallic foams.

Publications:

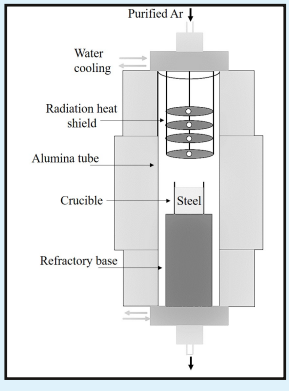
- Sanjay Pindar and Manish M Pande: Assessment of Si-O equilibria and non-metallic inclusion characteristics in high silicon steels, Steel Research International, 2023. https://doi.org/10.1002/srin.202300115
- Mir Ishfaq and Manish M Pande: Development of Higher Order Interaction Parameter Formalisms for a Ternary Solution in a Thermodynamically Consistent Manner, Steel Research International, 2023. https://doi.org/10.1002/srin.202200913
- Mir Ishfaq and Manish M Pande: Application and assessment of aluminium deoxidation equilibria in liquid steel using various formalisms based on some statistical thermodynamic models, Ironmaking and Steelmaking, 2022. https://doi.org/10.1080/03019233.2022.2082829



Si-O equilibria (experimental and calculated) in liquid iron/steel at 1873 K



Compositional evolution of complex (Si-Al-Ti-O) inclusions with ferrosilicon addition



Vertical tube furnace for equilibrium experiments (Schematic)

Associate Professor

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(+91) (022) 2576 7632

Education:

- PhD (Dr. rer. nat.) Physics, University of Freiburg, Germany, 2012
- M.Sc. Chemistry (Physical), University of Calcutta, India, 2008

RESEARCH INTERESTS

- Soft Condensed Matter,
- Polymer Physics,
- Droplets,
- Nonequlibrium Phenomena,
- Glass Transition

Mithun Chowdhury

▶TEACHING

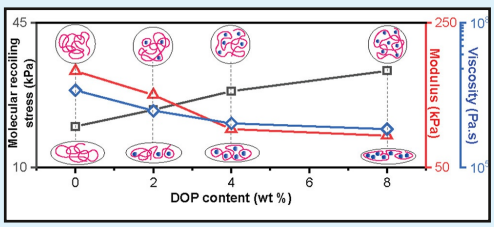
In his teaching Prof. Chowdhury emphasizes on the fundamental background and principles of soft matter including polymers, colloids and interfaces and composites. Some courses taught are

Undergraduate courses: Colloidal & Interfacial Science, Manufacturing Processes

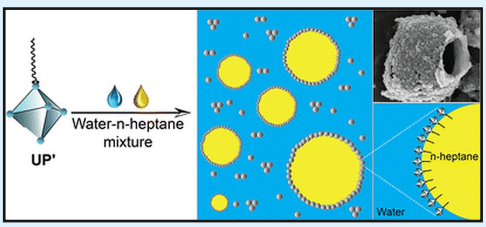
Postgraduate courses: Concepts of Advanced Polymer Science & Engineering, Advanced Composites

▶RESEARCH PROFILE

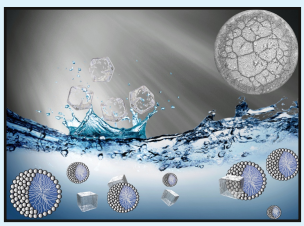
Prof. Chowdhury's area of research interest lies on the experimental area related to soft condensed matter with an emphasize to non-equlibrium phenomena. He mainly concentrates on problems where the dimension of sample reaches close to characteristic length scale defining a non-equilibrium phenomena occurring in polymers or broadly in structured fluids (including surfactants, self-propelling liquid crystals, active matter etc.). He looks into relaxation phenomena in polymers and complex fluids. Additionally, he is actively advancing understanding on droplet drying, colloids, artificial swimmers and porous metal-organic frame work materials with a outlook focused to fluid dynamics. Prof. Chowdhury joined IIT Bombay from the Department of Chemical & Biological Engineering at Princeton University, USA where he worked as an associate postdoctoral research scholar. He completed brief postdoctoral stays at Trinity College Dublin, Ireland and University of St Andrews, UK. He was awarded with Ramanujan fellowship (2018) and Early career research award (2019) by DST, SERB, India



Tuning the plasticization to decouple the effect of molecular recoiling stress from modulus and viscosity in dewetting thin polystyrene films



Engineering linker defects in functionalized UiO-66 MOF nanoparticles for oil-in-water Pickering emulsion stabilization



Cationic surfactant-directed structural control of NaCl crystals from evaporating sessile droplets

References:-

[1] Tuning the plasticization to decouple the effect of molecular recoiling stress from modulus and viscosity in dewetting thin polystyrene films, Mithun Madhusudanan, Jotypriya Sarkar, Sudeshna Dhar, Mithun Chowdhury* Macromolecules 56 (4), 1402-1409, 2023

[2] Engineering linker defects in functionalized UiO-66 MOF nanoparticles for oil-in-water Pickering emulsion stabilization, Mostakim SK, Salini Kar, Jayant K Dewangan, Mithun Chowdhury*, Dalton Transactions, 2023, 52, 11886-11896

[3] Cationic surfactant–directed structural control of NaCl crystals from evaporating sessile droplets, Jayant K. Dewangan, Nandita Basu, Mithun Chowdhury*, Soft Matter,18, 62-79 (2022), Outside back cover Soft Matter, 2022,18, 245-246

Associate Professor

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(+91) (022) 2576 7626

Education:

- Ph.D. - Materials Engineering, IISc Bangalore, 2013
- B.Tech - Met. & Matls. Engg., NIT Karnataka, 2007

RESEARCH INTERESTS

- Fracture mechanics of thin films, coatings and multilayered structures
- Design of damage tolerant composites and alloys through additive manufacturing
- In-situ micro- and nano-mechanical characterization of alloys

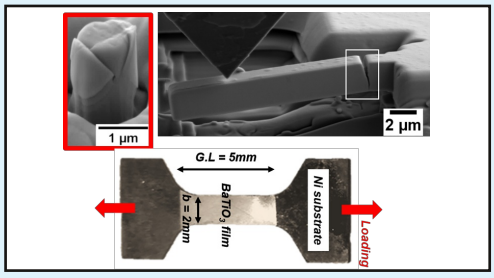
Nagamani Jaya Balila

▶TEACHING

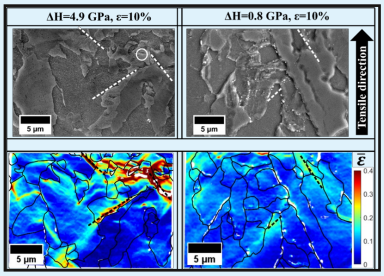
Prof. Jaya inculcates hands-on projects and laboratory components even in theoretical courses, to enhance both conceptual understanding and application of the concepts taught. She has been utilizing the maker space and her own mechanical test facility as resources.
Courses taught are: Mechanical Behavior of Materials, Fracture Mechanics and Failure Analysis, Mechanics of Materials, Micromechanics of Thin Films and Small Structures, Metallography and Structural Characterization Laboratory.

▶RESEARCH PROFILE

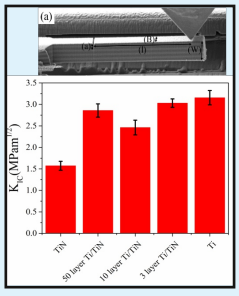
Prof Jaya's research interests are in mechanical behavior and structural integrity assessment of different classes of materials, across different length scales. Her focus is to deploy finite element modeling in combination with experiments to develop: Non-conventional fracture test geometries [1]; Design and development of damage resistant structures [2-3]; Microstructure and micro-mechanical characterization of interface dominated materials across stress states [4-6]. Her group is the first in the country to set up in-situ micromechanics techniques with full field strain mapping using digital image correlation under optical and electron microscopes [4-5]. She is funded by Pratt & Whitney, for her work on thermal spray coatings and additively manufactured superalloys, by IGCAR for solidification cracking in laser welded steels, and has been part of collaborations with TATA Steel to develop a miniature hole expansion ratio set up (patent filed) [6]. She has been the recipient of the Max Planck Society's External Partner-Group Leadership Award, KITs International Excellence Fellowship Award, and Visiting Fellowship Awards at Hiroshima University and Xian-Jiatong University, for her collaborative work.



Micromechanical testing techniques for small volumes



In-situ SEM-DIC strain mapping of DP steels



Fracture resistance optimization of multilayered Ti/TiN films

References:-

1. B. Nagamani Jaya, “Fracture in small-scale structures and confined volumes” MRS Bulletin, 47, 2022, 832-838
2. A. K. Mishra, H. Gopalan, M. Hans, C. Kirchlechner, J. Schneider, G. Dehm, B. Nagamani Jaya, “Strategies for damage tolerance enhancement in metal/ceramic thin films: Lessons learned from simulations and the system Ti/TiN”, Acta Materialia, Vol 228, 2022, 117777.
3. D. Yadav, B. Nagamani Jaya, Size effects governing damage resistance of architected PMMA, Engineering Fracture Mechanics, 2023, Vol. 290, 109526
4. S. Basu, B. Nagamani Jaya, H. Seekala, P. S. Phani, A. Patra, S. Ganguly, M. Dutta, I. Samajdar, Correlative Characterization and Plasticity Modeling of Microscopic Strain Localizations in a Dual Phase Steel, Materials Characterization, 2023, 197, 112704
5. N. G. Mathews, A. K. Saxena, N. Venkataramani, G. Dehm, B. Nagamani Jaya, “Multiscale characterization of damage tolerance in Barium Titanate thin films”, Journal of Applied Physics, Vol 132, Issue 4, 2022, 045302
6. S. Basu, B. Nagamani Jaya, S. Ganguly, M. Dutta, I. Samajdar, Novel miniature in-situ hole expansion test coupled with microscopic digital image correlation, Review of Scientific Instruments, 2023, (accepted)

Narasimhan Krishnaiyengar

Professor

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Education:

- PhD - Materials Science and Engineering, Purdue University, 1988;
- M.Tech. Indian Institute of Technology Madras, 1984;
- B.Tech. Institute of Technology, Banaras Hindu University, 1982.

RESEARCH INTERESTS

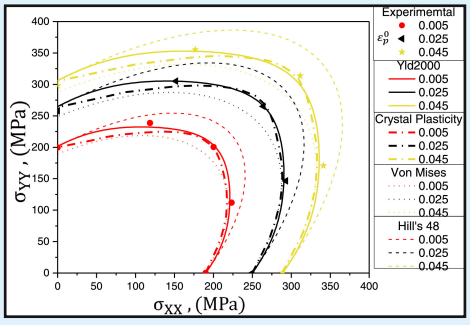
- Sheet Metal Forming Hydroforming
- Flow Forming Ring Rolling
- Modeling and Simulation of Forming Processes

TEACHING

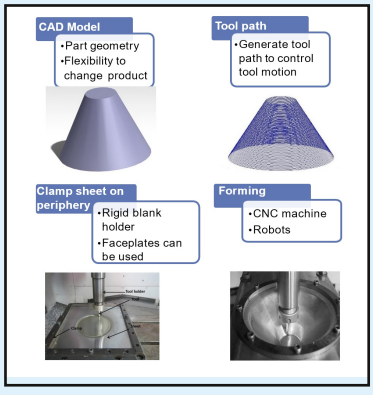
Involved in teaching of the following courses - Mechanics of Materials, Mechanical Working of Metals, Numerical Methods in Materials Processing, Computational Methods in Metal Forming Analysis, Steel Processing and Characterisation Lab, Computational Lab., Metallography Lab.

RESEARCH PROFILE

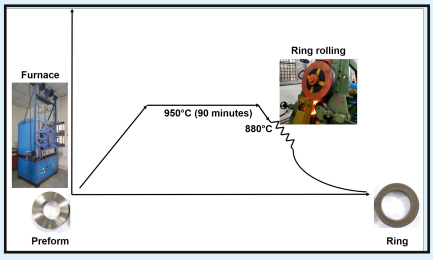
Prof. Narasimhan works in the broad area of metal forming. His approach is based on developing experimentally validated process models for the various metal forming processes. He not only focusses on fundamental research in metal forming, but also works on translating the research output to industrial applications. Specifically, he works in Sheet Metal Forming, hydroforming, hot stamping and other bulk forming processes like Ring Rolling and Flow Forming. His work also emphasizes on the evolution of microstructure during forming and its correlation to the properties of the formed components. He has developed a validated novel failure criterion for predicting splitting failures during forming. He has been involved in working with the industry for implementing two critical technology - The Tailor Welded Blank (TWB) forming and Tube Hydroforming. He has designed, fabricated and installed the first ever laboratory scale Ring Rolling facility in the Indian academia. The facility can be used for optimising the ring rolling process parameters for wide range of advanced materials. He works extensively with steel, aluminium, automotive, defence and space organisations.



Comparison of experimental work contour (σxx, σyy) with von Mises, Hill's 48, Yld2000-2d (Barlat) yield locus and crystal plasticity. Each symbol corresponds to a contour of plastic work for a value of equivalent plastic strain



Incremental Sheet Forming Process



Laboratory Scale Ring Rolling Facility and Process

Professor

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(+91) (022) 2576 7624

Education:

- Phd-Metallurgical Engineering and Materials Science, Carnegie Mellon University, Pittsbugh, 1991
- B. Tech- Metallurgical Engineering, IIT Bombay - 1985

RESEARCH INTERESTS

- Phase Transformations
- Electron Microscopy
- Physical Metallurgy

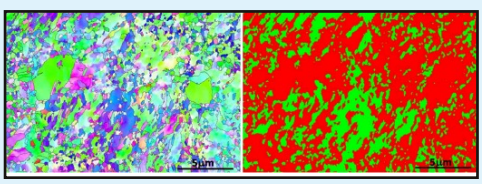
Nithyanand Prabhu

▶TEACHING

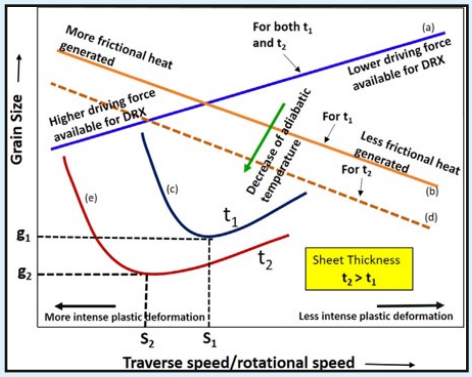
In his teaching, Prof. N.Prabhu, lays emphasis on the fundamental concepts while simultaneously illustrating the principles with practical developments. Some courses taught are
Undergraduate Courses: Phase Transformations, Metallography Lab, **Heat Treatment Lab Postgraduate Courses:** Topics in Phase Transformations, X-ray Diffraction and Electron Microscopy, Characterization of Materials

▶RESEARCH PROFILE

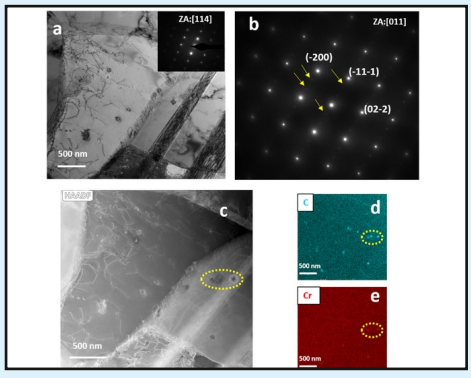
The theme of Prof. Prabhu's research is "Processing-structure-property relationship" in different materials. His research scholars have explored this relationship in Mg-, Al-, Ti-alloys and in steels viz., HSLA steel, Dual-phase steel, Super-duplex stainless steel and austenitic stainless steel. Currently he is collaborating with NMRL, Ambernath to develop suitable High-Entropy Alloy (HEA) for naval applications.



Strain induced martensite formation in 304 stainless steel.
a) EBSD-inverse pole figure map and b) phase map of austenite (70%) and martensite (30%) for the transition zone of SS-I after tensile deformation, showing SIM association with micro shear bands. Red: Austenite, Green: Ferrite[2]



Microstructure evolution in friction stir processed 2507 super duplex stainless steel. Schematic diagram depicting the individual and synergistic effect of processing parameters such as heat input, strain rate and strain on grain size with respect to the traverse to rotation speed ratio and the thickness of sheet[1]



Friction stir processed, metastable, dual-phase, Fe49.5Mn30Co10Cr10C0.5, multi-principal element alloy
(a) TEM bright field image showing the presence of M23C6 precipitates, (b) SAED pattern showing strong matrix reflections and weak precipitate reflections, (c) HAADF image showing the precipitates encircled in yellow colour
(d) X-ray elemental map showing the distribution of carbon and (e) chromium in the microstructure[3]

References:-

[1] M.K. Mishra, A.G. Rao, I. Balasundar, B.P. Kashyap, N. Prabhu, On the microstructure evolution in friction stir processed 2507 super duplex stainless steel and its effect on tensile behaviour at ambient and elevated temperatures, Materials Science & Engineering A 719 (2018) 82–92, doi.org.10.1016.j.msea.2018.02.032

[2] Sailaja Sharma, B. Ravi Kumar, B.P. Kashyap, N. Prabhu, Effects of concurrent strain induced martensite formation on tensile and texture properties of 304L stainless steel of varying grain size distribution, Materials Science & Engineering A 725 (2018) 215–227, doi.org.10.1016.j.msea.2018.03.099

[3] Neelam Meena, G. Gunasekaran, P. Veereiah, A.G. Rao, N. Prabhu, Corrosion behaviour of friction stir processed, metastable, dual-phase, Fe49.5Mn30Co10Cr10C0.5, multi-principal element alloy, Journal of Alloys and Compounds 952 (2023) 169967, doi.org.10.1016.j.jallcom.2023.169967

Parag Bhargava

Class of 1985 Chair Professor for Technology & Sustainable Development

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(+91) (022) 2576 7628

Education:

- Ph.D., Mats. Sci., University of Alabama (1996)
- M.S., Matls. Engg., University of Alabama (1994)
- B.Tech., Met. Engg. IIT Bombay (1991)

RESEARCH INTERESTS

- Powder Processing
- Shape Forming of Ceramics
- Rheology of inks, Pastes
- Synthesis of weakly agglomerated nanoparticles
- Dental Materials
- Glasses and glass ceramics
- Silver inks, Pastes for Sensors / Flexible Electronics / Solar PV
- Scaling-up and Product development

TEACHING

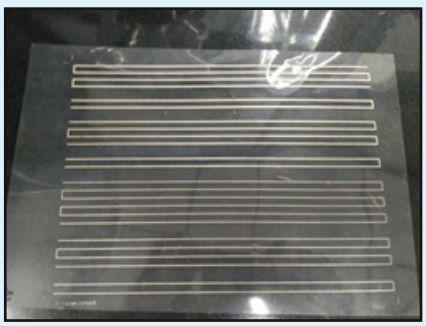
In the departmental introductory course (Materials & Technology) he always begins with discussion on engineering, its role in shaping the society and economy, the role of innovation etc.

In his teaching, besides the formal curriculum he has always included projects which require some hands-on thinking. Some of the projects assigned include disassembly of gadgets, machines, instruments where the students are required to study the function of each part, the materials that the parts are made of and the methods by which these parts are manufactured and whether they are produced in India. Other projects were based on fabrication, materials recycling and identification of a new need/ unsolved problem / improvement needed by interviewing at least 15 – 20 stakeholders.

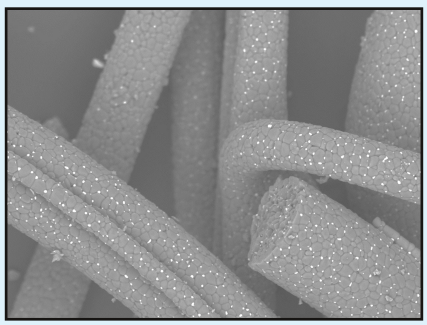
Courses taught: Experimental Techniques in Materials Science; Ceramic Processing Techniques; Colloid and Interfacial Science; Materials and Technology / It's a Materials World

RESEARCH PROFILE

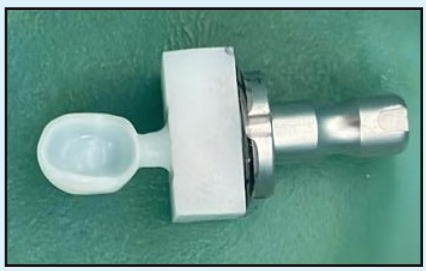
Most of Prof. Bhargava's work is centred around particulate materials. His group, while working on basic research, has always maintained a keen interest in application oriented or product development research. He and his group has also been undertaking research on scaling up of previously developed processes in the lab. He is a co-founder of several companies in the domain of particulate processing / ceramics (ANTS Ceramics, Digident LLP, Metwiz Materials). Some of the technology development work undertaken includes - Electrophoretic deposition of diamond particles on phosphor bronze wheels for jewellery diamond sawing applications, Conductive silver paste for flexible membranes for use in keyboards, Ceramic carbon resistors for electrical power applications, A process and machine for spinning ceramic (alumina) fibres, A process for making kg level quantity of nanozirconia, Ceramic foams for high temperature thermal insulation and machine for continuous production of ceramic foams.



Screen printed silver paste for flexible electronics



Centrifugally spun ceramic fibres for high temperature applications



Machinable glass ceramic for dental applications

Jindal Stainless Steel Chair Professor

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(+91) (022) 2576 7642

Education:

- PhD - Materials Engineering, IISc, Bangalore, 2010
- ME - Metallurgy, IISc, Bangalore, 2004
- BTech - Met. Engg. REC (now, NIT Warangal) 2002

RESEARCH INTERESTS

- Mechanical Behaviour of Metallic Materials
- Thermo-Mechanical Processing
- Metallic Coatings and Alloy Development Material Joining

Prasad M.J.N.V.

▶TEACHING

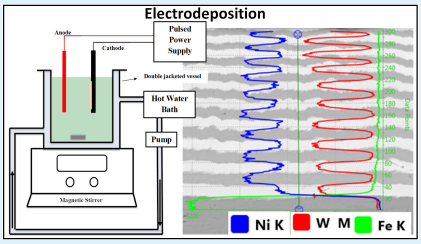
In teaching, Prof. Prasad focuses on fundamental aspects of relating the microstructure-mechanical properties- thermomechanical processing of materials.

Some courses taught are:

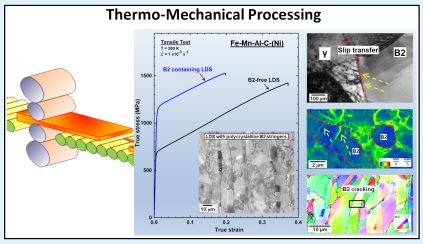
Thermomechanical Processing and Forming of Steel; Mechanical Characterization of Materials; Plastic Deformation and Microstructure Evolution; Fatigue, Creep and Superplasticity; Protective Coatings; Advanced Composites; Heat Treatment Laboratory.

▶RESEARCH PROFILE

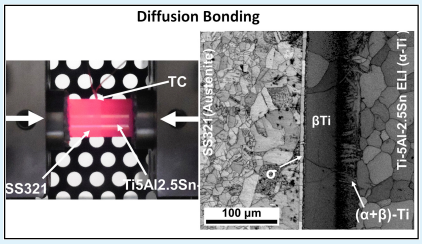
The traditional paradigm of the materials science tetrahedron illustrates the structure-processing- properties- performance correlations for a material. Along similar lines, Prof. Prasad has defined the focus of his research majorly on 'Microstructural Engineering and Mechanical Performance (MEMP)' of various metallic alloys (both ferrous and non-ferrous metals & alloys) and metal matrix/metal particles reinforced composites. One of the current thrust areas is to develop novel coatings and materials as a strategic approach to improve resistance against mechanical and chemical degradation of materials. The second one is on developing advanced high- strength steels and advanced light alloys (Al alloys, Mg alloys, Ti alloys) for automotive, aerospace, and defense applications by adopting proper alloy design and thermo-mechanical controlled processing. And, the third one is on developing novel and advanced similar and dissimilar metal joints by solid-state diffusion bonding and friction-stir welding. The group has been working on understanding the deformation behaviour, oxidation, and corrosion performance of metallic materials at different microstructural length scales.



Electrodeposition of Ni-W multilayer coatings [1].



The role of secondary B2 phase on tensile behaviour of Fe-Mn-Al-C-(Ni) based low-density steels [2].



Solid-state diffusion bonding to produce dissimilar metal joints between stainless steel and titanium alloy [3].

References:-

[1] Lavakumar Bathini, M.J.N.V. Prasad and Nitin P. Wasekar, "Compositionally modulated Ni-W multilayer coatings: A facile approach to enhance the tribological performance," Tribology International 179 (2023) 108145 (1-10).

[2] Bidyapati Mishra, R. Sarkar, Vajinder Singh, A. Mukhopadhyay, Rohit T. Mathew, V. Madhu, M.J.N.V. Prasad, "Microstructure and deformation behaviour of austenitic low-density steels: The defining role of B2 intermetallic phase," Materialia 20 (2021) 101198 (1-13).

[3] Ravi Ranjan Kumar, Rohit Kumar Gupta, Aditya Sarkar and M.J.N.V. Prasad, "Vacuum diffusion bonding of α titanium alloy to stainless steel for aerospace applications: Interfacial microstructure and mechanical characteristics," Materials Characterization 183 (2022) 111607 (1-15).

Assistant Professor

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Education:

- Ph.D. Nano Sci. & Engg. IISc, Bangalore 2017
- M.B.A. (Total Quality Management) Sikkim Manipal 2012
- M.Tech. (Plastic Tech.) - CIPET, Bhubaneshwar, 2009
- B.E. (Chem. Engg.) - N.I.T.Karnataka 2006

RESEARCH INTERESTS

- Polymer nanocomposites
- Membranes
- Piezotribo-electric materials
- Nanofibers

Prasanna Kumar S. Mural

▶TEACHING

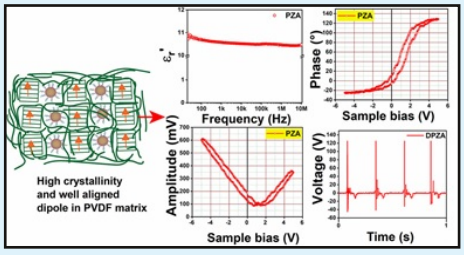
Prof. Prasanna kumar's teaching policy involves him being always humble and remain as a student for learning. He believes in teaching that imparts confidence in critical thinking to the students so they are in a position to communicate their knowledge efficiently. His teaching instills a foundation for students to venture and tackle the new problem with cutting-edge research. Some courses taught are:

Undergraduate Course - Engineering Polymers & Composites, Heat Treatment Laboratory

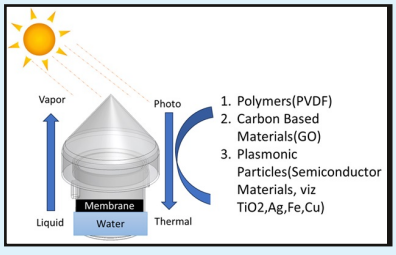
Postgraduate Course - Communication Skills, Sustainable Materials for Water Treatment

▶RESEARCH PROFILE

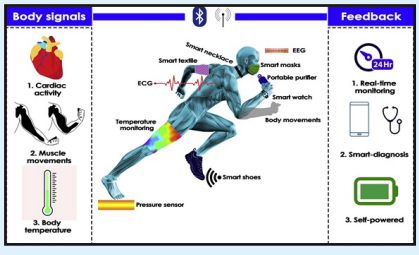
Prof. Prasanna Kumar's research interests are in the area of Polymer nanocomposites for developing sustainable technologies to meet energy and water demand. His work involves the synthesis of nanoparticle preparation, tailoring the nanoparticles with suitable chemical functionalities, polymer nanocomposite preparation, and materials characterization that benefit in developing suitable nanocomposite material which may assist in emerging sustainable technologies. His work is interdisciplinary research that involves bridging to connect nanotechnology from lab setup to industrial scale to meet energy and water demand. A major aspect of his research is the development model system for process integration of new avenues in developing future products. During his tenure at NIT Calicut, Kerala he established nanogenerator material for energy harvesting. His team at IITB is looking into developing multifaceted materials for energy, water, and sensor applications [1,2,3].



Films for Energy Harvesting



Thin-film composite membrane



Multi-functional material in real world

References:-

[1]. Chandran, Akash M., et al. "Zinc oxide nanoparticles coated with (3-aminopropyl) triethoxysilane as additives for boosting the dielectric, ferroelectric, and piezoelectric properties of poly (vinylidene fluoride) films for energy harvesting." ACS Applied Nano Materials 4.2 (2021): 1798-1809.

[2]. Chandran, Akash M., and Prasanna Kumar S. Mural. "Surface silanized MWCNTs doped PVDF nanocomposite with self-organized dipoles: an intrinsic study on the dielectric, piezoelectric, ferroelectric, and energy harvesting phenomenology." Sustainable Energy & Fuels 6.6 (2022): 1641-1653.

[3]. Chandran, Akash M., Ekta Tayal, and Prasanna Kumar S. Mural. "Polycaprolactone-blended cellulose acetate thin-film composite membrane for dairy waste treatment using forward osmosis." Environmental Science and and Pollution Research 29.57 (2022): 86418-86426.

Associate Professor

prasanna@iitb.ac.in

(+91) (022) 2576 7639

Education:

- PhD - Materials Science, MIT, 1991
- B.Tech - Metallurgical Engineering, IIT Madras, 1985

RESEARCH INTERESTS

- Computational Materials Science
- Ab Initio total energy studies
- Electron-phonon interactions
- Solid Oxide Fuel Cells

Prasanna T. R. S.

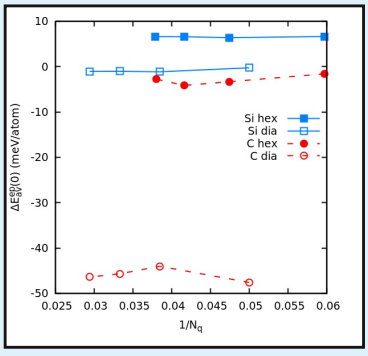
▶TEACHING

Some of the courses taught are: Undergraduate courses - Experimental techniques in Materials Science, Structure of Materials, Electronic properties of Materials Postgraduate courses - Thermodynamics of Materials, X-ray Diffraction and Electron Microscopy

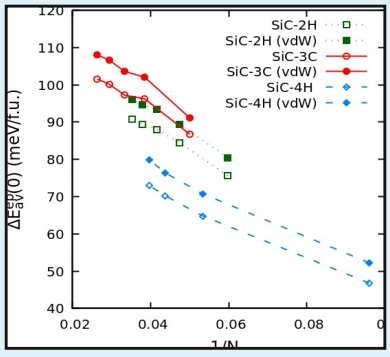
▶RESEARCH PROFILE

Currently, the ab initio total energy consists of the density functional theory (DFT) total energy and additional contributions from van der Waals dispersion and zero-point vibrational energy. We have introduced a new contribution to the total energy, from electron-phonon interaction. Due to its greater sensitivity to crystal structure (than vdW and ZPVE), by including EPI, we have resolved decades-old controversies on the stable structure of important materials e.g., hexagonal silicon carbide, SiC-4H, (not cubic SiC-3C) and cubic boron nitride, cBN, (not hexagonal hBN) are stable. We have derived the EPI contributions to the electronic and phonon free energies, relying on P.B. Allen's general formalism for interacting quasiparticles, to go beyond the standard Quasi-Harmonic Approximation, which is valid only for non-interacting quasiparticles. Our and Allen's contributions, taken together, lay the foundation to go beyond QHA and include EPI contributions on all thermodynamic properties e.g., structural properties, and to determine, more accurately, the phase transition temperatures, pressures and phase boundaries, for all materials.

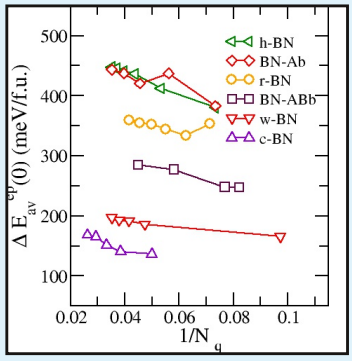
We have proposed the equilibrium combination of doped Lanthanum gallate electrolyte and lanthanum-doped Ceria buffer layer for intermediate temperature solid oxide fuel cells so that, with time, additional phases that can reduce the fuel cell efficiency are not formed.



EPI contribution to the total energy vs phonon grid density for carbon and silicon polytypes



EPI contribution to the total energy vs phonon grid density for silicon carbide polytypes



EPI contribution to the total energy vs phonon grid density for boron nitride polytypes

References:

1) A.V.R. Varma, S. Paul, A. Itale, P. Pable, R. Tibrewala, S. Dodal, H. Yerunkar, S. Bhaumik, V. Shah, M.P. Gururajan, and T.R.S. Prasanna. Electron−Phonon Interaction contribution to the total energy of Group IV semiconductor polymorphs. ACS Omega 8, 11251 (2023).

2) S. Paul, M.P. Gururajan, A. Bhattacharya, and T.R.S. Prasanna. Critical role of electron-phonon interactions in determining the relative stability of Boron Nitride polymorphs. (under review) https://arxiv.org/abs/2212.13877 (2022).

3) S. Kumar, A. Chakraborty, S. Kobi, P. Gopalan and T.R.S. Prasanna. Phase formation between La(Sr)Ga(Mg)O3 and Ce(La)O2 for solid oxide fuel cell applications. J Am Ceram Soc., 105:3625–3635 (2022)

Prita Pant

Professor

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Education:

- MS & PhD, Materials Science, Cornell University, USA, 2004,
- B. E. IIT Roorkee, 1997

RESEARCH INTERESTS

- Deformation of metals and alloys
- Microstructure evolution during deformation
- Dislocation dynamics simulations
- Molecular dynamics simulations

▶TEACHING

Prita has taught a variety of courses encompassing theory, computation, and experiments. In all her classes, she encourages student participation in discussions both within and outside the classroom.

List of some of the courses taught: UG Mechanical Behaviour of Materials, Computational Lab, Mechanical working of Metals. PG Computational Lab, Topics in mechanical behaviour of materials, Mechanical behaviour of thin films and small structures, Communication skills

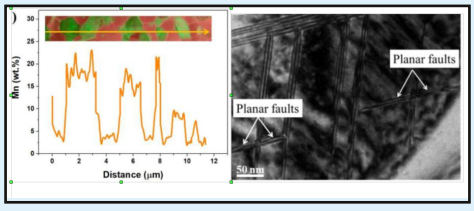
▶RESEARCH PROFILE

Prof. Prita's research group has been working on investigating the links between the microstructure of metals and alloys and their plastic deformation, using a combination of experiments and modelling.

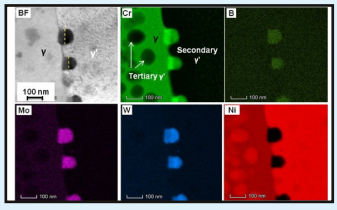
Medium Mn-steels comprise the third generation of advanced high strength steels (AHSS), which have a combination of high strength and ductility. These properties are achieved by tailoring a two-phase microstructure, which, during plastic deformation, undergoes deformation by multiple modes, namely twinning, phase transformation and dislocation slip. We show that both twinning and phase transformation can occur depending on the local composition of austenite grains (Fig 1) [2].

Ni based superalloy GTD444, is used to make directionally solidified blades for later stage turbines. Since Boron is added as a grain boundary strengthener, the microchemistry near boundaries and the crystallographic orientation of grains both influence deformation at elevated temperatures. We show that M2B type borides are present near boundaries, where M is Cr, W, and Mo (Fig. 2) [2]. These borides transform into M6C and M23C6 type carbides upon thermal aging, present discretely along the boundary, and prevent inter-granular fracture.

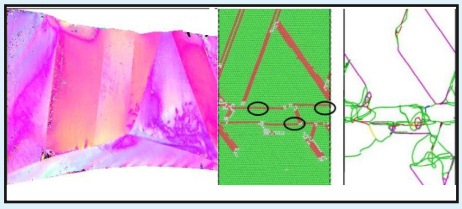
Cu-Al alloys are excellent model system to study solute strengthening and the effect of stacking fault energy, which reduces by an order of magnitude as Al content increases from 0 to about 8 wt%. Deformation of miniature tensile samples was carried out, and misorientation developed along twin and high angle boundaries measured (Fig. 3) [3]. This was explained based on molecular dynamics (MD) simulations of twinned crystals by observing dislocation accumulation near twin boundaries.



Mn distribution in austenite grains, when the average Mn is about 6 wt%. Intersection of planar faults, which are potential sites for martensite nucleation [1]



Nano-precipitates at grain boundary present along the gamma-gamma prime interface. STEM-EDS composition maps show the presence of Boron, and gradients in Cr and W [2]



Gauge section of deformed miniature tensile sample. Changes in colour show misorientation development. MD simulations of twinned crystal with green FCC coordinated atoms and red are HCP coordinated atoms. Dislocation accumulation at twin boundaries [3]

References:-

1. Simultaneous Occurrence of Twinning and Phase Transformation During Yield Point Elongation in Medium Manganese Steels, P Satyampet et al. Metallurgical and Materials Transactions A 54 6-10 (2023)
2. Compositionally Graded Nano-Sized Borides in a Directionally Solidified Nickel-Base Superalloy, Gupta, Richa et al., Scripta Materialia (2021)
3. Misorientation Development at Σ3 Boundaries in Pure Copper: Experiments and MD Simulations, Sandhya Verma et al., Metallurgical and Materials Transactions A, 1-14 (2022)

Institute Chair Professor

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(+91) (022) 2576 7633

Education:

- Ph.D. - Physics, 1990, Univ. of Poona, Pune,
- M.Sc. - Physics, Nagpur Univ - 1984

RESEARCH INTERESTS

- Semiconductor thin films for optoelectronic devices,
- Photovoltaic devices,
- Energy storage

Recent Patent Granted: "A METHOD FOR PRODUCING SILICON NANOWIRES HAVING COMPOSITE STRUCTURE"
Patent No.: 414337,
Date of Grant: 13/12/2022

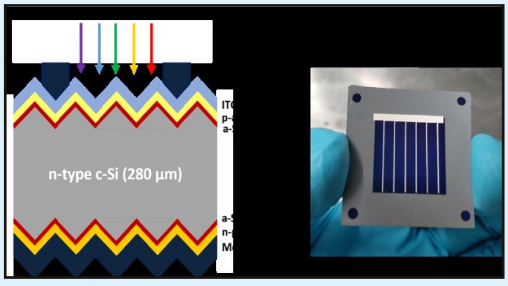
Rajiv O. Dusane

▶TEACHING

Prof. Dusane has engaged students in thin films and semiconductor device processing courses over the last 20 or more years with special emphasis on the practical aspects. He also established the Thin Film lab for both UG and PG students. As his special interest he also took the communication course for the PG students.
UG course: Science and Technology of Thin Films **PG course:** Materials and Processes for Semiconductor Device Manufacturing

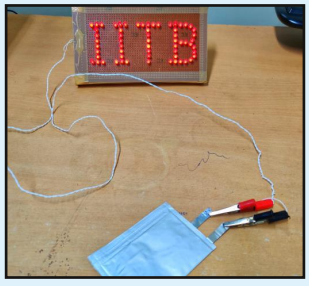
▶RESEARCH PROFILE

Prof. Dusane has over the last 30 years carried out fundamental and applied research in the area of semiconductor thin films and devices, surface modification and plasma processing of various materials with a view to develop new processes and materials in thin film and nano structure form, capable for a variety of applications ranging from solar cells, thin film light emitting devices (TFLEDs), microelectronic devices, sensors and actuators (MEMS) and batteries. He has done pioneering work in the area of Hot Wire Chemical Vapor Deposition (HWCVD) process in this country. Several patents have resulted out of this work and some successful industrial collaborations have also been undertaken. Over these years he has established state of the art facilities for thin film deposition and characterization. Recent significant work from his group is the Silicon nanowire-based anode for Li-ion battery. The work carried out till now has demonstrated the capabilities of the Hot Wire process in diverse areas like Microelectronics, Biocompatible materials, surface functionalization and modification, barrier layers etc. This has given new directions to the applicability of the HWCVD process in the area of MEMS and sensors. Recently he has designed and developed a HWCVD multi-chamber cluster tool, the first of its kind in the country.



HIT solar cell on textured Silicon wafer architecture and fabricated cell

The newly developed HWCVD multichamber system



Silicon Nanowire Anode based Li-ion pouch cell

References:-

1. Rashmi Tripathi, V Chauhan, P Gandharapu, S Kobi, A Mukhopadhyay, R O Dusane. “Si Nanowires Grown on Cu Substrates via the Hot-Wire-Assisted Vapor–Liquid–Solid Method for Use as Anodes for Li-Ion Batteries”. ACS Applied Nano Materials (2022), 17767–17782.
2. "Conformal Deposition of BxC in High Aspect Ratio Trenches for 3-D neutron detectors", Gourav Kumar, Partha Karar, D S Patil, Arvind Singh, Anita Topkar, R O Dusane Thin Solid Films 720 (2021) 138521
3. "Piezoresistive pressure sensor using nanocrystalline silicon thin film on flexible substrate", V Pandey, A Mandal, S Sisle, MP Gururajan, R O Dusane Sensors and Actuators A: Physical 316, 112372

Professor of Practice

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Education:

- PhD Metallurgy, Univ of British Columbia, Canada, 1992,
- B.Tech Metallurgy, Institute of Technology, BHU, 1983

RESEARCH INTERESTS

- Process Modelling
- Iron and Steel Metallurgy
- Phase Transformation Modelling

Sanjay Chandra

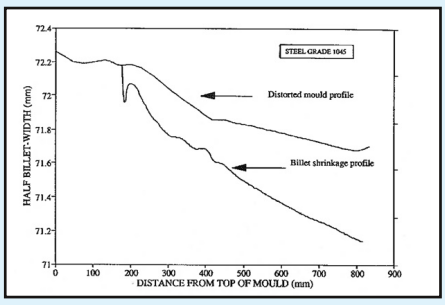
▶TEACHING

Prof. Sanjay Chandra teaches Modelling of Metallurgical Process to postgraduate students and Plant Engineering (a course that illustrates the workings of a manufacturing unit) to dual degree students. He shares the responsibility of Mechanical Testing laboratory (undergraduate) and computational lab (post graduate) with his colleagues. The thrust of the teaching is to bring in computation and quantification to metallurgical processes.

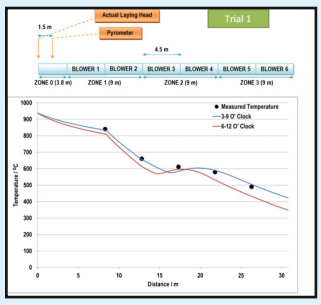
▶RESEARCH PROFILE

Prof. Sanjay Chandra's research interest has been in the area of modelling of metallurgical processes for a steel plant. He has worked on heat transfer and solidification of billets during continuous casting and the design of model tapers that derives from it[1]. New insights into the interplay of mould tapers around the meniscus region and the solidfying steel shell could be gleaned from a combination of mathematical models and plant trials with instrumented billet moulds. Development of a coupled phase transformation and heat transfer during cooling of high carbon wire rods has been used extensively at Tata Steel for quality control as well as upgradation of the wire rod mill[2]. This modelling work also revealed the inade quacies of the Continuous Cooling Transformation (CCT) diagram for predicting phase transformation kinetics during non-isothermal processes. This is of particular importance as the CCT diagrams are often touted to be useful for, and used in, industrial processes. Modelling of cored wire injection into a steel ladle done to optimise the injection parameters for improved alloy recovery during wire injection has been used to set the injection parameters at Tata Steel[3]. This has been able to link the recovery of Calcium, Aluminium to the grade of steel, thickness and carbon content of the casing, wire speed amongst other injection related variables.

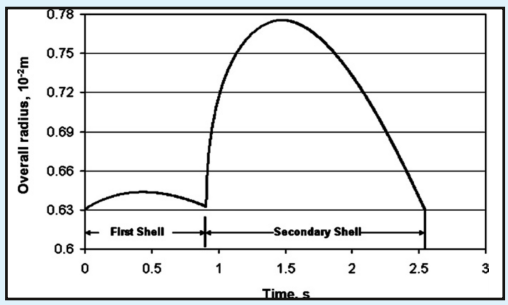
Currently Prof. Chandra is working on prediction of cut-edge corrosion protection of coated steel sheets and recrystallisation kinetics in low-carbon steel using a combination of experiments, numerical techniques and plant trials.



Computed Billet Shrinkage and Distorted Mould Profile



Model Prediction and its Validation for a Wire Rod Mill



Model Predicted increase in Cored Wire Injected into a Steel Melt.

Shobha Shukla

Professor

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Education:

- PhD (Microelectronics, Photonics and Materials) – Dept. of Electrical Engineering, University at Buffalo/SUNY-Buffalo, NY, USA – 2010
- MS (Electrical Engineering with major in photonics & microelectronics – Dept. of Electrical Engineering, University at Buffalo/SUNY-Buffalo, NY, USA – 2008.
- MSc (Electronics) - Dept. of Physics, Lucknow University, Lucknow, UP, India – 2002.

RESEARCH INTERESTS

- Two-photon lithography
- Wastewater treatment
- Biophotonics Plasmonic devices

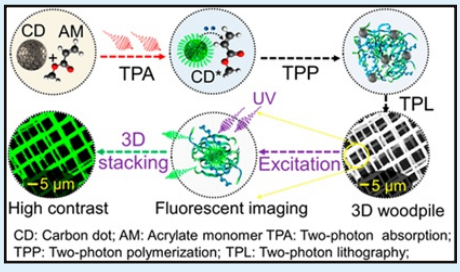
TEACHING

Prof. Shobha Shukla teaches a range of courses, encompassing not only technical but also soft skills. Some of the courses offered by her are-

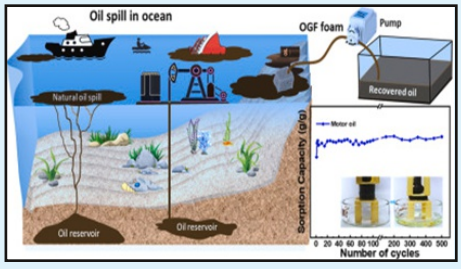
- Vibrational Spectroscopy for Material Scientists
- Laser Processing and nanostructures
- Electrical characterization of Materials
- Communication skills

RESEARCH PROFILE

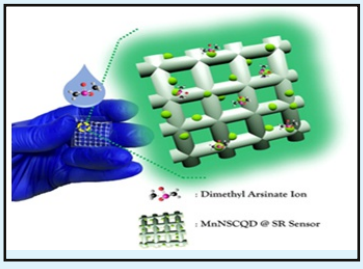
Prof. Shobha Shukla specializes in research areas including 3D/4D micro/nanofabrication using two-photon lithography, wastewater treatment, biophotonics, and plasmonic devices. She collaborates extensively with industry, government, and academic partners, employing both experimental and computational approaches to address global environmental challenges related to air, water, and energy. Recently, her team at IIT Bombay has developed the first additive-free all-carbon composite for patterning of fluorescent micro/nanostructures [1]. Another team is focused on wastewater treatment, using graphene-based porous materials and nanocomposite polymer membranes. They have developed a range of working devices, like Oil Shark_R, Dye Monster, H-MetaS, and Oil Trapper, aimed at resource recovery and water purification [2]. The development of a miniaturized nano- sensor for the detection of the arsenic species in water, is another example of work which lies at the intersection of chemistry, photonics and water quality monitoring. In addition to her research, Prof. Shukla serves as the Center-in- Charge at the Water Innovation Center: Technology Research & Education (WICTRE). She is also an associated faculty member at the IITB-Ohio State Frontier Science and Engineering Research Center. She also serves an an Editorial Board member of 'Scientific Reports' (Nature Publishing Group), 'Journal of Physics-Photonics' and 'Nanotechnology' (IoP Publishing), and the Editorial Advisory Board Member of 'Materials Open Research' by Taylor & Francis. She has also been involved as a Guest Editor for “Thematic issue in Graphene synthesis & patterning” by 'Frontiers in Materials' and a special issue focussed on "Metaphotonics" in 'Journal of Physics-Photonics.”



Two-photon patternable all carbon material system for the fabrication of fluorescent micro/nanostructures [1].



Development of graphene-based materials for oil and organic solvent recovery and water purification [2].



Single-platform device developed for the detection of organo-arsenic species in water [3].

Smrutiranjan Parida

Professor

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Education:

- Ph.D. - University of Saarlandes, Germany - 2007
- M.Tech.-Mals Sci. & Engg., IIT Kharagpur - 2002

RESEARCH INTERESTS

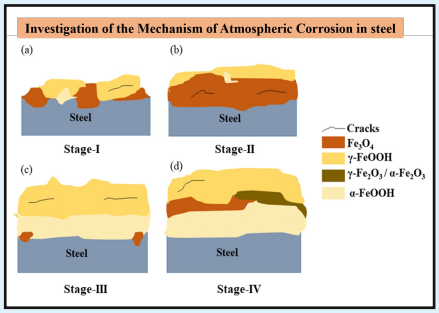
- Corrosion, Multifunctional Coatings,
- Nanomaterials for corrosion protection
- Electrochemical Materials Science

TEACHING

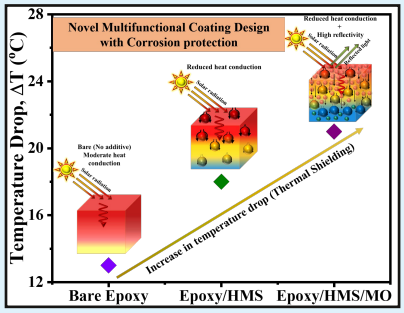
Prof. Parida currently teaches advance level PG courses on aqueous corrosion and coatings. He has taught advance level courses on the electrochemical materials science to PG and Ph.D. students. Courses taught UG and PG levels are Corrosion and Protection of Materials, Thermodynamics and Kinetics of Corrosion, Protective Coatings, Aqueous corrosion and Electrochemical Materials Science. He is also conducting two corrosion labs, each for UG and PG students.

RESEARCH PROFILE

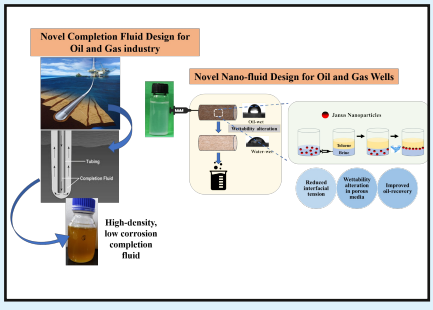
Prof. Parida's research focus is on corrosion, coating and electrochemistry. In corrosion he is focussed on the understanding the mechanism of the atmospheric corrosion in metals and alloy development for the better corrosion protection. He is also focussed on the development and testing of both metallic (galvanized) and organic coatings. He has developed novel Zn-alloy galvanized coatings using indigenously developed hot-dip galvanization simulator. He is also working on the development of multifunctional organic coatings for corrosion protection, low- surface energy and thermal shielding. Prof. Parida has also involved in the development and design of improved materials for oil and gas industry. He has developed and patented an economical, low corrosion, high density, clear completion fluid for HTHP oil wells. Currently, he is working on nanofluids design for EOR, which is focussed on tuning the surface wetting using earth-abundant nanomaterials. Prof. Parida has significantly worked on nanomaterials (nanocarbons, nano-oxides and trimetallic alloys) for electrochemical energy such as supercapacitor and electrocatalyst.



Investigation of the Mechanism of Atmospheric Corrosion.



Novel Multifunctional Coating Design with corrosion protection.



Development and design of improved materials for oil and gas industry.

Somnath Basu

Professor

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Education:

- PhD - Materials Process Science, Royal Institute of Technology, Stockholm, 2007
- M.Tech. -Met. Engg. & Mats. Sci.,, IIT Bombay, 2001
- B.E. - Met. Engg. Jadavpur University, 1998

RESEARCH INTERESTS

- Extraction and refining of metals
- Slag-metal, slag-refractory and metal-refractory interactions
- Thermo-physical characteristics of molten slag
- Continous casting of steel

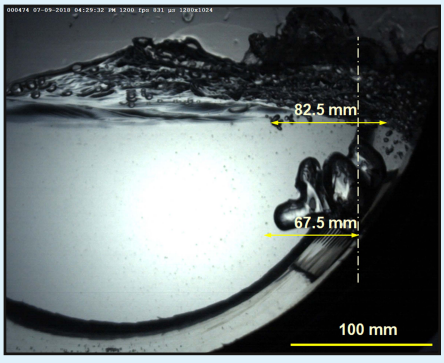
TEACHING

While teaching, Prof. Basu aims to connect the fundamental principles with the real-life applications. The numerical problems, in particular, are designed with data obtained largely from industrial processes. His prior experience of working in the industry (Tata Motors and Tata Steel) helps in identifying suitable application cases.
Some the key courses are:
UG - Principles of extractive metallurgy, iron and steel making PG - Techniques for high temperature experiments

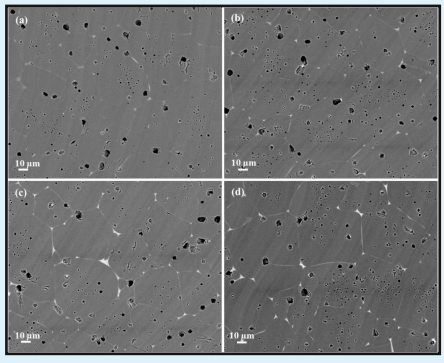
RESEARCH PROFILE

Prof. Basu's research interest lies in the area of metal extraction and refining, primarily production of iron & steel and copper. His takes special interest in design and development of customised experimental facilities to investigate phenomena associated with extraction and refining of metals, and also to explore the thermo-physical behaviour of molten slag and flux.
He has had academic collaboration with Northeastern University (Shenyang, China) and University of Toronto (Canada), as well as collaborative research projects with several industries (ABSTCPL, SAIL, Tata Steel, etc.).

Development of low-fluoride fluxes for ESR processing of alloy steels



Physical simulation of interaction between injected gas and molten copper matte



Development of age-hardenable spinel-magnesia composite oxides

Sudhanshu Mallick

Professor

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Education:

- Ph.D (Mat. Eng.) – Purdue Univ., USA, 2005
- M.S (Elec. Eng.) – Purdue Univ., USA, 2004
- B.Tech (Met. Engg. & Mtls. Sci.) – IIT Bombay, 2000

RESEARCH INTERESTS

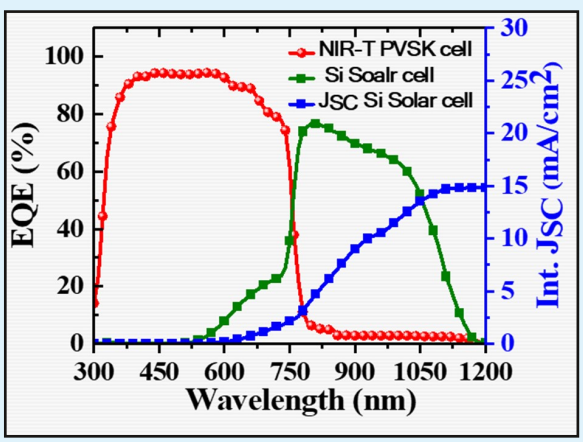
- Photovoltaics
- Recycling
- Coatings
- Encapsulants
- Ceramics and Power Metallurgy

TEACHING

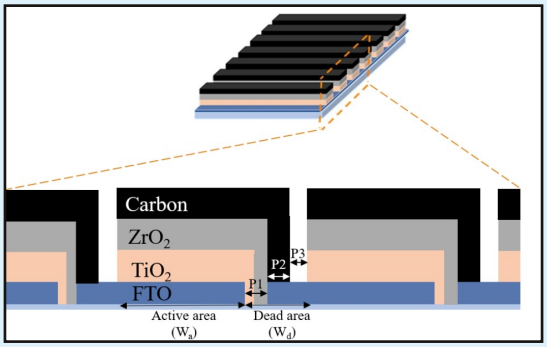
Prof. Sudhanshu Mallick has taught a wide spectrum of courses. Some of them are:
Undergraduate courses – Semiconductor devices and processing, Ceramics and powder metallurgy, Experimental techniques in Materials Science, Thin film lab, Manufacturing processes lab
Postgraduate courses – Electrical and Magnetic Materials, Communication skills

RESEARCH PROFILE

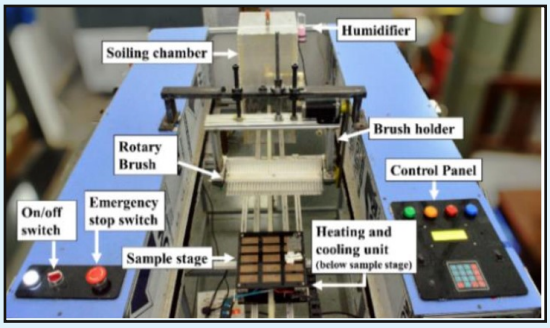
Prof. Sudhanshu Mallick's research interests are in the area of Photovoltaics, Module reliability, Encapsulants, Soiling mitigation strategies as well as Recycling of End-of-life PV modules, Solar cells and other e-waste. His students have demonstrated some remarkable achievements such as – development of 26.03% tandem Perovskite solar cells, large area screen printed solar cells, Qualification of new PV module encapsulants, Development of various accelerated testing tools like artificial dust deposition and cleaning cycle simulator, Rainfall simulator, tool for Quantification of Manual cleaning of PV panels, robust anti-soiling coatings, etc. So far, three of his students have been awarded the award for excellence in Doctoral research award.



IV of 26.03% Perovskite tandem solar cell



Large area screen printed perovskite solar cells



Artificial dust deposition and cleaning cycle simulator

Professor

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Education:

- PhD - Matls. Sci., New Jersey Inst. of Tech., USA, 2010
- MSc. - Physics, IIT Kanpur, India, 2001
- Bsc. - Physics& Mathematics, Bundelkhand University, India, 1999

Sumit Saxena (FRSC, FIMMM, FNESA)

▶TEACHING

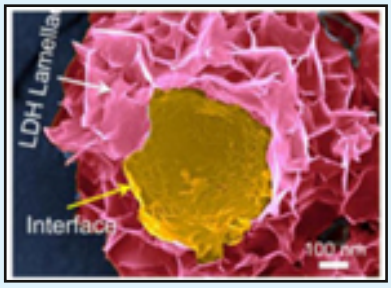
Prof. Saxena has taught courses related to electronic properties and structure along with optimization techniques at undergraduate and graduate level. The recent courses taught by him are
1) Introduction to Ab-inito Methods in Materials Science - PG
2) Simulation and Optimization (UG+PG)

▶ RESEARCH PROFILE

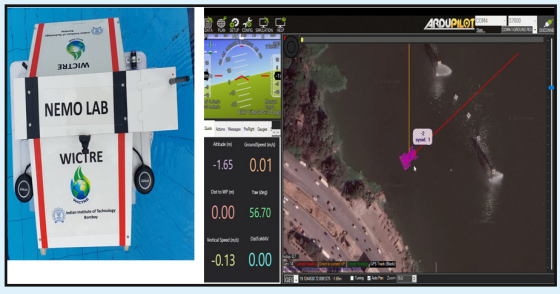
Prof. Saxena has pursued research interests in various areas which has led to breakthrough research in various domains such as discovery of plasmonic effects and extraordinary transmission in microapertures, experimental realization of stanene and is currently involved in developing silicon chemistry in 2D lattices. He has made significant contributions in the area of energy storage devices by developing coronal architectures at nanoscale for hybrid energy storage devices. He has been involved in development of several technologies in the area of water sensing and purification such as development of oil skimmer, development of heavy metal sensors.

RESEARCH INTERESTS

- Energy storage (Super capacitors,
- Sodium ion Batteries,
- Hybrid devices) Water (Purification)
- Sensors (heavy metal, gas) Density Functional Theory AI/ML



Novel coronal nanostructures for hybrid devices



IoT enabled, automated surface water vehicle in action at Powai lake

Portable hand held heavy metal (Hg/As) sensor

References:-

1) S Saxena, RP Chaudhary, A Singh, S Awasthi and S Shukla, "Plasmonic Micro Lens for Extraordinary Transmission of Broadband Light", Scientific Reports 4, 5586 (2014)
2) S Saxena, RP Chaudhary and S Shukla, "Stanene: atomically thick free-standing layer of 2D hexagonal tin", Scientific reports 6 (1), 31073 (2016)
3) SK Kiran, S Shukla, A Struck and S Saxena, "Surface enhanced 3D rGO hybrids and porous rGO nano-networks as high performance supercapacitor electrodes for integrated energy storage devices", CARBON 158, 527 (2020)
4) S Rani, RK Das, A Jaiswal, GP Singh, A Palwe, S Saxena and S Shukla, "4D nanoprinted sensor for facile organo-arsenic detection: A two-photon lithography-based approach" Chemical Engineering Journal 454, 140130 (2023)

Tanushree H. Choudhury

Assistant Professor

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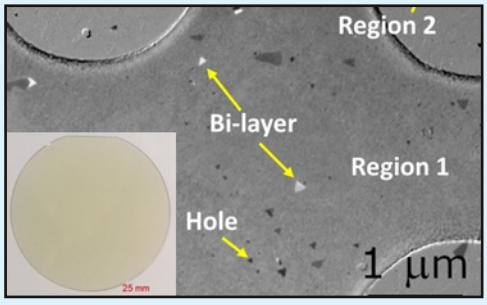
(+91) (022) 2576 7610

Education:

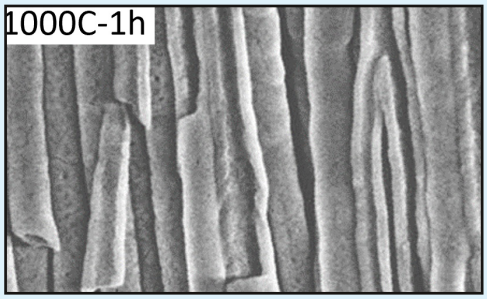
- PhD-Materials Research Centre, IISc, Bangalore, 2014;
- MSc, Materials Science- Anna University, Chennai 2007

RESEARCH INTERESTS

- Layered semiconductor synthesis Nanostructure synthesis
- Wafer scale semiconductor thin film synthesis Process-property correlation for optoelectronics



Wafer-scale WS2 grown by MOCVD



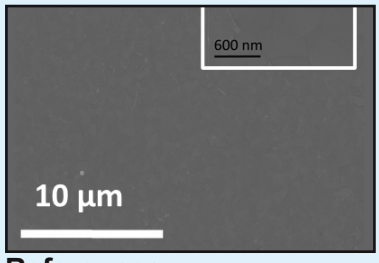
Anodized nanostructured zirconia after 1000C treatment

TEACHING

In her teaching, Prof. Tanushree H. Choudhury gives special emphasis on correlating optoelectronic properties of materials with applications. A few courses taught by her are as follows:
Undergraduate courses: Electronic properties of mate rials, Sensors and Measurements lab **Postgraduate course:** Electrical materials: fundamentals to applications

RESEARCH PROFILE

Prof. Tanushree Choudhury is interested in the processing of electronic materials for optoelectronic applications. She has experience with wafer-scale synthesis of 'near-single crystal' epitaxial layered transition metal dichalcogenides by metalorganic chemical vapor deposition (MOCVD). The key to achieving epitaxial coalesced films was controlling the surface termination of the sapphire substrate.[1,2] The nucleation and growth stages were separated out to achieve larger domains and lower grain boundaries. She is extending this work by introducing defects and modulating composition of these monolayer epitaxial films. She has also been involved in the synthesis of anodized oxide nanostructures on films and as free-standing membranes, where solution treatment can be used to increase the thermal stability of these nanostructures.[3] These anodized nanostructures are ideal candidates for sensing and capacitive deionization. Her group is now exploring the synthesis of air-stable layered materials by solution synthesis which can be used for low power transistors and neuromorphic applications. By controlling the solvent, ambient for crystallization and the nucleation rates, coalesced films of layered molybdenum oxide have been synthesized. Controlling the nucleation rates and suppressing diffusion of species is key to achieving coalesced films of these materials. These coalesced oxide films can now serve as substrates as will used as independent optoelectronic elements. Her research focusses on establishing the processing-property correlation while emphasizing on the mechanism for the microstructure formation.



Coalesced MoO3 films synthesized by solution synthesis

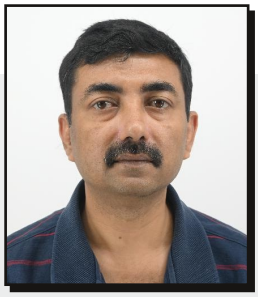
References:

[1] Choudhury, T.H., Zhu, H., Nayir, N., et al. Step engineering for nucleation and domain orientation control in WSe2 epitaxy on c-plane sapphire. Nat. Nanotechnol. (2023).

[2] Choudhury, T.H., Chubarov, M., Wafer-Scale Epitaxial Growth of Unidirectional WS2 Monolayers on Sapphire. ACS Nano, 15, 2, 2532–2541(2021)

[3] Choudhury, T.H. et al. Chemically enhanced thermal stability of anodized nanostructured zirconia membranes, J. Mater. Chem., 22, 6885-6893 (2012)

Titas Dasgupta



Associate Professor

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(+91) (022) 2576 7627

Education:

- PhD - Materials Research Center, IISc, Bangalore, 2007
- MSc(Engg) Materials Research Center, IISc, Bangalore, 2002

RESEARCH INTERESTS

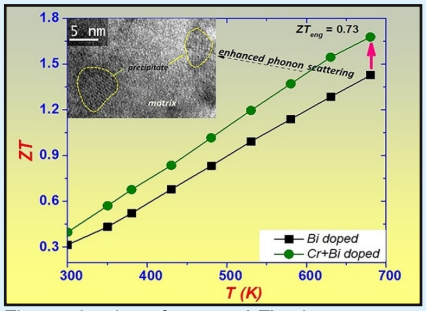
- Thermoelectric materials and devices
- Charge and Heat Transport Modelling in semiconductors
- Thermoelectric metrology and instrumentation

▶TEACHING

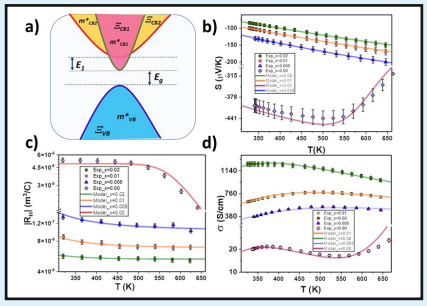
Some courses taught are:
Undergraduate Courses: Electronic Properties of Materials, Instrumentation and Process
Control Postgraduate Courses: Thermo electric Materials, Modelling and Analysis

▶RESEARCH PROFILE

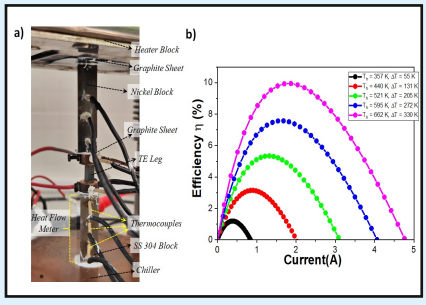
Our research group (Thermoelectric Materials and Devices Lab) is specifically interested in bulk thermoelectric materials for Power Generation. Some of our current research activities are listed below:
a) High performance materials discovery by engineering electrical and thermal properties: Material systems which are currently being investigated are solid solutions of Mg2Si-Mg2Sn, Mg3Sb2-Mg3Bi2 and ZnSb-CdSb. Solid solutions are known to possess better thermoelectric properties compared to the end members. This is due to the possibility for tuning both the electrical and thermal properties by varying the chemical composition. Our work involves improving TE properties in these solid solutions using a combination of conventional techniques and material specific effects identified from our research.
b) Modelling of electronic band structure of thermoelectric materials: Band structure modelling is a topic of interest in TE research as it provides valuable information regarding microscopic material parameters and also for predicting high performance compositions. The modelling work carried out in our group can be subdivided into (i) solution-based approach and (ii) refinement-based optimization approach. We have recently developed a refinement based technique (MBRT) which can handle multiple EBS variables and therefore provide information in TE materials with complex band structures.
c) Thermoelectric device fabrication and measu
rements: Our research also involves development of suitable electrodes (contacting) and fabrication of TE modules from the in-house developed materials and their property measurements. We have developed a generic approach for contacting (multi-layer contacting technique) TE materials and demonstrated a conversion efficiency of up to 10% using the high performance materials developed in our group.



Thermoelectric performance (zT) enhancement due to formation of embedded nano-precipitates in Mg2Si0.3Sn0.7



Estimation of electronic band structure parameters and calculation of thermoelectric properties in Mg2Si using the MBRT technique



Demonstration of 10% conversion efficiency in a single leg Mg3Sb1.5Bi0.5 thermoelectric device

Assistant Professor

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(+91) (022) 2576 7640

Education:

- B.Tech and M.Tech (Dual Degree), MEMS, IIT Bombay 2009
- PhD - Chemical and Materials Engineering, University of Alberta, 2014

RESEARCH INTERESTS

- Metal and Semiconducting Materials for logic/memory device applications Modelling of vacuum processes for thin film deposition and etching
- Atomic Layer Deposition and Atomic Layer Etching (ALD/ALE)
- Lab-to-Fab ALD/ALE process solutions

Triratna P. Muneshwar

▶TEACHING

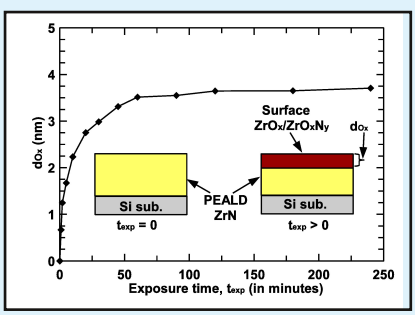
In his teaching, Prof. Muneshwar uses examples from range applications (like modern electronics, biology, sensors, etc) for students to appreciate the underlying fundamental materials science processes.

Some of the courses taught are:

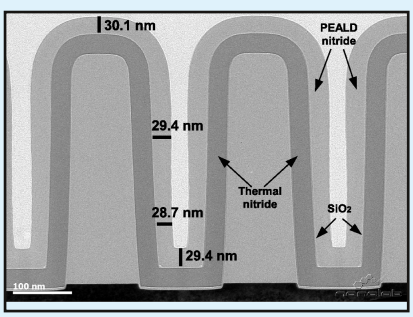
Undergraduate Courses: Kinetics of Processes, Semiconductor Devices and Processing Postgraduate Courses: Experiments Vacuum Thin film Materials Processing Lab

▶RESEARCH PROFILE

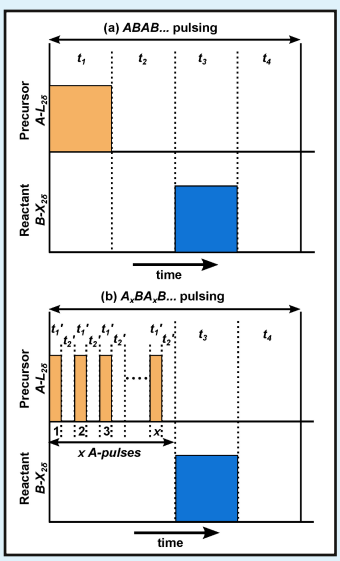
Prof. Triratna P Muneshwar's research interests are in the development of thin film deposition and etching processes for applications in modern semiconductor devices, flexible electronics, Modification of interface layers in fuel-cells and battery. He uses fundamental understanding of the involved steps (precursor/by-product transport under vacuum, surface reactions, surface diffusion, etc,) for rapid development of the novel deposition/etching processes and making existing processes more efficient.



Thickness of surface oxide (dOx) on bare ZrN PEALD film against ambient exposure time (texp) using spectroscopic ellipsometry measurements. ZrN films grown at 150 °C were cooled under vacuum before ambient exposure.



Cross-sectional TEM image of SiNx PEALD film deposited at 100 °C, showing a side-wall step coverage > 95% in a trench structure of aspect ratio 4.5.



Micro-pulsing using AxBAxB... sequence against conventional ABAB... sequence for high throughput ALD processes

References:-

1) T. Muneshwar, K. Cadien, AxBAxB… pulsed atomic layer deposition: Numerical growth model and experiments, J. Appl. Phys. 119 (2016) 085306) [1]

2) T. Muneshwar, K. Cadien, Comparing XPS on bare and capped ZrN films grown by plasma enhanced ALD: Effect of ambient oxidation, App. Surf. Sci. 435, (2018) 367-376) [2]

3) T. Muneshwar, K. Cadien, Resolving self-limiting growth in silicon nitride plasma enhanced atomic layer deposition with tris-dimethylamino silane precursor, J. Vac. Sci. Technol. A. 38 (2020) 062406) [3]

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Education:

- B.Tech (Chem. Engg.) – IIT Guwahati, 2009
- MS (Mats. Sci. & Engg.) – Rensselaer Polytechnic Institute, USA, 2011
- PhD (Matls. Engg.) – Ruhr University Germany, 2017

RESEARCH INTERESTS

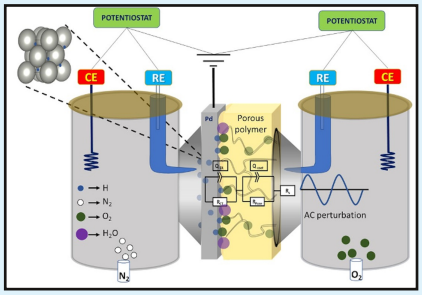
- Hydrogen electrochemistry
- Organic coatings and Electrochemical Impedance Spectroscopy
- Stress Corrosion Cracking
- Scanning Kelvin Probe

▶TEACHING

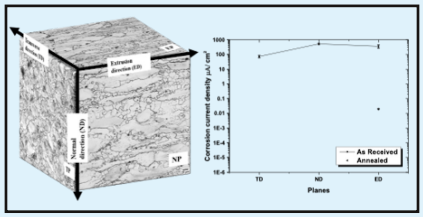
Prof. Vijay emphasizes on mechanistic understanding of corrosion phenomena relevant to metallic materials to develop environmentally stable alloys for addressing pressing global energy needs.
Courses taught are
Undergraduate – Corrosion and Protection of Materials (Theory and Lab) **Graduate –** High Temperature Corrosion, Corrosion Lab

▶RESEARCH PROFILE

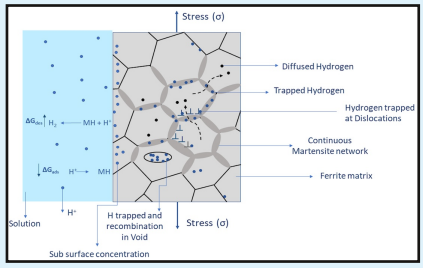
Prof. Vijay' research interests are in the development of techniques for quantification of corrosion rate. Using principles of electrochemical hydrogen sensing combined with classical impedance spectroscopy a novel technique to screen polymer coatings for corrosion protection was developed [1]. As part of IITB-Monash Academy, with Prof. MJNV Prasad and Prof. Raman Singh (Monash), current work focusses on understanding the effects of microstructure and stress on corrosion of bio-degradable magnesium alloys for temporary human implant applications [2]. As part of the Start-up Research Grant (SRG) funding provided by Science and Engineering Research Board (SERB), India development of a novel in-situ electrochemical hydrogen permeation setup to work in tandem with tensile stress application to identify hydrogen and stress effects on failure of dual phase steels with defined microstructure relevant for the automobile industry is ongoing [3].



Hydrogen potentiometry and impedance spectroscopy for quantifying organic coating corrosion rate



Microstructure effects along different planes of extruded ZK60 alloy on corrosion rate in 3.5 wt % NaCl



Novel tensile testing with in-situ hydrogen permeation to determine failure of dual phase automobile steels

References:-

1. Combined Hydrogen Potentiometry and Electrochemical Impedance Spectroscopy Approach for Quantification of Oxygen Reduction Kinetics at Buried Metal/Organic Coating Interfaces, Rasmi Ranjan Tripathy and Dandapani Vijayshankar. J. Electrochem. Soc. , 170(5), 051501 (2023). https://doi.org/10.1149/1945-7111/accf3c
2. Electrochemical Corrosion Resistance of Mg Alloy ZK60 in Different Planes with Respect to Extrusion Direction, Keerthiga G, Vijayshankar D, Prasad M, Peron M, Albinmousa J, Singh Raman R. Metals. 2022; 12(5):782. https://doi.org/10.3390/met12050782
3. In-situ tensile testing for understanding hydrogen induced failure of high strength dual-phase ferrite-martensite steels. Sudha Gautam and Dandapani Vijayshankar (In preparation)

Viswanathan N Nurni

Sajjan Jindal Steel Chair Professor

vichu@iitb.ac.in

(+91) (022) 2576 7611

Education:

- PhD, Metallurgy, IISc, Bangalore, 1997
- ME(Integrated) - Metallurgy, IISc, Bangalore - 1992
- BSc - Phy - Govt. Victoria College, Palakkad - 1988

RESEARCH INTERESTS

- Process Modeling
- Iron and Steel Making (Sustainable and Green)
- Process Metallurgy

TEACHING

In his teaching, Prof. Viswanathan N Nurni gives special attention to quantitative and computational approaches taking examples from materials processing.

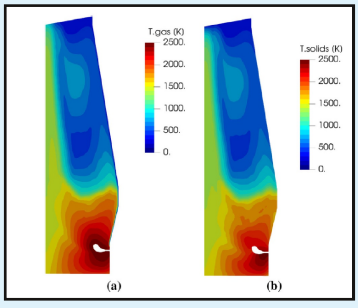
Some courses taught are:

Undergraduate Courses - Thermodynamics of Materials, Transport Phenomena & Kinetics, Iron and Steel Making

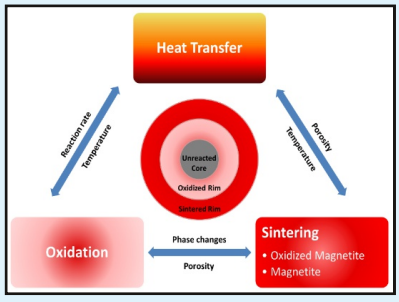
Postgraduate Courses - Advanced Concepts in Iron Making, Advanced Concepts in Steel Making, Simulation and Optimization.

RESEARCH PROFILE

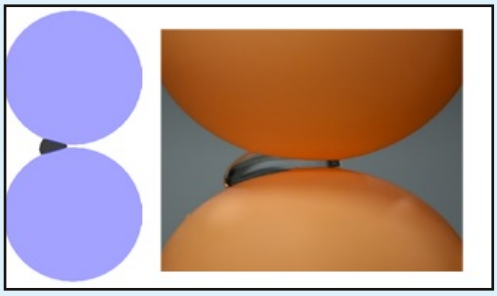
Prof. Viswanathan N Nurni research interests are in the area of Modeling & Simulation of Iron and Steel Making Processes. He uses the principles of Materials Thermodynamics, Fluid Flow, Heat & Mass Transfer and Chemical Kinetics in conjunction with AI/ML techniques to develop process models. He works closely with steel industries towards decarbonization that can gradually lead to more green and sustainable steel making. During his tenure as LKAB Chair Professor at Lulea University of Technology, Sweden he developed a Single Pellet Induration Model (SPIM) in collaboration with LKAB[1]. In collaboration with Tridiagonal Pvt. Ltd., Pune and Tata Steel, he developed a 2-D comprehensive model for blast furnace (BlaSIM) using open source CFD tool, Open FOAM[2]. His team at IIT Bombay has looked into the fundamental aspects of static hold up in the dripping zone of blast furnaces which can help in improving the productivity of blast furnaces[3]. Recently, under his leadership, a JSW Technology Hub for Steel Manufacturing has been established at IIT Bombay.



BlaSIM – 2-D Comprehensive Blast Furnace Simulation Model in Open FOAM in collaboration with Tata Steel and Tridiagonal Solutions [1]



Single Pellet Induration Model (SPIM) [2]



Fundamental insight into the Static Holdup in Packed bed such as Blast Furnace Dripping Zone [3]

References:-

[1] Abhale, Prakash; Nag, S. ; Bapat, Yogesh ; Kulkarni, A.; Nurni, Viswanathan; and Padmapal,. (2022). Development of 2D Steady-State Mathematical Model for Blast Furnace Using Open FOAM. Metallurgical and Materials Transactions B, DOI: 10.1007/s11663-022-02610-6

[2] T. K. Sandeep Kumar , N.N. Viswanathan , A. Ericsson , C. Andersson , and H. Ahmed, Development of Single Pellet Induration Model for Magnetite Pellet: A Holistic approach, (2023), Metallurgical and Materials Transactions - B DOI:10.1007/s11663-023-02879-1

[3] S. Snigdha, Viswanathan N N and N. B. Ballal “Fundamental insight into the dripping criteria of slag and hot metal in a coke bed using energy minimization model”, Metallurgical and Materials Transactions , 2021, pp. 2829-2842. https://doi.org/10.1007/s11663-020-01943-4

Ajit Kulkarni

Emeritus Fellow

Email: ajit.kulkarni@iitb.ac.in

Solid Electrolytes: Sensors and Batteries,

Nano materials: Synthesis, electrical properties of nanocomposites, Nano Phosphors and UV filters for Cancer protection, Electro ceramics: Dielectric Ceramics and Thin Films and devices, synthesis structure property correlations in materials. Resulted in 8 patents and Technology transfer, Visiting Professor Universities, abroad, Member of several National funding agencies and monitoring committee strategic projects. Member of the board and Governing council on engineering and Technical Institutes

1. Teaching :

Methods of Synthesis, Characterization of Materials, Thermal Properties of Materials, Materials for Electronic and Electrical Applications, Concepts in Materials Science, Non-Crystalline Materials, Physics of Materials, Electrical Characterization of Materials, developed teaching laboratory for DD Ceramics and Composites

Technical : Solid Electrolytes: Sensors and Batteries, Glasses, Polymer Gels,

Nano materials: Synthesis-electrical properties of CNT-polymer nanocomposites, Nano Phosphors and UV filters for Cancer protection,

Electro ceramics: Dielectric Ceramics and Thin Films and devices, synthesis-structure-property correlations in materials

Bhanumurthy Karanam

Adjunct Professor

Email: kbhanumurthy@iitb.ac.in

Advanced Joining processes

Phase Transformations in Metals and Alloys

Teaching several courses for undergraduate and graduate students in the area of materials joining, diffusion in solids and phase transformations

Carlos Tome

Distinguished Visiting Professor

Email: tome@lanl.gov

Materials Science in Radiation and Dynamic Extremes Group (MST-8), Materials Science and Technology Division - MS G755, Los Alamos National Laboratory - Los Alamos - NM 87545 USA Elastic, plastic, viscous and thermal properties of single crystals and polycrystal aggregates.

Constitutive models for simulating plastic forming, texture development, elasto-plastic response, internal stresses, and creep of polycrystals, based on physical mechanisms (scale bridging paradigm).

Prediction of mechanical properties and mechanical response of polycrystalline aggregates as a function of deformation rate, temperature, pressure and irradiation conditions.

Dinkar S. Patil

Adjunct Professor

Email: dspatil@iitb.ac.in

(1979-2014) 35 years of Research Experience at Bhabha Atomic Research Center, Trombay, Mumbai 400085.
Last position held: Senior Professor
Senior Professor, Homi Bhabha National Institute,
Outstanding Scientist and Head, Plasma Processing Section, Laser and Plasma Technology Division, Bhabha Atomic Research Center, Mumbai

(1989-91) Research Scientist in the Institute of Materials Processing at Michigan Technological University, Houghton, Michigan 49931 (U.S.A.).

(2000-2001) Guest Scientist, Technical University Munich, Germany

Teaching:

MM 724: Plasma Processing of Materials, MM 731: Experiments in Advanced Materials Processing (Lab), MM 426: Process and Equipment Design Lab , MM 448: Thin Films Lab

Research Interests and Areas of Expertise:

Plasma Processing of Materials, Surface Engineering and Thin Films, Diamond / Diamond Like Carbon thin films, Plasma Enhanced Metal Organic Chemical Vapour Deposition (MOCVD), Atmosheric Pressure Plasma Jets for Cleaning / Decontamination, Development of Nanocrystalline Superhard Composite Coatings, Microwave Sintering of Ceramics / Microwave Processing of Materials, Bioceramic Coatings, Ceramic Matrix Composites, Electronic Ceramics.

Donald McNaughton

Visiting Professor

Email: Donald.McNaughton@monash.edu

Prof. McNaughton is an emeritus professor of molecular sciences in the school of chemistry and a member of the centre for biospectroscopy, Monash University.

His main interests are : Infrared and Raman spectroscopy and spectroscopic imaging directed to understanding the molecular basis of biological systems; microwave and high resolution infrared spectroscopy directed at characterizing transient species, atmospheric species and interstellar molecules; synchrotron infrared spectroscopy. He teaches a course on Spectroscopy at IIT Bombay.

Hina Gokhale

Adjunct Professor

Email: hinagokhale@iitb.ac.in

Statistics Data Analysis and Interpretation AI/ML

Application of Statistics and AI/ML in Metallurgy

Nirdosh K Khosla

Adjunct Professor, Professor at IIT Bombay

Email: n.khosla@iitb.ac.in

Mineral processing, Instrumentation

Rajarshi Banerjee

Visting Professor

Email: rajarshi.banerjee@unt.edu

Dr. Rajarshi Banerjee is the University Presidential Professor at the Dept. of Materials Sci. and Engg. Denton, University of North Texas

Titanium and Its Alloys, Nickel Based Superalloys, Metal Matrix Composites and Metallic Thin Films.

V S Raja

Emeritus Fellow

Email: vsraja@iitb.ac.in

Structure-Property-Corrosion Correlation, Stress Corrosion Cracking, Protective Coatings, Weld-Corrosion, Advanced Ultra Super Critical Oxidation and Industrial Consultancy

Taught several courses including Aqueous Corrosion and Its Control, Advances in Design and Control of Corrosion, Cathodic Protection, Industrial Corrosion and Control, Characterization of Materials for Corrosion Control, Electrochemical Materials Science and Materials Science for Corrosion Engineers

Ajay Kumar

Email: kumarajay@iitb.ac.in

Laboratories/Offices:

Dual beam FIB SEM lab and TEM sample preparation lab

Skills/Responsibilities:

TEM lamella preparation, FIB cross section imaging, nanofabrication via FIB, TEM sample preparation of all bulk materials.

Amit Joshi

Email: amitjoshi@iitb.ac.in

Laboratories/Offices:

Ferrous process laboratory, Clean steel lab, Transit building lab, High temperature microscopy lab, Metal forming lab, Process visualisation lab.

Skills/Responsibilities:

Design/Fabrication of expt. setups, Foundry, Electroslag Refining, Sintering iron ore, Induction melting, Salt bath, Rolling, Iron ore reduction with H2, Metal casting, Frugal engineering, etc.

Anil Gaikar

Email: anilgaikar@iitb.ac.in

Laboratories/Offices:

Workshop

Skills/Responsibilities:

I am doing work PG, UG, M Tech, PHD students work

Ankush Gangaram Tambitkar

Email: ankusht@iitb.ac.in

Laboratories/Offices:

Ferrous Process Lab (F2 Shed)

Skills/Responsibilities:

I operate Letches Machine, Drill Machine, Shaping, Milling, Grinding, Induction furnace, Brazing, Centring, ESR, Fabrication work and Making heating furnace.

Deepak Moreshwar Kharkar

Email: deepakk@iitb.ac.in

Laboratories/Offices:

Associated with Laboratories

Skills/Responsibilities:

Laboratories experiment setups, Laboratories equipment maintenance, Examination Invigilation, Electronic circuits related help for students, etc.

Haresh Sham Nevarekar

Email: anandi@iitb.ac.in

Laboratories/Offices:

Corrosion Teaching lab,Coating Lab,GDOES Lab

Skills/Responsibilities:

Help the M.Tech and Research Scholars students to conduct the DD Lab(MM-462) and M.Tech Lab (MM-699). Handle and Maintain the instruments of Laboratory.

Hitesh Thakur

Email: hitesht@iitb.ac.in

Laboratories/Offices:

X-ray Lab

Skills/Responsibilities:

1) To operate the XRD Instrument in XRD lab
2) Dept. exam time table formulation & conducting Mid and End Sem. Examination.

Kritharth Krishnan

Email: kritharthkrishnan@iitb.ac.in

Laboratories/Offices:

Instrumentation Lab, HPC Server Cluster, Computation Lab

Skills/Responsibilities:

System Administration, ECE Lab Demonstrator, HPC Cluster server, Mail server, Computer Hardware and Networking

Meena Vinayak Sadalgekar

Email: meena123@iitb.ac.in

Laboratories/Offices:

Junior Supdt., Dept. Office, Metallurgical Engineering & Materials Science Dept.

Skills/Responsibilities:

Faculty Recruitment (External candidates), Internal Faculty Promotion of Associates & Professors' including Emeritus Fellow, Chair Professorship & HAG, Visiting Faculty Recruitment, Post-Doc Recruitment (Internal, External & N-PDF), Meetings of above

Naresh R Ingale

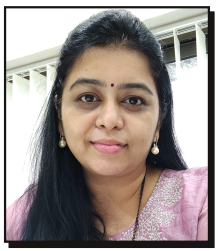
Email: naresh1978@iitb.ac.in

Laboratories/Offices:

Department Stores

Skills/Responsibilities:

Departmental purchase work as well as students TA claim



Neelam Bhatkar

Email: neel_9@iitb.ac.in

Laboratories/Offices:

Heat Treatment and Metallography Lab. High Temperature lab, Nano Indentation lab.

Skills/Responsibilities:

Optical Microscopy, Stereo Microscopy and Image Analyzer. MICRO and MACRO hardness, BULK Hardness, NANO Indentation, Dilatometer, High Temperature Muffle Furnaces, High Temperature Vacuum Furnace, BTech and MTech Semester Practical Laboratory.

Prakash Govind Ishte

Email: prakash007@iitb.ac.in

Laboratories/Offices:

Transmission Electron Microscopy Lab

Skills/Responsibilities:

Trained in Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM), Thermal Analysis (DSC,TGA,DTA), Metallography and Optical Microscopy

Prashant D Shinde

Email: 10001908@iitb.ac.in

Laboratories/Offices:

Workshop

Skills/Responsibilities:

1) Sample preparation for experimental works (Tensile, Compression, Notch making)
2) Cutting, drilling of the bulk samples into small pieces as per the students requirement

Pritee Rahul Navghare

Email: pritee.navghare@iitb.ac.in

Laboratories/Offices:

Materials Characterization Lab II, Dual Vacuum HR SEM, LFA Thermal Conductivity Facility

Skills/Responsibilities:

- Scanning Electron Microscope, FEG SEM with EDS and EBSD
- Thermal Analysis(TG-DTA/TG-DSC/DSC/TGA)
- Laser Flash Analyser Thermal Conductivity Facility

Rajib Kumar Barik

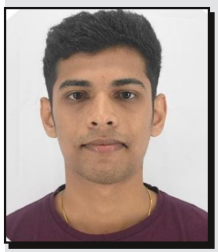
Email: rajibkb@iitb.ac.in

Laboratories/Offices:

Associated with all Departmental Laboratories as well as Offices

Skills/Responsibilities:

Technical Skills in Electrical Maintenance, Laboratories experimental set up, equipment maintenance, Soldering, Thermocouple welding.



Rajnish Kharat

Email: rajnishkharat@iitb.ac.in

Laboratories/Offices:

Department Office

Skills/Responsibilities:

Department purchase work and handling the administration related activities

Sachin S. Talashilkar

Email: neel_9@iitb.ac.in

Laboratories/Offices:

Electronics Workshop
Organizing and Assisting in UG labs:-MM103,EE209,MM221,MM435

Skills/Responsibilities:

Electronics Workshop: -
1] Setting up an Electronic workshop to provide support for various academic and research activities to PhD, M.Tech& Undergraduate Students in their research projects.
2] Preliminary Instrument /Equipment Maintenance
3] Purchasing Of Electronic, Electrical, and Computer related items /accessories Items from market.

Teaching Experience (Undergraduate Laboratories) :-
1] Demonstrated Laboratories to Undergraduate (U.G.) Students for past 20 years. (50+ U.G. labs)
2] Laboratories Associated With are :- MM103,EE209,MM221,MM435
3] Development of Experiments and Procedural manuals
4] Creation and deployment of training methodologies and programs to Teaching Assistant.

Other Technical & administrative and duties as assigned by Head of Department.

Sangeeta Ashok Shirole

Email: neel_9@iitb.ac.in

Laboratories/Offices:

Heat Treatment and Metallography Lab, High Temperature Lab

Skills/Responsibilities:

Multiskilled Assistant

Santhos P Naik

Email: santoshn@iitb.ac.in

Laboratories/Offices:

Mechanical Characterization Lab

Skills/Responsibilities:

1) Mechanical Characterization instruments (UTM, Hardness, Impact, Torsion, Creep, rolling mill, Wear test).
2) Technical supporting staff for B.Tech. and M. Tech. lab course.
3) Technical support for Ph.D. experiments.
4) Experimental for external colleges (Dental and Engineering colleges).
4) Lab related billing and maintenance works.

Sneha Suresh

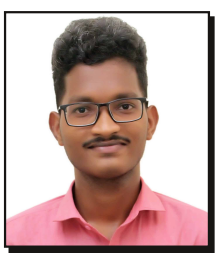
Email: snehas@iitb.ac.in

Laboratories/Offices:

MEMS Department office

Skills/Responsibilities:

Handling UG & PG Academic activities.



Yash Vinod Dalvi

Email: yash.dalvi@iitb.ac.in

Laboratories/Offices:

MEMS Department Office

Skills/Responsibilities:

As a administrative staff in MEMS department office, I handle the academic related tasks and operations.

Metallurgical Engineering and Materials Science

IIT Bombay