Overview of the department

Metallurgical Engineering & Materials Science

Indian Institute of Technology Indore

https://mems.iiti.ac.in/

About IIT Indore

- Inception in **2009**
- Students in UG, PG, and PhD Programs: **2700+**
- Departments: **12**
- Centers: **8**
- Faculty Members: **208+**
- Post doctoral fellows: **40+**
- Ph.D. Students: **600+**

https://iiti.ac.in/

~450th QS WORLD UNIVERSITY RANKINGS

14th nirf ENGINEERING INDIA, 2023 NATIONAL INSTITUTIONAL RANKING FRAMEWORK

Departments

Engineering

- Astronomy, Astrophysics, Space Engineering
- Bio-sciences and Biomedical
- Computer Science
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering
- Metallurgical Engineering and Materials Science

Programs offered:
B.Tech.
B.Tech.+M.Tech.
B.Tech.+M.Tech.+PhD.
M.Tech.
MS (Research)
Ph.D.

Science

- Chemistry
- Physics
- Mathematics

Programs offered:
MSc.
MSc.+PhD
PhD

Humanities

- Economics
- English
- Philosophy
- Psychology
- Sociology

Programs offered:
MS (Research)
PhD

Academic Programs @IIT Indore

Bachelor of Technology (B.Tech.)

- Computer Science and Engineering
- Electrical Engineering
- Mechanical Engineering
- Civil Engineering
- Metallurgical Engineering and Materials Science
- Chemical Engineering
- Mathematics and Computing
- Engineering Physics
- Space Science and Engineering

Master of Technology (M. Tech.)

- Communication and Signal Processing
- VLSI Design and Nanoelectronics
- Advanced Manufacturing (AM)
- Thermal Energy Systems (TES)
- Mechanical Systems Design
- Materials Science and Engineering
- Metallurgical Engineering
- Electric Vehicle Technology
- Space Engineering
- Computer Science and Engineering
- Water Climate and Sustainability
- Biomedical Engineering
- Applied Optics and Laser Technology
- Structural Engineering
- Defence Technology

Master of Science (MSc.)

- Chemistry
- Biotechnology
- Physics
- Mathematics

M S (Research)

- CSE, EE
- ME, ASE and HSS

MSDSM offered by IIT Indore and IIM Indore

Global Cooperation

- **90+** MoUs signed across the globe
- **35+** Bilateral research grants with foreign institutes
- **200+** international publications
- **75+** GIAN Projects
- **20+** Projects SPARC, VAJRA and ASEM-DUO

https://ir.iiti.ac.in/#/

Metallurgical Engineering & Materials Science

Indian Institute of Technology Indore

Academic Programs @ MEMS, IIT Indore

PhD Admission process

Our PhD program provides an exceptional opportunity for aspiring researchers and scholars to contribute to the field of metallurgical engineering and materials science through cutting-edge research and innovation. Minimum educational Qualifications (MEQs) and Qualifying Examination for Indian applicants criteria:

Master's degree (M.Tech. or M.E. or MS) in Metallurgy/ Materials Science and Engineering/ Mechanical/ Manufacturing/ Production Engineering/ Nanotechnology/ Engineering Science/ Engineering Physics/Ceramics Engineering/ Electronics/ Chemical Engineering/Energy Science and Engineering (with first division as defined by the awarding Institute/ University) AND GATE qualified.

OR

Master's degree (M.Sc.) in Chemistry/ Physics/ Materials Science/ Electronics/ Nanoscience and Technology/Forensic Science (with first division as defined by the awarding Institute/ University) AND GATE qualified with a valid score card OR valid UGC-JRF/CSIR-JRF/DST Inspire fellowship/other equivalent Fellowship

OR

B.E./ B.Tech. degree in Metallurgy/ Materials Science and Engineering/ Mechanical/ Manufacturing/ Production Engineering/ Nanotechnology/ Engineering Science/Engineering Physics/Ceramics Engineering/ Electronics/ Chemical Engineering/Energy Science and Engineering (with first division as defined by the awarding Institute/ University) AND GATE qualified with a valid scorecard

(Please refer to the main page on our academic portal Link: https://academic.iiti.ac.in/phdadvt.php for more details)

PhD Program

- **Institute-funded** international & national conference.
- **Financial suppor**t to work abroad up to 3 months.
- Opportunity to apply for Prestigious Fellowships such as PMRF, OVDF, DAAD, etc.
- Student driven activities: Student Symposia, scientific chapters etc.
- Several inhouse high-end research facilities.
- Young and dedicated faculties.

Ph.D. Students

55 No of Ph.D. Completed

06 PMRF fellows

46 Ongoing PhD

4.5 Year Average time of completion

M.Tech. Program

- **M. Tech.** in Materials Science and Engineering

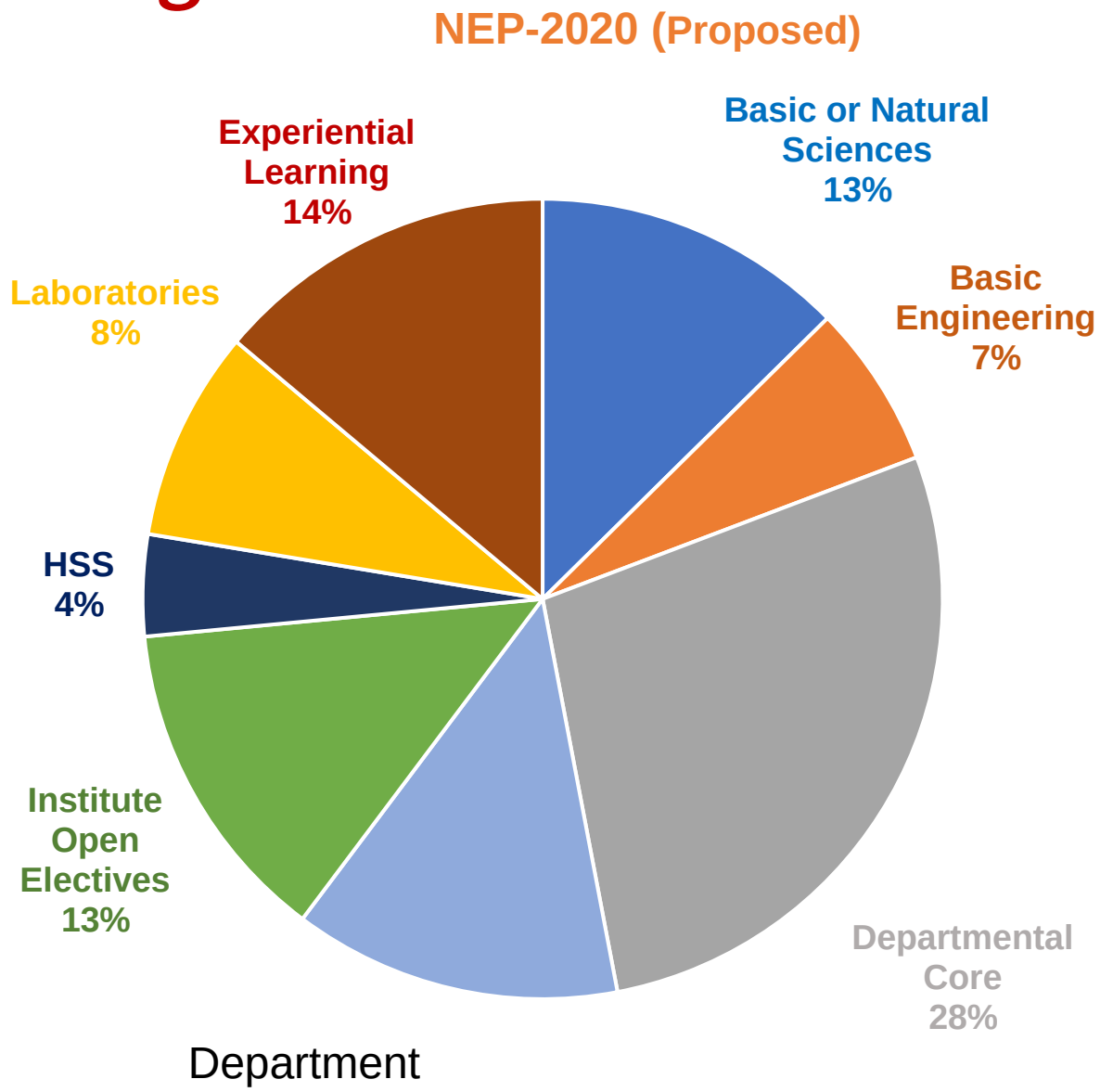
Four-year bachelor's degree or **five-years integrated degree** (with the first division as defined by the awarding Institute/University) in *Materials Science/ Physics/ Chemistry/ Nanoscience/ Nanotechnology/ Engineering Science/ Engineering Physics/ Metallurgy Engineering or* **two years master's degree** *in Chemistry/ Physics/ Material Science/ Nanoscience/ Nanotechnology."* Relaxation of 5% in qualifying degree is applicable for SC and ST category applicants.

- **M. Tech.** in Metallurgical Engineering

Four-year Bachelor's degree or five-year integrated degree (with first division as defined by the awarding Institute/ University) in either in *Metallurgy/ Materials Science and Engineering/ Mechanical/ Manufacturing/ Production Engineering. Relaxation of 5% in qualifying degree is applicable for SC and ST category applicants.*

- *Research Driven Courses*
- *Financial Support for Conferences & Projects*
- *Opportunities for networking, seminar participation, extracurricular engagement and industry interactions.*

B.Tech. Program



- **FLEXIBLE COURSE STRUCTURE**
- **Experiential Learning Based Program**
- **Options for Minor Porgrams**

Experiential learning includes: BTP+ Makerspace + Internships

Research Themes

- Energy & Environmental Materials
- Alloy Design, Development & Deformation
- Electronic & Photonic Materials
- Materials Degradation & Surface Engineering
- Nanomaterials & Soft-materials
- Diffusion & Phase Transformations

2016 *Established*

21 *Faculty*

4 *Academic programs*

40+ *Projects*

251 *Students [43 PhDs]*

450+ *Publications*

Metallurgical Engineering & Materials Science

Indian Institute of Technology Indore

https://mems.iiti.ac.in/

Faculty @ MEMS, IIT Indore


Abhijit Ghosh


Ajay Kumar Kushwaha


Chandan Halder


Dhirendra Kumar Rai


Dudekula Althaf Basha


Eswara Prasad Korimilli


Hemant Borkar


Jayaprakash Murugesan


Khushubo Devi


Mrigendra Dubey


Nisheeth Kumar Prasad


Parasharam M. Shirage


Ram Sajeevan Maurya


Ranjith Kumar Poobalan


Rupesh Devan


Santosh Hosmani


Sumanta Samal


Sunil Kumar


Venkata Vamsi Koruprolu


Vinod Kumar

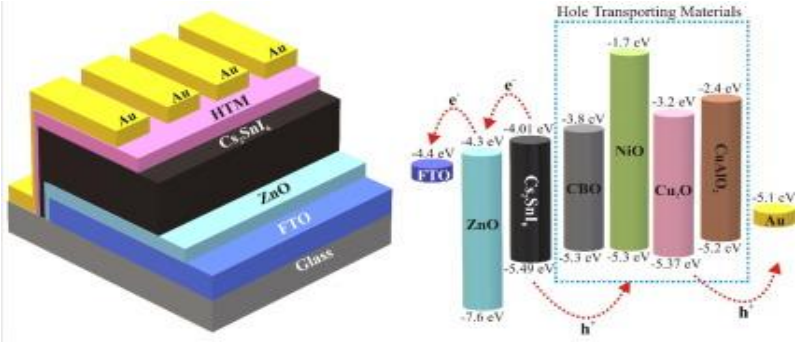

Vivek Verma

https://mems.iiti.ac.in/

Energy, Environmental Materials & Sustainability

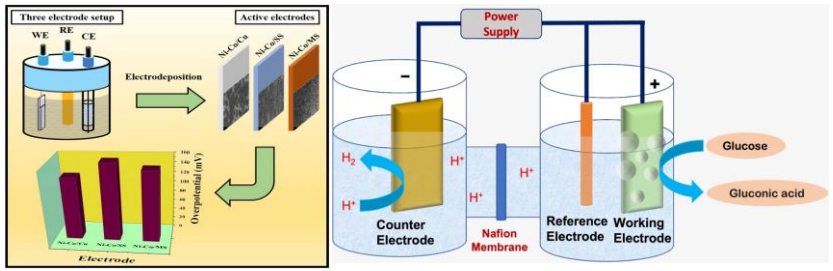
Energy Conversion

New generation Solar Cells



Devan et al., ***Solar Energy*** 256 (2023) 76-87
Devan et al., ***J. Materials Chemistry C*** 10 (2022) 15725
Shirage et al., ***Electrochimica Acta*** 441 (2022) 141793
Shirage et al., ***Optical Materials*** 124 (2022) 112066
Kushwaha et al., ***J Mater Sci: Mater Electron*** 33 (2022) 17404

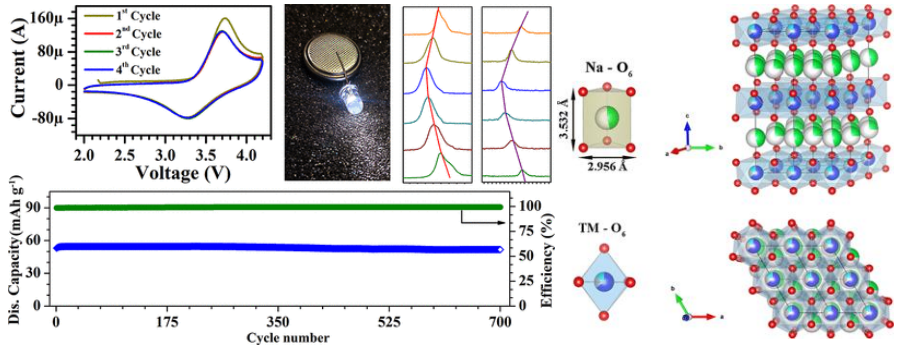
Green Hydrogen Production: *EC &PEC*



Kushwaha et al., ***Electrocatalysis*** 14 (2023) 68
Kushwaha et al., ***J. Alloys and Compounds*** 928 (2022) 167127
Kushwaha et al., ***Int. Journal of Hydrogen Energy*** 46 (2021) 34689
Devan et al., ***Int. Journal of Hydrogen Energy*** 47 (2022) 39018

Energy Storage

Batteries & Supercapacitors



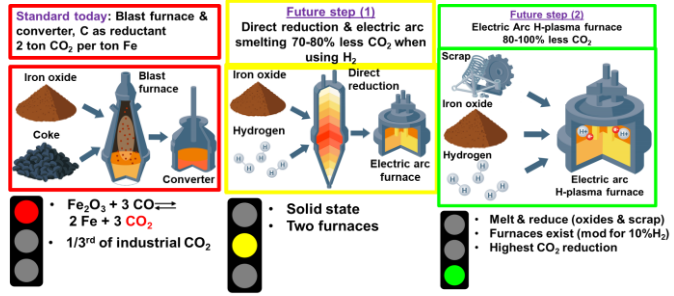
Sunil et al., ***ACS Appl. Energy Mater.*** 6 (2023) 2440
Sunil et al., ***Journal of Energy Storage***, 64 (2023) 107242
Shirage et al., ***Applied Surface Science*** 615 (2023) 156352
Shirage et al., ***RSC advances*** 12 (2022) 23284
Rai et al., ***Electrochimica Acta*** 441 (2023) 141825
Rai et al., ***Journal of Energy Storage*** 43 (2021) 103301

Sensors, Electrocatalysis & CO_2 Captures

Rai et al. ***Chemnanomat***, 2023, DOI: 10.1002/cnma.202200519
Rai et al, ***Journal of CO2 Utilization***, 2021, (49), 101575.

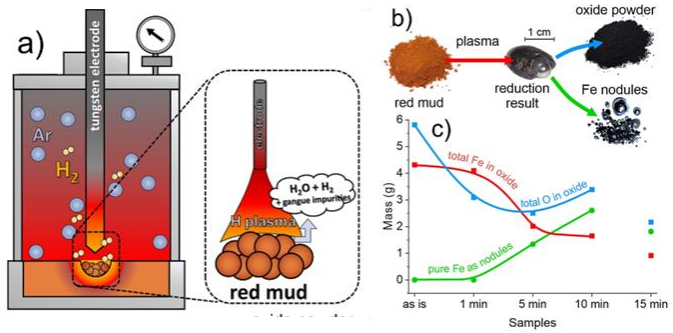
Green Metallurgy

Hydrogen based Reduction: Green Steel



D. Raabe et al, ***Nature*** 575 (2019) 64–74
Souza Filho et al, . ***Acta Materialia*** (2021)., 213, 116971.

Recovery of Industrial Metals from Low-Grade Iron Ore



Prof. P. M. Shirage, Dr. Sunil Kumar, Prof, Rupesh Devan, Dr. Ajay K. Kushwaha, Dr. Dhirendra K. Rai & Dr. Khushubo Devi

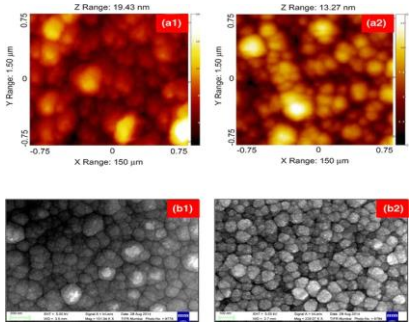
Electronic and Photonic Materials

Wide Band Gap Semiconductors: Metal Oxides, Chalcogenides, Gallium Nitride, Silicon Carbide

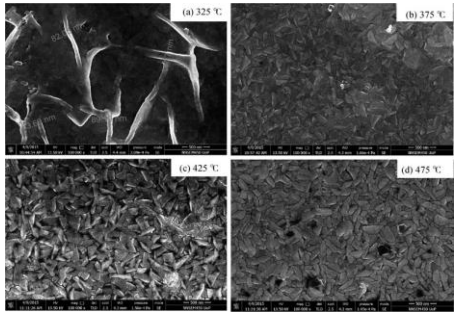
Thin Films Deposition

- DC Sputtering, Chemical Vapor Deposition
- Electrodeposition, Chemical bath Deposition

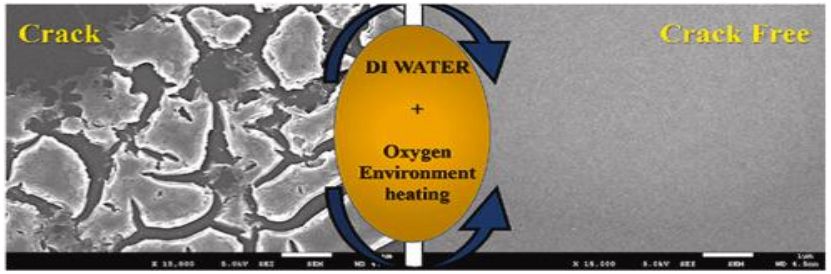
CVD deposited SiC film



Spray pyrolysis deposited CdS



Chemical bath Deposited Ga_2O_3 films

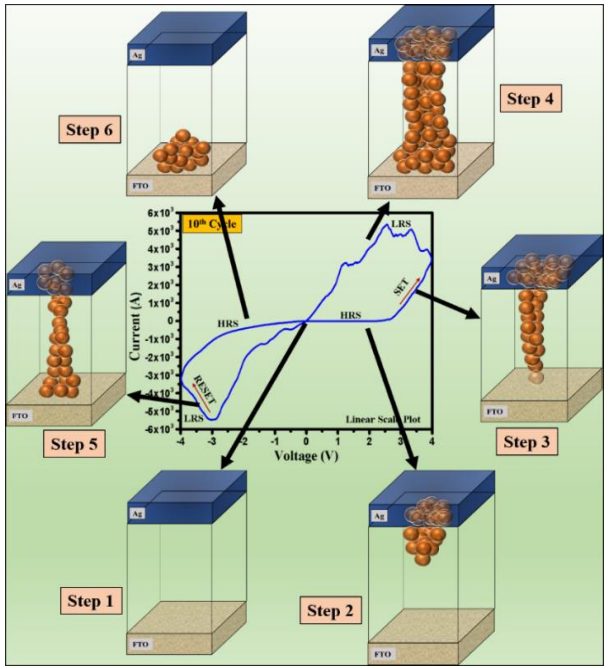


Kushwaha et al. ***Electrocatalysis*** 14 (2023) 68
Kushwaha et al. ***Journal of Solid-State Chemistry*** *313, 123293 (2022)*
Kushwaha et al. ***Materials Chemistry and Physics*** *271 (2021) 124958*
Devan et al. ***J. Semicond****. 38 (2017) 023001*
Devan et al. ***J Mater Sci: Mater Electron*** 27 (2016) 12340

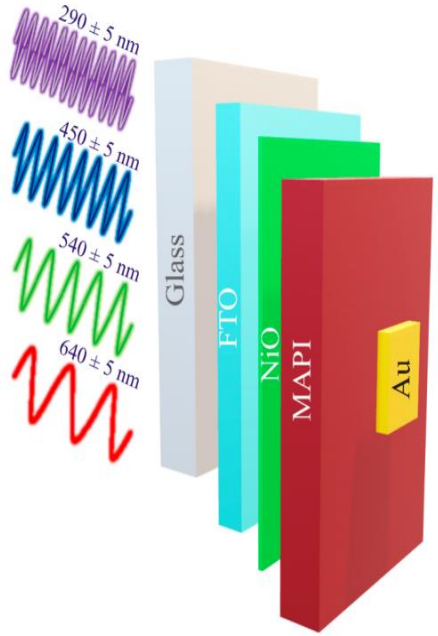
Electronic Devices

- Memristor, Photodetectors, LEDs, Power Electronics

Ga_2O_3 Based Memristor



Perovskites based Photodetector



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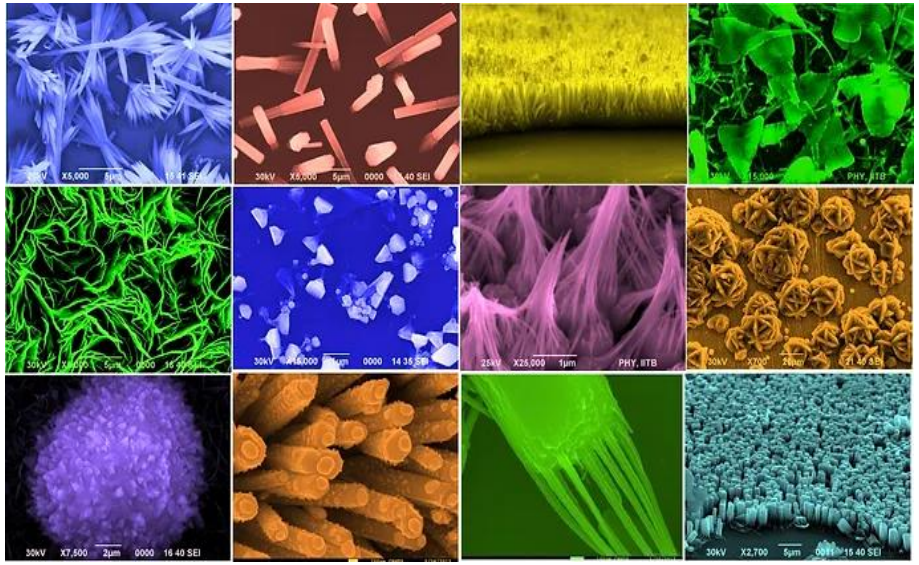
Kushwaha et al., ***Materials Letters*** 305 (2021) 130815
Shirage et al. ***ACS Appl. Electron. Mater***. 3(2021) 4548
Shirage et al. ***Applied Physics A*** 129 (2023) 1-12

Dr. Ajay K. Kushwaha, Prof. Parasharam M. Shirage, Dr. Ranjith, and Prof. Rupesh Devan

Nanomaterials & Soft-Materials

Controlled growth of Nanomaterials

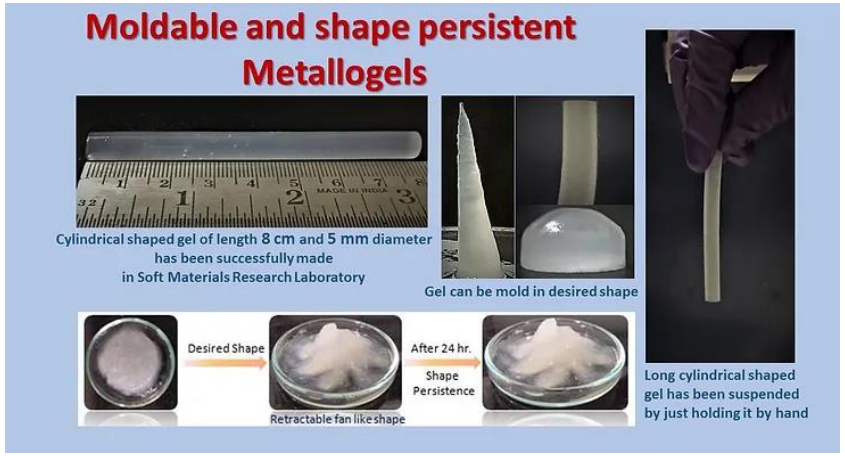
- Hydrothermal, CVD, Hot-injection methods.
- Metal oxides, Metals, Chalcogenides and Graphene & Mxenes.

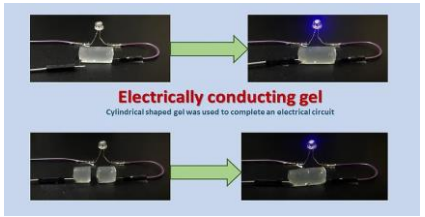


Kushwaha et al., ***Ceramics International*** (2023)
Kushwaha et al., ***Journal of Alloys and Compounds***, 928, (2022) 167127
Kushwaha et al., ***J Mater Sci: Mater Electron*** 33, 17404 (2022)
Kushwaha et al., ***Applied Surface Science*** 551, (2021) 149377
Rai et al. ***ACS Appl. Nano Mater***., 3, (2020) 11203
Rai et al. ***Chemical Engineering Journal***, 435 (2022) 135042
Shirage et al. ***New Journal of Chemistry*** 45(2021), 1404
Shirage et al. ***Materials Today Physics*** 26 (2022) 100731
Devan et al. ***New J. of Chemistry*** 45 (2021) 1403
Devan et al. ***Solar Energy*** 244 (2022) 75

Soft-Materials & Applications

- Conductive and Fluorescent Metallogel
- Gel for battery Electrolyte
- Superabsorbent Materials





Dubey et al., **ACS *Appl. mater. interfaces***, 2023 (Accepted)
Dubey et al. ***Mol. Syst. Des. Eng***., 2022,7, 1422-1433
Dubey et al, **Chemical Communications**., 2022, 58, 549
Dubey et al. *Sustainable Energy Fuels*, 2021, 5, 1708

Prof. Parasharam M. Shirage, Dr. Ajay K. Kushwaha, Prof. Rupesh Devan, Dr. Dhirendra K. Rai, Dr. Ranjith, Dr. S. Samal, Dr. Vinod Kumar, Dr. M. Dubey,

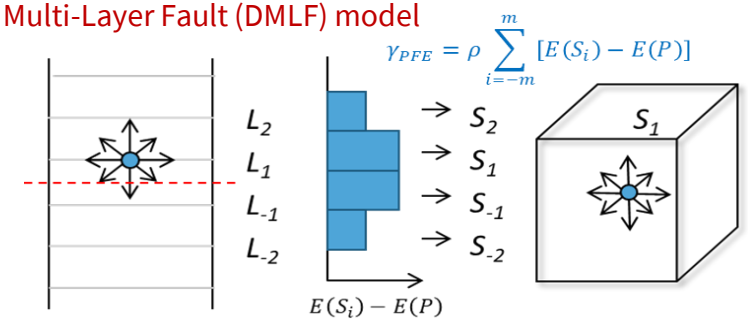
Alloy Design, Development and Deformation

Computational Materials Design

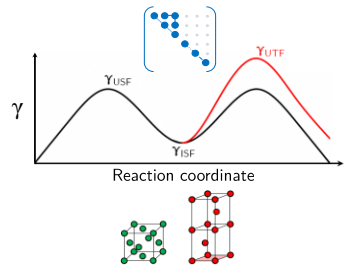
Atomistic simulations: DFT

- Computational thermodynamics,
- Superalloys, Multi-principal element alloys (MPEAs),
- Energy Devices

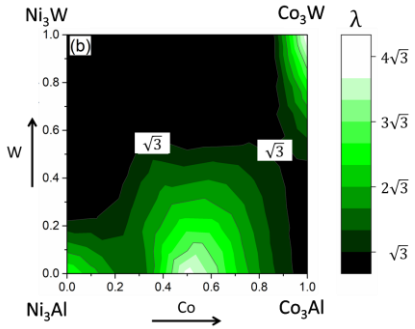
Diffuse Multi-Layer Fault (DMLF) model



Intrinsic Energy Barriers (FCC)



Yield anomaly in $(Ni,Co)_3(Al,W)$

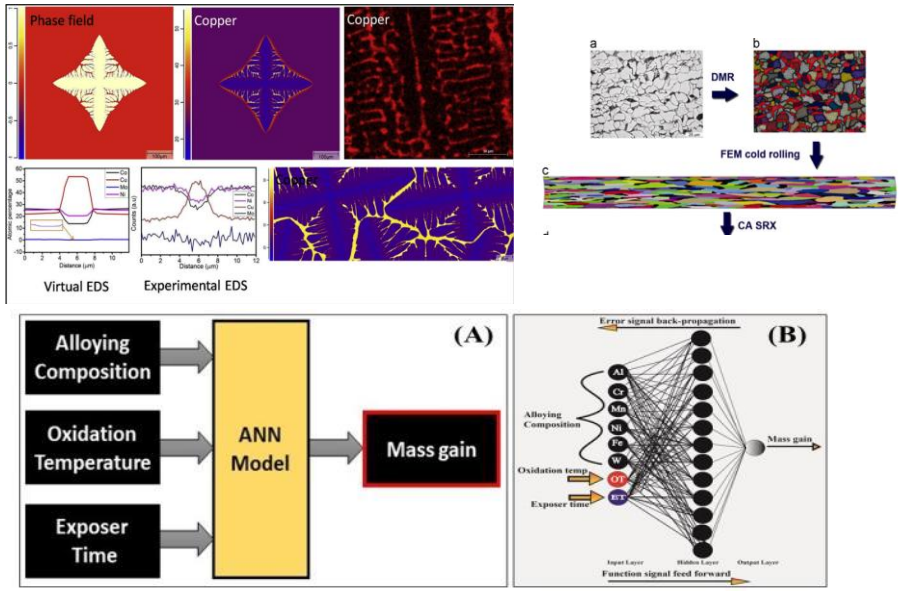


Vamsi et al. ***Annual Reviews in Materials Research***, 51, (2021), 209.
Vamsi et al. ***Scr. Mater***. 204, (2021), 114126.
Vamsi et al. **Superalloys** 2020, (2020), 948
Ghosh et al. ***Computational Materials Science***, 226, (2023) 112211.

Data-Driven Modeling, AI & ML

- Microstructure Modeling and Simulation
- Phase equilibria: Materials for the future

Phase field modelling



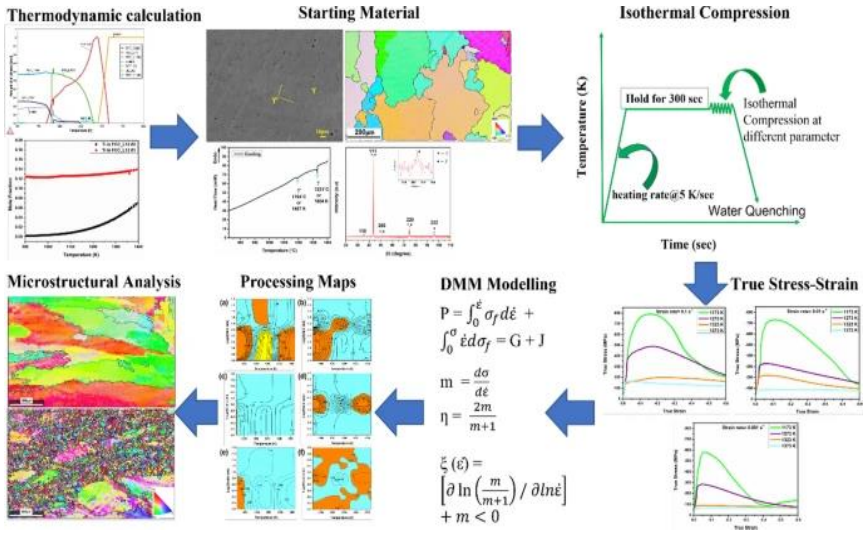
Samal, et al. ***JALCOM,*** 956, (2023) 170193.
Samal et al. ***JALCOM***, 821, (2020) 153488.
C. Halder, et al. **Archives of Civil and Mechanical Engineering**, 14, (2014) 96

Dr. K. V. Vamsi, Dr. C. Haldar, Dr. S. Samal, Dr. A. Ghosh, & Dr. E. P. Korimilli

Alloy Design, Development and Deformation

High Entropy Alloys

- New design methodology for eutectic HEAs
- Crystallographic texture & Processing maps
- Mechanical behavior of materials
- Magnetic properties
- Diffusion and Phase transformations

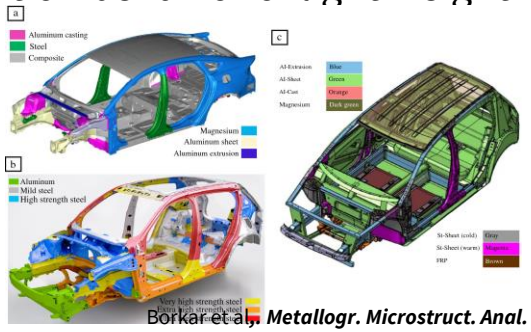


Samal et al. ***Met. Mater. Int.*** 253 (2023).
Vinod et al. ***Met. Mater. Int***. (2023)
Maurya et al. ***Materials Letters*** 344 (2023) 134420.
Ghosh et al. ***Materials Science and Engineering: A***, 872, (2023), 144930.
Eswar et al. ***Materials Science and Engineering: A***, 822, (2021), 141656,
Borkar et al. ***Materials Science and Technology*** **(2023)**

FOCUSED APPLICATIONs:
High temperature, Nuclear Reactor, refractory & Aerospace

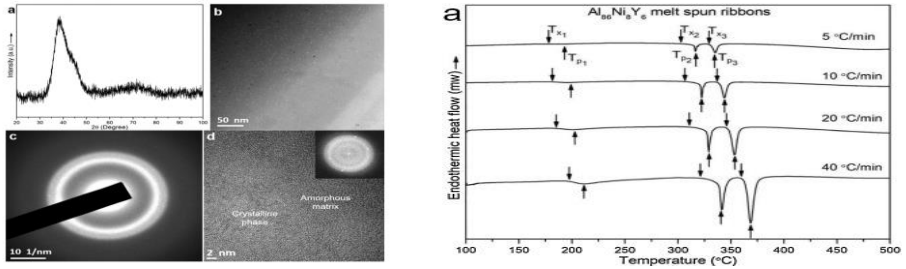
Light Weight Materials

- Mg, Al, Ti alloys and composites
- Deformation behavior of light weight materials



Borkar et al., ***Metallogr. Microstruct. Anal.*** (2023)

Bulk Metallic Glasses



Maurya et al. ***Journal of Non-Crystalline Solids*** 453 (2016) 1–7
Maurya et al. ***Metall Mater Trans A*** **51**, (2020) 5110.
Maurya et al. ***Int. J. Mat. Research*** 111 (2) (2020) , 160
Eswar et al., ***Journal of Alloys and Compounds***, 921, (2022), 165991.
Kushwaha et al, ***Electrocatalysis*** 14, (2023) 68.

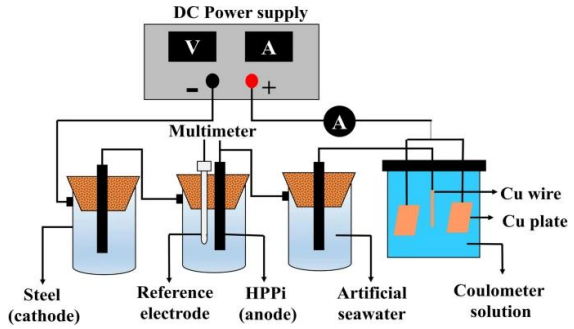
FOCUSED APPLICATIONS
Bio-implant, aircraft body, BMG-composite armour-piercing projectiles, microelectronics, corrosion protection

Dr. S. Samal, Dr. V. Kumar, Dr. E. P. Korimilli, Dr. A. Ghosh, Dr. H. Borkar, Dr. Khushubo Devi, Dr. V. Verma
Dr. D. Basha, Dr. R.S Maurya, & Dr. K . V. Vamsi

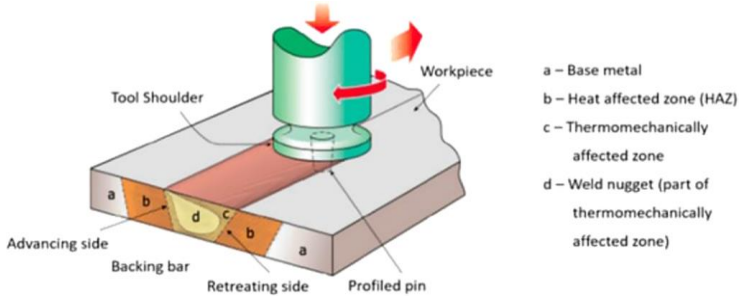
Materials Degradation and Surface Engineering

Metal Corrosion, Oxidation & Welding

- Pig Iron as Sacrificial Anode in Seawater
- Joining of Materials
- Fatigue and fracture,
- Crack propagation behavior



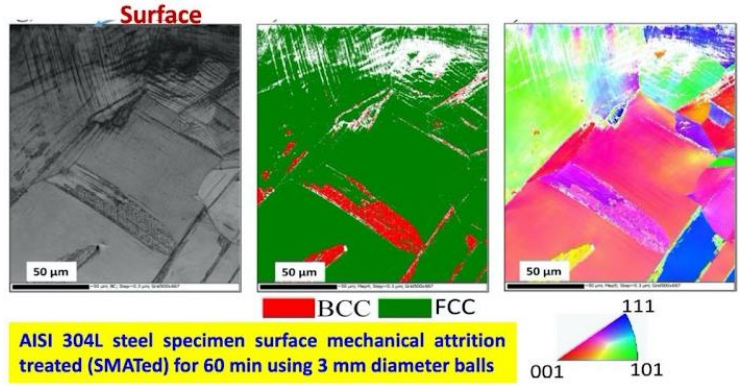
Prasad et al. ***Journal of Applied Electrochemistry*** 53 (2023), 141
Prasad et al. ***Journal of The Electrochemical Society*** 168 (2022), 111504
Prasad et al. ***Corrosion Science*** 189, (2021) 109616

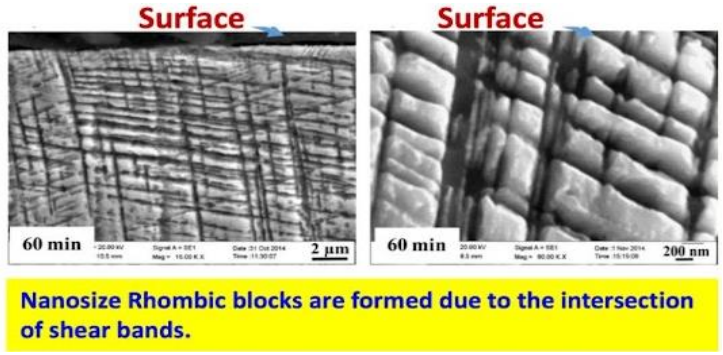


Murugesan et al. ***Journal of Adhesion Science and Technology*** 36 (2022), 1365
Murugesan et al. ***IRP Journal of Manufacturing Science and Technology*** 38, (2022) 252

Surface Coatings and Texturing

- Surface Alloying, Surface Deformation
- Heat treatment of Metals and Alloys



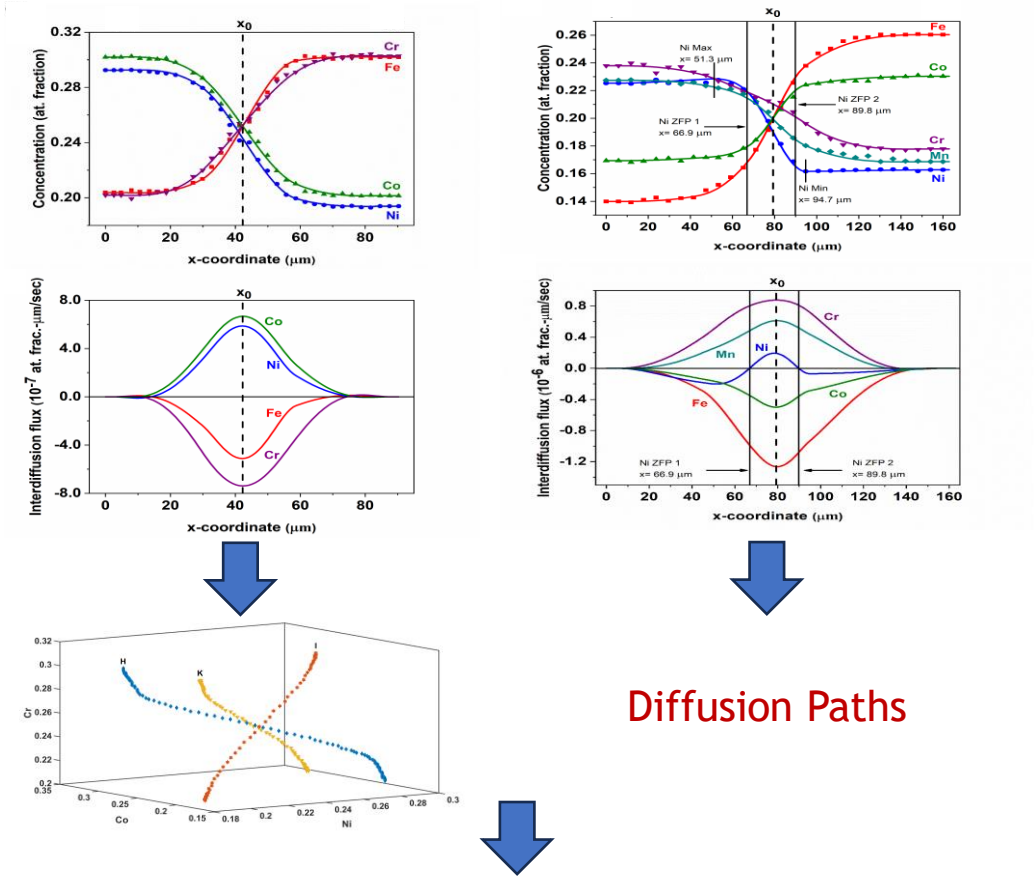


Hosmani et al. ***Surface and Coatings Technology*** 447 (2022) 128829
Hosmani et al. ***Applied Surface Science***, 581, (2022) 152437
Hosmani et al. ***Journal of Tribology***, 143, (2021), 031701

Dr. S. Hosmani, Dr. J. Murugesan, Dr. N. K. Prasad, Dr. M. Dubey, Dr. V. Kumar, Dr. D. A. Basha, Dr. Ranjith

Diffusion & Phase Transformations

Diffusion in Quaternary and Quinary Systems



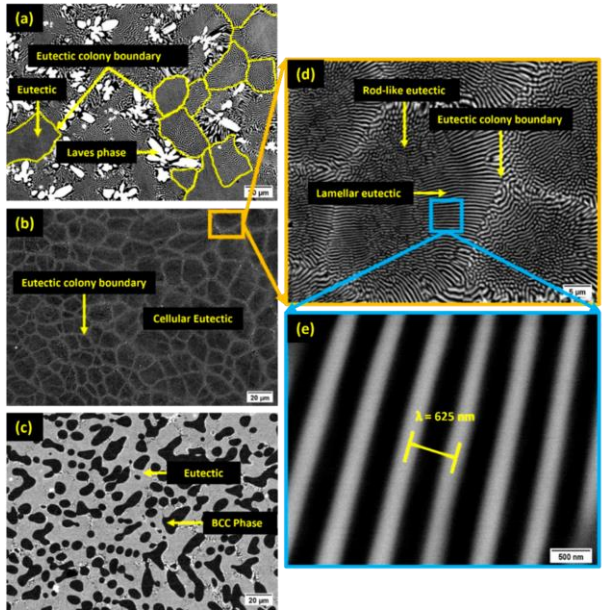
Diffusion Paths

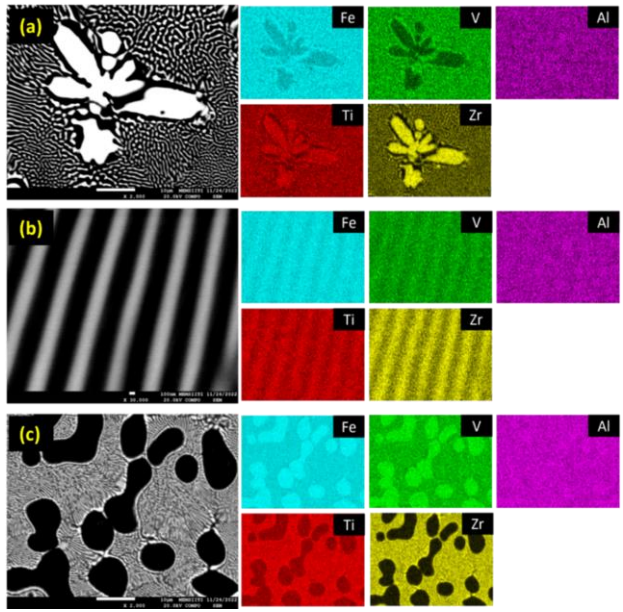
Diffusion coefficients

Verma et al., **Journal of Materials Research**, 35(2), 162-171
Verma et al., **Journal of Phase Equilibria and Diffusion**, 43(6), 903-915

Eutectic Multi-principal Alloys

Demonstration of eutectic in AlFeTiVZr and AlCoFeNi alloy systems





Talluri et al., **Journal of Alloys and Compounds**, 976, 173278
Talluri et al., **Journal of Alloys and Compounds**, *960*, 170834

Dr. V. Verma, Dr. S. Samal, Dr. V. Kumar, Dr. A. Ghosh, Dr. H. Borkar, Dr. R.S Maurya, Dr. Khushubo Devi & K. V Vamsi.

Prospective PhD Topics/Areas

Dr. Abhijit Ghosh

- Crystallographic texture, Creep, Shape memory alloy.

Dr. Ajay Kumar Kushwaha

- Nanomaterials for green hydrogen production.
- Metal oxide films for memristor.

Dr. Chandan Halder

- Hot Deformation Behaviour of Super and Hyper Duplex Stainless Steel.
- Study the diffusion behaviour in alloy steel through Finite Element Method (ABAQUS).

Dr. Dhirendra Kumar Rai

- Energy Storage (Batteries and Supercapacitors).
- Electrochemical conversion (CO_2 reduction, HER, OER).
- Blue energy harvesting.

Prospective PhD Topics/Areas

Dr. D. Althaf Basha

- Deformation behaviour of magnesium alloys.
- Development of non-rare earth magnesium alloys.

Dr. Eswara Prasad Korimilli

- High strain rate deformation behaviour of Additively Manufactured Structural alloys
- Laser shock peening and Tribological behaviour of alloys and their performance.
- Thin film solid lubrication coatings, Archaeometallurgy.

Dr. Hemant Borkar

- Wire arc additive manufacturing of Al alloys.
- Study of deformation behaviour of Magnesium alloys.

Dr. Jayaprakash Murugesan

- Energy Storage (Batteries and Supercapacitors).
- Electrochemical conversion (CO_2 reduction, HER, OER).
- Blue energy harvesting.

Prospective PhD Topics/Areas

Dr. Khushubo Devi (Tiwari)

- Phase Transformation of Direct Reduced Iron Ore Under Hydrogen Atmosphere.
- Recovery of Ferro Nickel from Low Grade Iron Ore,
- Synthesis and Phase Transformation behaviour of nanomaterials.

Dr. Mrigendra Dubey

- Development of Soft Materials, Fluorescent carbon dots, Metallogels and conductive materials for electronic applications.

Dr. Nisheeth Kumar Prasad

- Dimensionally stable anodes for application in harsh corrosive environments.
- Thermal barrier coatings for oxidation and hot corrosion resistance.

Prof. Parasharam M. Shirage

- Energy Conversion and Storage Materials and Devices (Solar cells, Batteries and Supercapacitors).
- Quantum Materials and Devices.

Prospective PhD Topics/Areas

Dr. Ram Sanjeev Maurya

- Design and development of metallic glass for various applications such as bioimplant, magnetic, structural etc.
- Synthesis and characterisation of metal based composites for automobile applications

Dr. Ranjith Kumar Poobalan

- Carbon-based coatings by Spray pyrolysis.
- Solar Selective Absorber coatings by Magnetron Sputtering.

Prof. Rupesh Devan

- Photo-active materials for H2 and water treatment/remediation (OER, HER, Desalination, etc.).
- Energy storage Materials, Nano-hetero-architectures.

Prof. Santosh Hosmani

- Surface Engineering, Gradient Structured Surface, Coatings, Corrosion, Tribology, Microstructure-Property Correlation, and Physical Metallurgy

Prospective PhD Topics/Areas

Dr. Sumanta Samal

- Processing-microstructure-property correlation in Ni-based superalloys.
- Design and development of refractory high entropy alloys (RHEAs) for high temperature applications.

Dr. Sunil Kumar

- Electrode and Electrolyte Materials for Lithium- and Sodium-ion Batteries

Dr. K. V. Vamsi

- Design of precipitate strengthened alloys for high temperature structural applications - superalloys and beyond.
- Understanding segregation to interfaces in multicomponent alloys

Dr. Vinod Kumar

- Development and characterization of Ni718 composite for cryogenic engine component.
- Development and characterization of ceramic wafer for electronic application

Prospective PhD Topics/Areas

Dr. Vivek Verma

- Investigation of Interdiffusion in Refractory High Entropy Alloys.
- Understanding of multicomponent diffusion behaviour using high throughput approaches.

Admission process

Our PhD program provides an exceptional opportunity for aspiring researchers and scholars to contribute to the field of metallurgical engineering and materials science through cutting-edge research and innovation. Minimum educational Qualifications (MEQs) and Qualifying Examination for Indian applicants criteria:

Master's degree (M.Tech. or M.E. or MS) in Metallurgy/ Materials Science and Engineering/ Mechanical/ Manufacturing/ Production Engineering/ Nanotechnology/ Engineering Science/ Engineering Physics/Ceramics Engineering/ Electronics/ Chemical Engineering/Energy Science and Engineering (with first division as defined by the awarding Institute/ University) AND GATE qualified.

OR

Master's degree (M.Sc.) in Chemistry/ Physics/ Materials Science/ Electronics/ Nanoscience and Technology/Forensic Science (with first division as defined by the awarding Institute/ University) AND GATE qualified with a valid score card OR valid UGC-JRF/CSIR-JRF/DST Inspire fellowship/other equivalent Fellowship

OR

B.E./ B.Tech. degree in Metallurgy/ Materials Science and Engineering/ Mechanical/ Manufacturing/ Production Engineering/ Nanotechnology/ Engineering Science/Engineering Physics/Ceramics Engineering/ Electronics/ Chemical Engineering/Energy Science and Engineering (with first division as defined by the awarding Institute/ University) AND GATE qualified with a valid scorecard

(Please refer to the main page on our academic portal Link: https://academic.iiti.ac.in/phdadvt.php for more details)

Opportunities

Under the guidance of renowned faculty members, through a combination of coursework, seminars, and hands-on research experience, our doctoral candidates develop critical thinking, analytical skills, and expertise to become future leaders in academia, industry, and research institutions.

- **Progress Review and Global Exposure**: Annual progress seminars ensure continual refinement of theses, complemented by institute-funded international conference travel for a global research perspective.
- **Prestigious Fellowships and Student Symposia** : PhD scholars secure esteemed PMRF funding and actively engage in student-led symposiums, showcasing their research prowess and academic leadership.
- **Materials Advantage Chapter**: Our active MA chapter connects students with four materials societies, fostering academic growth and networking opportunities.

Facilities @MEMS (and many more…)

DMA

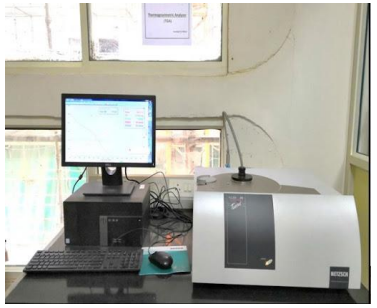
Creep Testing

Electrochemical Workstation

X-ray diffraction

Split Hopkinson Pressure Bar

Automatic polisher,
Inverted Microscope



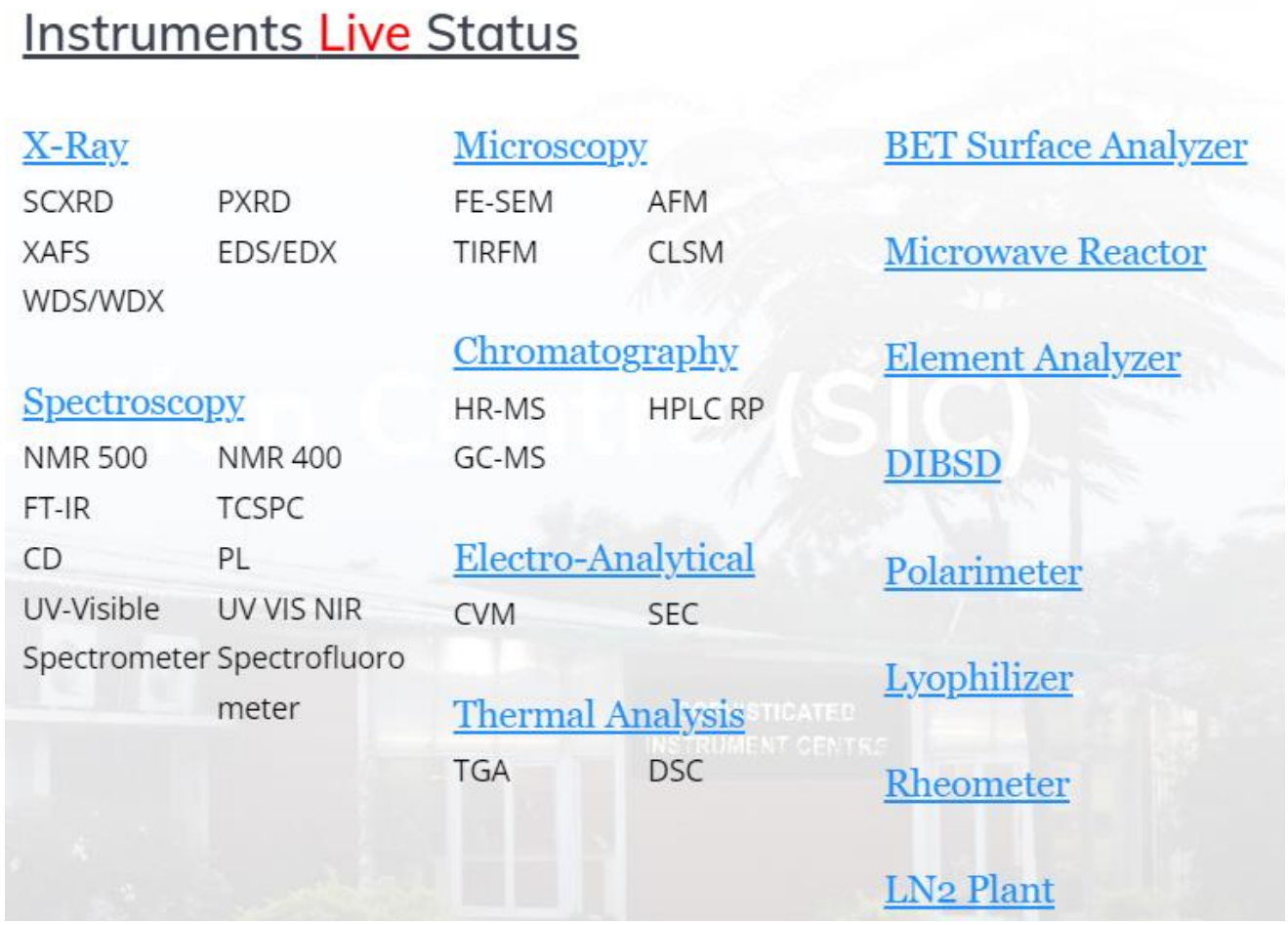
Thermo Analyser

Facilities @ SIC, IIT Indore (and many more…)

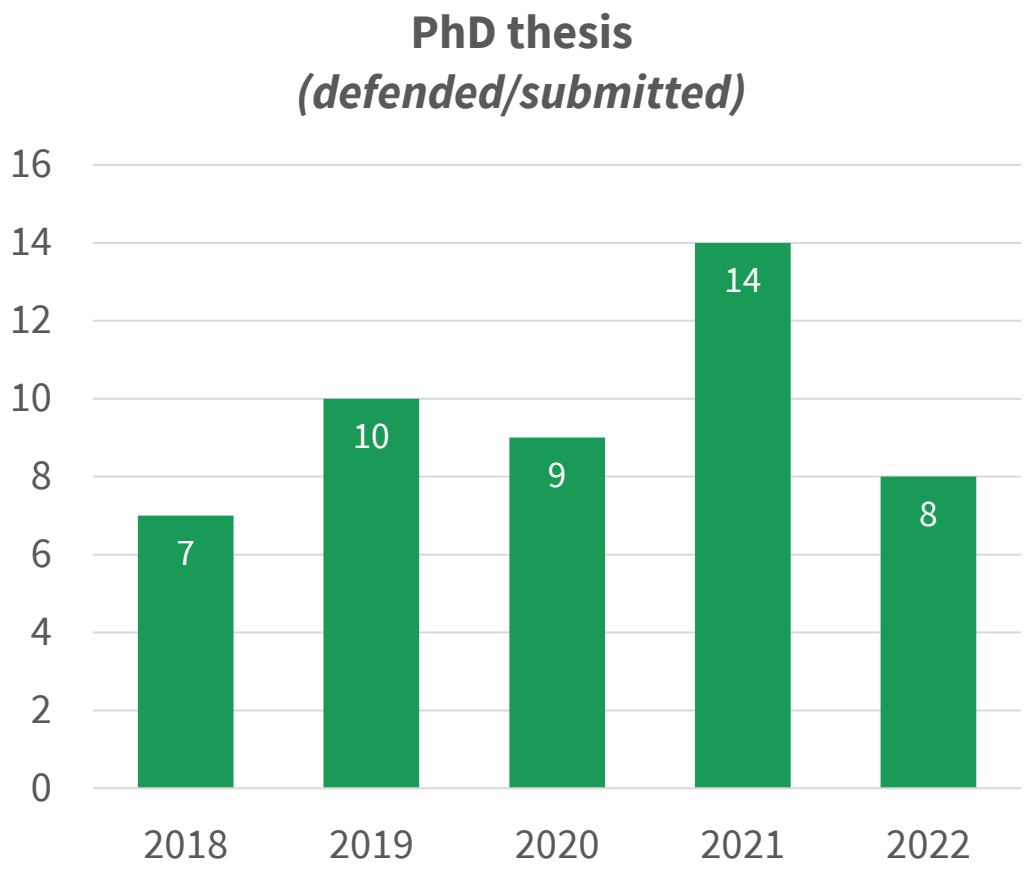
Sophisticated Instrumentation Centre (SIC):

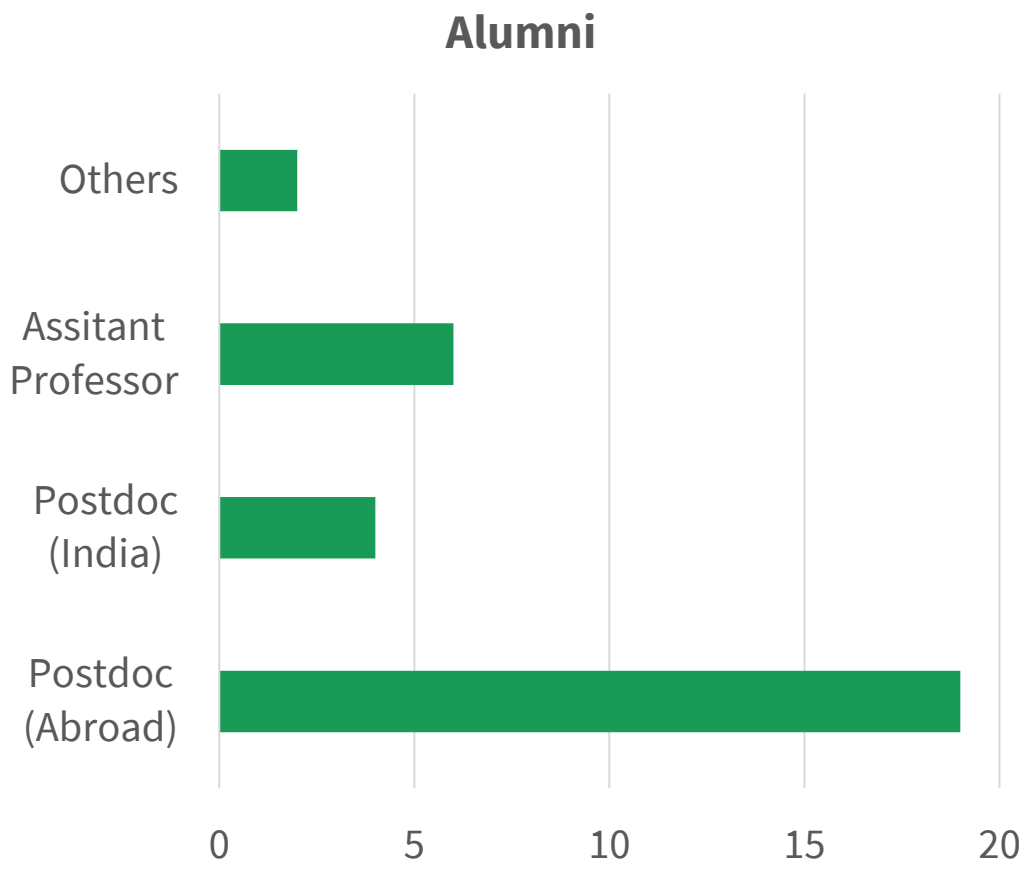
A National Facility at IIT Indore

More details:
https://sic.iiti.ac.in/



Department Statistics (PhD students)





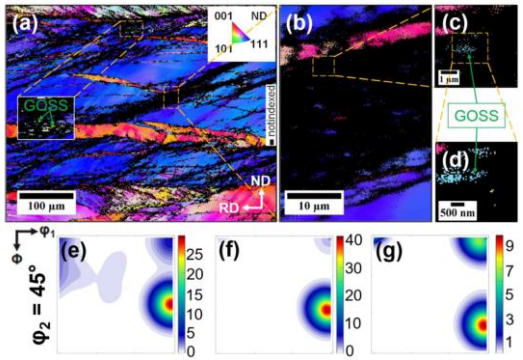
Faculty Profiles

*"**Abhijit Ghosh**, currently serving as an Assistant Professor in the Department of Metallurgical Engineering and Materials Science at the Indian Institute of Technology Indore, India, obtained his B.E. in Metallurgical Engineering from BESU Shibpur in 2009. Subsequently, he pursued his M.Tech. and Ph.D. from the Department of Metallurgical and Materials Engineering at IIT Kharagpur."*

Dr. Abhijit Ghosh

Email: aghosh@iiti.ac.in

The Microstructure and Texture Engineering Lab, headed by Dr. Abhijit possess the expertise within the realms of Physical and Mechanical Metallurgy. With a research background spanning crystallographic texture, small-scale mechanical testing, fracture micro mechanisms, and creep, He also possesses a strong interest he also harbors a keen interest in the theoretical underpinnings of metallurgical fundamentals. His group is extensively involved in following research areas:



- ***Understanding martensitic transformation***
- ***Creep deformation and fracture***
- ***Crystal plasticity and texture***

Key words: Alloy design, Structure-property correlations, High temperature deformation, Crystallograhic texture, Martensitic transformation.

Dr. Ajay Kumar Kushwaha

Associate Professor & HoD,

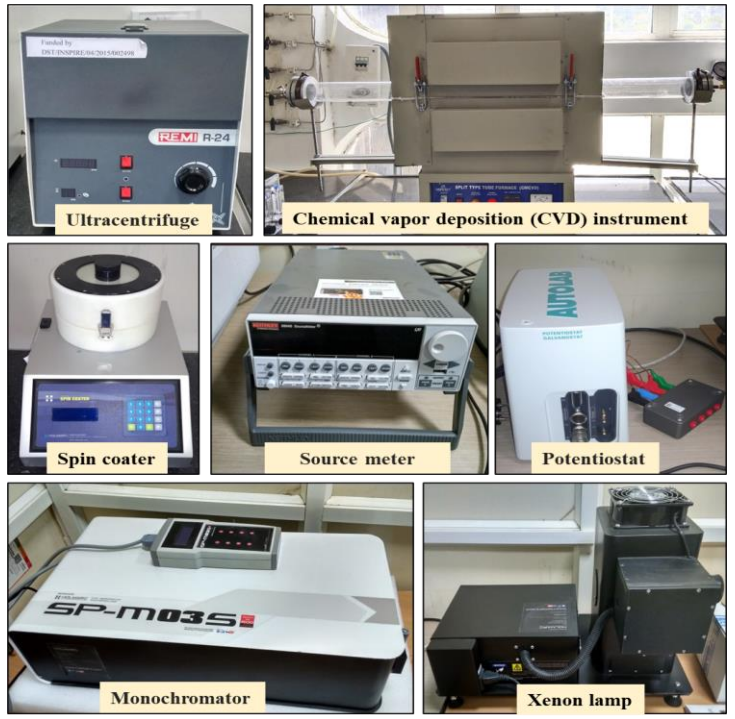
Email: akk@iiti.ac.in

***Dr. Ajay Kumar Kushwaha** is a nanomaterials expert with a Ph.D. from IIT Bombay and a former scientist at IMRE Singapore. Now at IIT Indore, he specializes in functional coatings and clean energy. Honored with DST-INSPIRE and SERB awards, he's published widely in his field.*

Research Interests

Nanomaterials	· Metal-oxides, Chalcogenides, Metal/Alloys, & 2D Materials · Controlled Crystal Growth, Surface Modification · Defects, Electron Transport and Optoelectronic Properties
Materials Electrochemistry	· Electrodeposition & Electrochemical Interfaces · Electrochemical Sensors · Corrosion
Clean Energy	· Solar Energy Harvesting: Solar Cell & PEC Cell · Green Hydrogen: HER & OER materials, Electrolyzer · Electrochemical fuels
Electronic Devices	· Photodetectors · Resistive Memory · Power semiconductor device

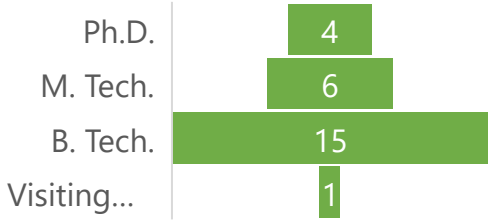
Facilities



Research Group

- *Lokanath Mohaptra (PhD)*
- *Akshay Kumar Sonwane (PhD)*
- *Navdeep Srivastava (PhD)*
- *Ojasvi Singh (PhD)*
- *Sonali Samal (JRF)*
- *Prosenjit Mondal (M.Tech)*
- *Dhruv Jain (B.Tech)*

Alumni



Projects

5 Completed Projects

3 Ongoing Projects

1 Nano-heterostructures Development for Solar Water Splitting

2 Indo-South Korea Joint Network Center for Environmental Cyber Physical Systems

3 Indo-Russia Project on Biomass Glucose Oxidation for Acid and Hydrogen Production

Publication

1 Patent

70^{+} Journal Articles

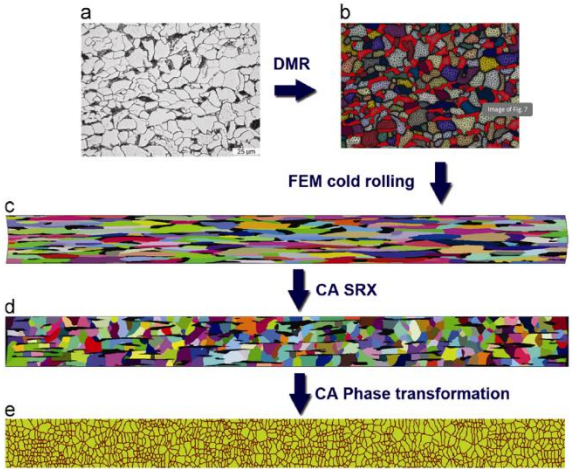
6 Book chapter

Dr. Chandan Halder

Email: chalder@iiti.ac.in

*"**Chandan Halder**, presently an Assistant Professor in the Department of Metallurgical Engineering and Materials Science at the Indian Institute of Technology Indore, India, brings a wealth of industrial experience to his academic role. Prior to joining academia, he spent six years at Mishra Dhatu Nigam Limited, Hyderabad, where he gained invaluable insights and practical knowledge in the field of metallurgy. His academic journey began with a B.Tech in Metallurgical Engineering from NIT Durgapur in 2009. He furthered his studies at the prestigious Indian Institute of Technology Kharagpur, obtaining an M.Tech in Materials Engineering in 2011, followed by a Ph.D. in Materials Engineering in 2016. "*

Multi-Scale Modeling Group pioneers materials science and engineering through multi-scale finite element, diffusion, hot deformation, and data-driven modeling. We blend theory, computation, and experimentation to tackle material challenges across diverse scales effectively.



Mechanistic diffusion modeling: Diffusion bonded elemental analysis integrates Finite Element Modeling (FEM) with experimental techniques to scrutinize the intricate atomic interactions occurring during bonding processes to enhance material performance.

Understanding hot deformation in the super and hyper duplex stainless steel: This research aims to comprehensively investigate and understand the hot deformation behavior of super and hyper duplex stainless steel, with a focus on advanced processing techniques and the resultant microstructural changes.

Neural Network based alloy design : This approach combines principles from materials science, computational modeling, and machine learning to expedite the alloy design process. It can uncover non-intuitive relationships between alloy compositions and properties, leading to the discovery of novel materials with exceptional performance characteristics.

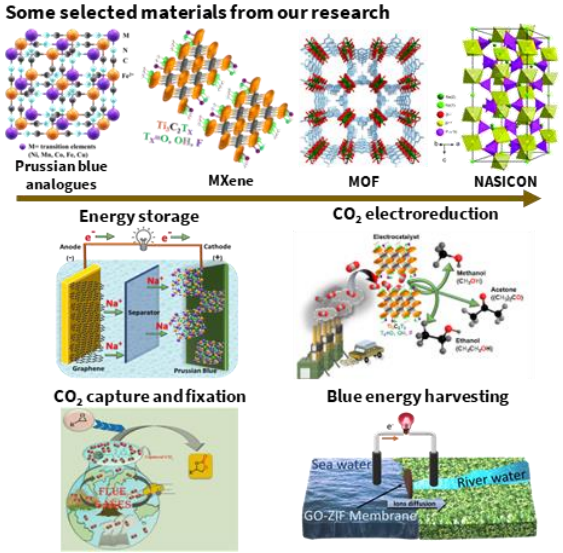
Key words: Materials Modeling, Diffusion bonding, Duplex stainless steel, Finite Element Method, Alloy design

Dhirendra Kumar Rai *currently serves as an Associate Professor and leads the Sustainable Energy and Environmental Materials (SEEM) Laboratory within the department. He became part of the department in 2017. Prior to this, he earned his Master's and Ph.D. degrees from Banaras Hindu University (BHU) and the Indian Institute of Technology Bombay (IIT Bombay), respectively. Additionally, he held the position of DST Young Scientist at IIT Indore. Dr. Rai's research group focuses primarily on tackling global challenges outlined in the UN Sustainable Development Goals, specifically Goal 06 (Clean water and sanitation), Goal 07 (Affordable & Clean Energy), and Goal 13 (Climate action). His work involves the design and development of cost-effective and environmentally friendly materials for various applications. These applications include batteries and supercapacitors, heterogeneous catalysts for CO2 fixation and conversion, green hydrogen and oxygen generation through water electrolysis, and the detoxification of chemical warfare agents.*

Dr. Dhirendra Kumar Rai

Email: dkrai@iiti.ac.in

To realize the research goals, ***Sustainable Energy & Environmental Materials Laboratory*** is equipped with all the required facilities, including Glove box, Battery assembly unit, Battery tester, Electrochemical workstation, high temperature furnaces, etc. For further information please visit Dr. Rai's lab webpage.



Energy Storage: *Study and understanding of the structure-property relationship of novel electrode materials and electrolytes for supercapacitors, aqueous batteries and beyond Li-ion batteries.*

Energy Harvesting: *Exploring materials for the production of renewable and value-added fuels with high current density (>100 mA/cm^2) such as H_2, and CO_2-reduced products by water/CO_2 electrolysis. Fabrication of flexible membranes for nanogenerators to harvest the energy from seawater.*

Heterogeneous Catalysis: *Development of functional porous metal/covalent-organic frameworks (MOF/COF) as heterogeneous catalysts for CO_2 capture and fixation and for detoxification of chemical warfare agents.*

Key words: Beyond Li-ion batteries, Electrode and electrolyte design, Structure-property relationship, Catalyst for HER, OER, CO_2ER, Porous materials for CO_2 capture and fixation and warfare agent detoxification, Blue energy harvesting.

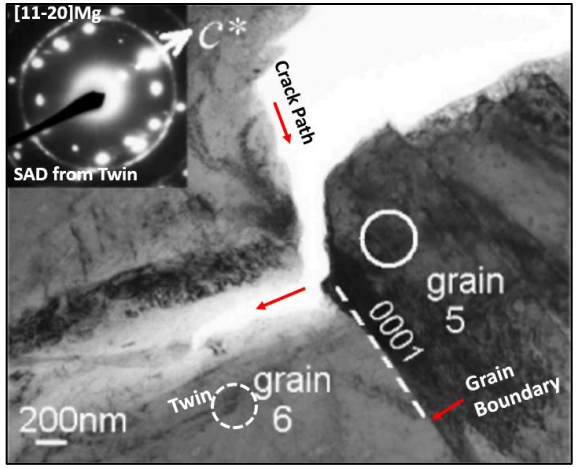
Dr. D. Althaf Basha

Email: bashada@iiti.ac.in

***Dudekula Althaf Basha**, Asst. Prof., completed his M.Sc (Physics) in 2007 from Sri Venkateswara University, Tirupati. He obtained his Ph.D in 2014 from Indian Institute of Science, Bangalore, India. Later, he worked as a Post Doctoral Researcher in National Institute for Materials Science, Tsukuba, Japan until his joining as an Assistant Professor at IIT INDORE.*

Basha's research group studies crystal defects, recrystallization phenomenon and crack propagation behavior in severely deformed light weight magnesium alloys by applying novel transmission electron microscopy (TEM) techniques. Further, his group also aims to understand microstructure evolution, particle shape, crystallographic orientation relationships among different phases, phase stability and the first order transformation behavior of alloy nanoparticles embedded in metallic matrices.

Deformation Behavior of Magnesium Alloys: Severe Plastic Deformation behavior study of magnesium alloys through advanced transmission electron microscopy techniques



Crack Propagation Behavior in Magnesium Alloys : Crack propagation behavior study of magnesium and its alloys through in-situ straining in transmission electron microscope

Phase transformation behavior of embedded alloy nano particles: Phase transformation behavior of embedded alloy nano particles through in-situ heating studies in transmission electron microscope.

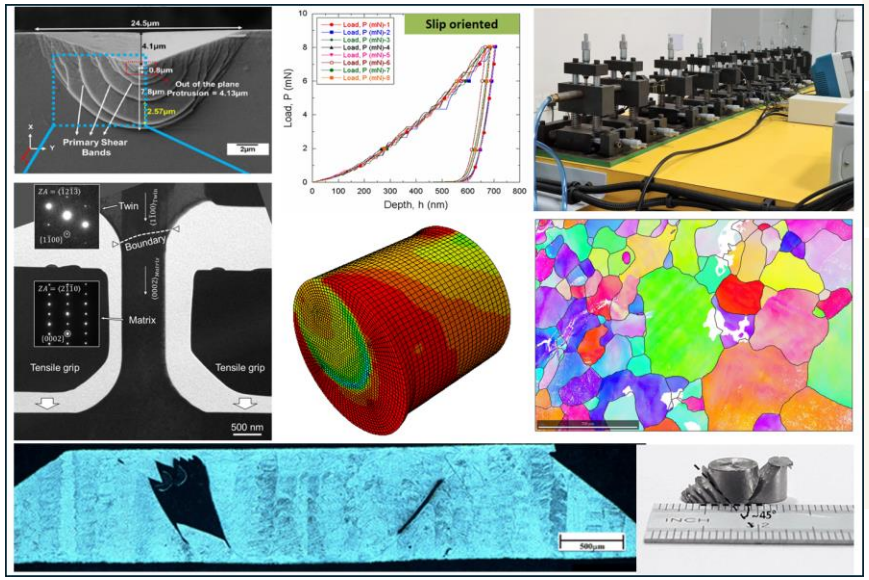
Key words: Magnesium, Deformation, Nano Particles, Phase Transformation, TEM/STEM, in-situ, SEM-EBSD

Prof. Eswara Prasad K.

Email: eswar@iiti.ac.in

Eswara Prasad Korimilli *is an Associate Professor in the Department of Metallurgical Engineering and Materials Science, at IIT Indore. He obtained his B.Tech from NIT Warangal, Master's and Ph.D. degrees from the Department of Materials Engineering, IISc Bangalore. Before joining IIT Indore, he worked as a Postdoc at the Hopkins Extreme Materials Institute, Johns Hopkins University, USA, and as a faculty member at Mahindra Ecole Centrale, Hyderabad. He also served as a visiting faculty/scientist at Ecole Centrale Paris, France, Karlsruhe Institute of Technology, Germany, and Xi'an Jiaotong Technological University, China.*

Eswar leads the group of ***Mechanics of Materials*** *and does research in the area of mechanical behavior of materials primarily to characterize the effect of microstructural length scales and experimental time scales on the deformation behavior of materials. His group uses both experimental and computational techniques to develop a holistic understanding of the role of various micro-structural features in the deformation and failure of various materials.*



High strain rate (HSR) deformation of materials: Many of the engineering components and structures experience HSR loading conditions and deformation mechanisms under these loading conditions are quite complex as compared to the quasi-static loading conditions. The overarching goal of this research is to develop a comprehensive understanding of deformation mechanisms under HSR to design ballistic resistance materials and microstructures.

Tribological behavior of materials: The main aim of this study is to characterize the tribological behavior, particularly the wear resistance, of materials under contact and sliding loading conditions.

Deformation behavior of materials at small length scales: Understanding the deformation behavior of materials at small length scales is extremely important, particularly in MEMS and NEMS applications, as they exhibit myriad deformation mechanisms at these length scales. The goal of this research is to investigate the small-scale deformation behavior of materials using nanoindentation, in-situ OM, SEM, and TEM experiments and understand the deformation mechanisms.

Keywords: High strain rate deformation, Deformation and failure of materials, Nanoindentation, Tribology, In-situ experiments, Contact fatigue,

Dr. Hemant Borkar

Email: h.Borkar@iiti.ac.in

***Hemant Borkar** is an Assistant Professor in the Department of Metallurgical Engineering and Materials Science at the Indian Institute of Technology Indore, India. His academic journey began with a B.E. in Metallurgical Engineering and Materials Science at VNIT Nagpur followed by M.Tech from IIT Bombay. Later on, he pursued his PhD from McGill University, Canada. He has worked in Sweden and UK for research and academic activities.*

Dr. Borkar's research group works on 'lightweight metals for structural applications, especially Mg and Al alloys for automotive applications. The research focuses on improvement of properties of lightweight metals through various approaches of microstructure and texture modification. The advanced processing of lightweight metals and their characterization are also topics of interest.

Research Interests:

- ***Lightweight materials***
- ***Deformation behavior***
- ***Crystallographic texture and microstructural characterization***
- ***Additive manufacturing***

Key words: Mg alloys, Al alloys, additive manufacturing, deformation behavior

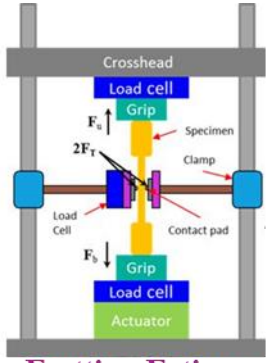
Dr. Jayaprakash Murugesan

Email: jayaprakash@iiti.ac.in

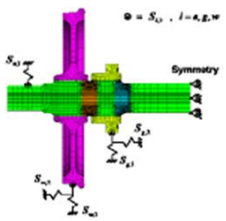
*"**Jayaprakash Murugesan** is an Associate Professor in the Department of Metallurgical Engineering and Materials Science at the Indian Institute of Technology Indore, India. His academic journey began with a B.E. in Metallurgical Engineering from Govt College of Engineering, Salem , TN in 2002. He pursue M.S. in Metallurgical and Materials Engineering at IIT Madras in 2006 and a Ph.D. in Materials Science Engineering at Nagaoka University of Technology, Japan in 2010"*

Work Experience

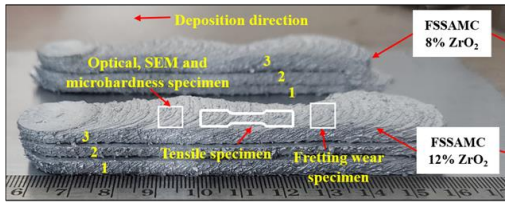
- Post Doc Researcher, Nagaoka University of Technology , Japan - 1 Year
- Post Doc Researcher, National institute for Materials Science, Japan – 2.5 Years
- Senior researcher, Japan Nuclear energy safety organization, Japan 1 Year
- Associate professor, Nagaoka University of Technology, Japan 2 .5 Years
- Assistant professor, MEMS, IIT Indore, 5 Years



Fretting Fatigue testing



Finite element modelling



Friction Stir additive manufactured Al alloy

Jayaprakash Research Group mainly deals with advances in materials joining, joining of dissimilar, solid state welding, Wire Arc additive manufacturing, friction based additive manufacturing, mechanical behavior of weld joint, fatigue and fracture behavior of advanced materials, fretting fatigue, fracture mechanics, surface engineering and alloy development . Following are few key research topics currently ongoing

- *Fatigue behavior of FSW Aluminum stainless steel dissimilar joint under hydrogen atmosphere*
- *Enhancing the fatigue properties of structural materials using advanced surface modification*
- *Fretting fatigue behavior of aerospace and nuclear materials*
- *Development of high temperature Ti alloys with improved properties for jet engine applications*
- *Additive manufacturing of advanced materials*

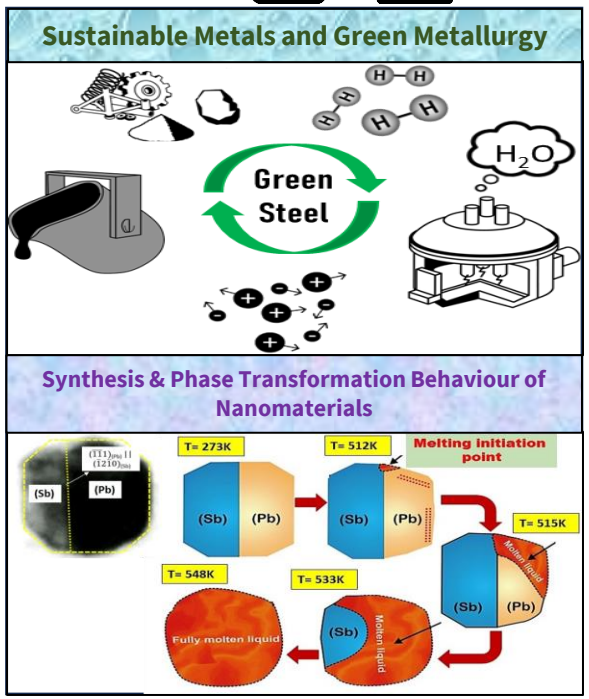
Key words: Mechanical behavior of materials, Structure-property correlations, welding engineering, dissimilar materials joining, alloy development, additive manufacturing, surface engineering , finite element analysis, fatigue, fretting fatigue.

*"**Khushubo Devi (Tiwari)** is an Assistant Professor at the Indian Institute of Technology Indore, specializing in Materials Science and Engineering. Her academic journey began with a B.Tech. in Metallurgical Engineering from the National Institute of Technology, Raipur, in 2012. Continuing her pursuit of higher studies, she obtained an M.Tech. in Metallurgy Engineering from the Indian Institute of Technology, Varanasi (BHU), in 2015. Dr. Devi then completed her Ph.D. in Materials and Metallurgical Engineering from the Indian Institute of Technology, Kanpur, in 2021, followed by a prestigious tenure as an Alexander von Humboldt Postdoctoral Research Fellow at the Max Planck Institute for Iron Research GmbH in Düsseldorf, Germany, from 2021 to November 2023 before joining IIT Indore."*

Dr. Khushubo Devi (Tiwari)

Email: khushubo@iiti.ac.in

Our research group focuses on advancing materials science through innovative studies in phase transformations, materials synthesis, and process optimization. Using multidisciplinary approaches and cutting-edge facilities, we aim to understand material behaviour at the nanoscale and develop sustainable solutions for industries such as steel production, metal extraction, and nanotechnology.



Phase Transformation of Direct Reduced Iron Ore Under Hydrogen Atmosphere:

- ✓ Understanding the phase transformation of direct reduced iron ore under a hydrogen atmosphere for advancing the efficiency, sustainability, and quality of iron and steel production processes.
- ✓ Focus on identifying and characterizing the rate-limiting step(s) during the hydrogen-based direct reduction of iron ore.

Recovery of Ferro Nickel from Low-Grade Iron Ore:

- ✓ Investigate optimal extraction methods and technologies for recovering Ferro-Nickel from low-grade iron ore. Characterize the chemical and physical properties of low-grade iron ore to understand its suitability for Ferro-Nickel extraction.

Synthesis and Phase Transformation behaviour of Nanomaterials

- ✓ Synthesis of complex multicomponent alloy nanoparticles by chemical and physical routes and understanding the phase transformation behaviour of these alloys through integrating thermodynamics and *in-situ* microscopy.
- ✓ Using advanced characterization tools such as *in-situ* heating and climate *in-situ* TEM as well as *in-situ* heating and cooling XRD to comprehend the kinetics, nucleation and growth mechanisms associated to nanomaterials

Keywords: Phase transformation, Direct reduced iron ore, Hydrogen atmosphere, Synthesis, Sustainability, *in-situ* Microscopy

Dr. Mrigendra Dubey

Email: mdubey@iiti.ac.in

*"**Mrigendra** Dubey is an Associate Professor in the Department of Metallurgical Engineering and Materials Science at the Indian Institute of Technology Indore, India. He pursued his academic journey with UG And PG. in from University of Allahabad (2003-2007). He obtained his Ph.D. degree in Chemistry from Indian Institute of Technology, Guwahati and afterwards continued as post doctorate fellow (2011-2014) at Institute of Chemistry, Academia Sinica, Taiwan, Banaras Hindu University. He has been awarded DST-INSPIRE faculty award and served at IIT (BHU) Varanasi (2015-2017). Further, he moved to IIT Indore (May 2017) as an Assistant Professor. "*

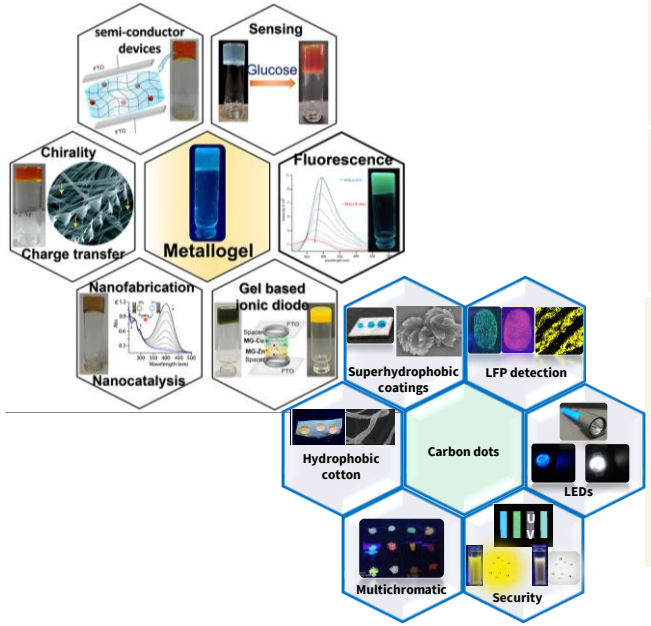
Our research group (***Soft Materials Research Laboratory***) is dedicated to develop multifunctional Soft Materials with an objective to achieve conductance, chirality, fluorescence, charge transfer, catalysis, super absorbance, superhydrophobicity, morphology, rheological properties for various kind of real world applications.

Development of stimuli-responsive supramolecular smart Materials: In this direction, we are interested in development of various kinds of self-assembled metallogels where their properties can be manipulated using several factors such as pH, ultrasound, heat, mechanical which make them suitable as - (i) Superabsorbent, (ii) Conductive, (iii) fluorescent, (iv) Chiro-optical materials with tuneable morphology and rheological characteristics.

Metallogels towards electrochemical and semiconductor application: Electronic conductivity in metallogels arises due to the facilitation of electron transport *via* ligand–ligand and metal–ligand pathways. In order to achieve such materials, our laboratory is focused on the development and utilization of metallogels for the fabrication of mixed conductive electrochemical semiconductors (MIEC).

Gel application in agriculture (Agri-gel): We have developed the super absorbent stable gels for agricultural applications. Moving ahead, we have also developed the scope for immobilization of fertilizers within the gel matrix. Thus, the outcome this topic will be definitely a breakthrough for society.

Multichromatic carbon dot synthesis and their application: Generally, CDs exhibit wide spectrum of fluorescence covering complete visible region. On the other hand, super hydrophobicity is an intriguing research area and it is utilized to induce self-cleaning, anti-icing, anti-fogging properties in materials. Our research group are currently interested to merge these two research areas into one. We are dedicated to develop superhydrophobic, multichromatic fluorescent carbon dots to enable fabrication of smart superhydrophobic textiles, anticounterfeiting devices, optical devices etc.



Key words: Stimuli-responsive soft materials, gels, agri-gels, superabsorbent gels, superhydrophobic materials

***Nisheeth Kumar Prasad**, is an Assistant Professor in the Department of Metallurgical Engineering and Materials Science at the Indian Institute of Technology Indore, holds a Ph.D. in Materials Science and Engineering from IIT Kanpur, where he received the Best Thesis award. With an M.Tech from MNIT Jaipur and a B.Tech from BPUT Rourkela, he has garnered recognition including a Gold medal and Overall excellence award. His industrial tenure at Hindustan Petroleum Green R&D Centre, Bengaluru, focused on corrosion-related challenges in refinery operations and root cause failure analysis*

Dr. Nisheeth K. Prasad

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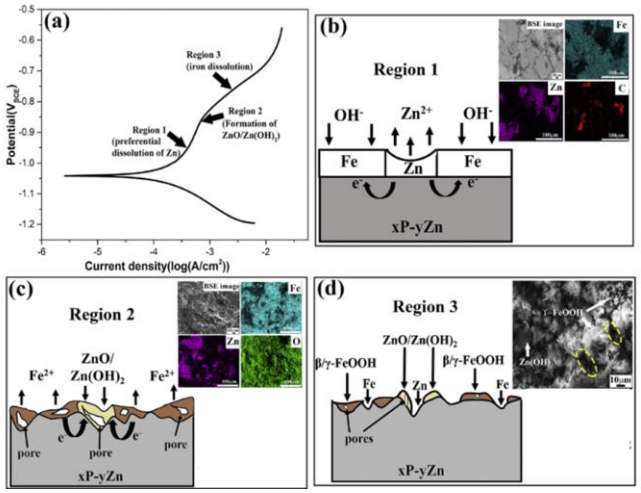
Corrosion and Materials Protection Lab is mainly focused on development of novel materials to resist corrosion under harsh environments, understand the underlying mechanism at the metal/electrolyte interface and sustainable approach for corrosion prevention. they explore the following key research areas:



Dissolution behaviour of hybrid anodes

Some of my key research areas include:

- Processing-structure-corrosion property correlation
- Anode design for cathodic protection
- Corrosion resistant multi-principal element alloys
- Concrete corrosion and its prevention
- Development of protective coatings

Prof. P. M. Shirage

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Researcher Id: 3011874

Google Scholar Id: hf2x04QAAAAJ

Parasharam M. Shirage *is a Full Professor in the Department of Metallurgical Engineering and Materials Science at the Indian Institute of Technology Indore, Since 2022. He obtained his PhD from Shivaji University Kolhapur (2004), completed Post-doc at Korea Electrotechnology Research Institute, Changwon, South Korea (2004-2006), JSPS Japan Fellow (2006-2008) and AIST Senior Scientist Japan (2008-2012), TIFR Fellow (2012-2013) and Ramanujan Fellow (2013-2018). He is listed in top 2 % world scientist list. Under his guidance, 17 PhD students have completed their PhD thesis from IIT Indore. He Has published more than 230 research with citations over 6700 and h-index 47.*

Advanced Functional Materials Research Group of Prof. Shirage, studies Quantum Materials, Energy Materials (Solar Cells, Batteries and Supercapacitors), Bio- and Chemical Sensors, Piezoelectric Materials, etc. His Representative Research topics are as Follows:

Quantum Materials: Synthesis of Superconducting materials single srystals and polycrystals for understanding the Basic mechanism and device fabrication for Quantum Physics Measurements.

Energy Materials: Dimensional controlled growth of advanced functional materials for energy conversion (Perovskite, DSSC, and Hybrid Solar cells) and Storage (Sodium Ion Batteries and Supercapacitors).

Sensors: Chemical Gas Sensors and Bio-sensors.

Fig. 1 Represents CR2032 Sodium Ion Battery and Pouch Cell Supercapacitors Devices fabricated by Prof. Shirage's research group

Key words: Advanced Functional Materials, Energy Conversion and Storage, Sensors, Piezoelectric, Quantum Materials

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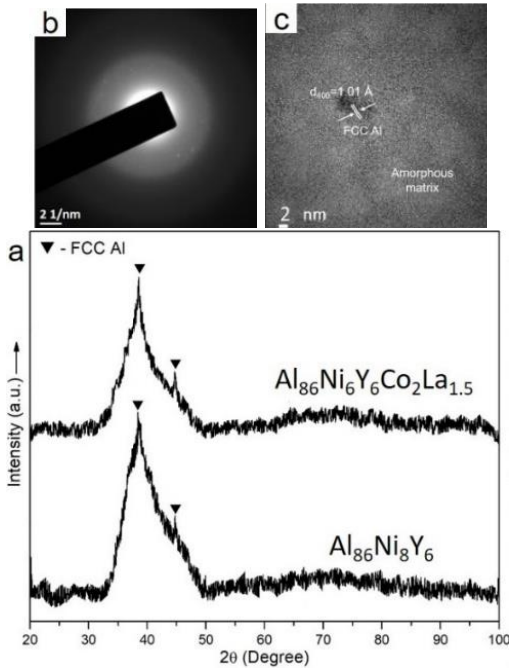
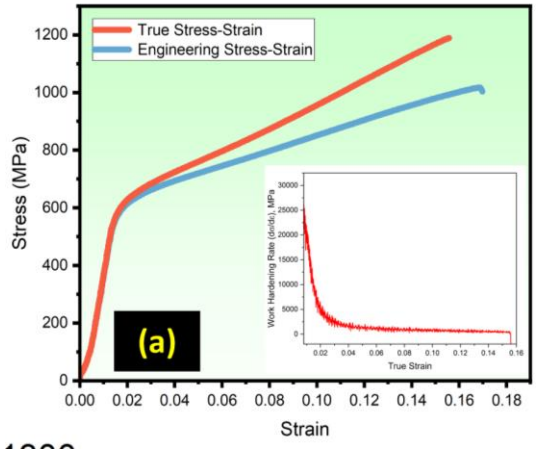
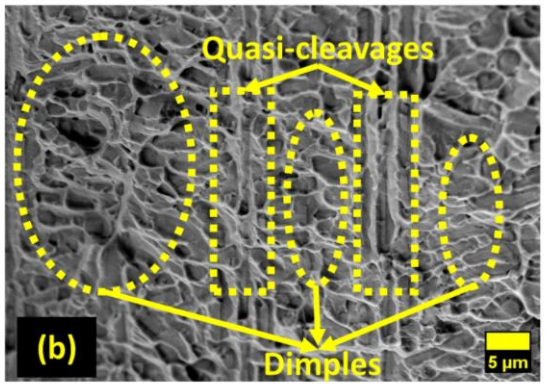
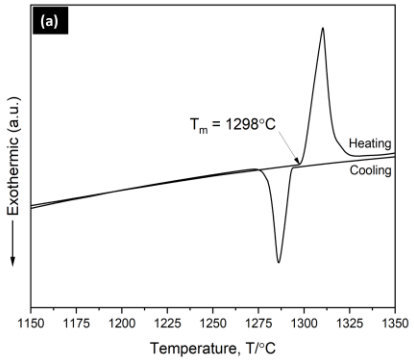
*"**Ram Sajeevan Maurya**, is an Assistant Professor in the Department of Metallurgical Engineering and Materials Science at the Indian Institute of Technology Indore, India. His academic journey began with a B.Tech. in Metallurgical and Materials Engineering from NIT Durgapur in 2007-2011. After working for short duration of one year in TCS, I continued to pursue higher studies at Indian Institute of Technology Kharagpur, earning a Ph.D in Metallurgical and Materials Engineering in 2017. Later, After a short tenure of post-doctoral research at Indian Institute of Technology Madras, I joined Department of Metallurgical and Materials Engineering at NIT Rourkela in 2018. After working there for 1.5 years, I joined Department of Metallurgical Engineering and Materials Science at IIT Indore in 2019.*

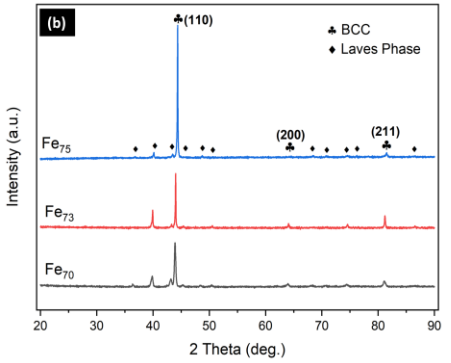
Amorphous Metals Laboratory Research Group broadly works on extensive investigation and exploration of structure-property relationships of metals and alloys through design, synthesis and characterization of advanced materials such as metallic glass, high entropy alloys, ODS alloys, W based alloys etc. Targeted application area includes defense, automobile, aerospace, biomedical sectors etc. Our Group's primary objective is to understand the effect of multi-phase microstructure, alloy addition on the mechanical and microstructural properties.











Key words: Metallic glass, High entropy alloys, Powder Metallurgy, Sintering, Alloy design, Structure-property correlations

Dr. Ranjith K Poobalan

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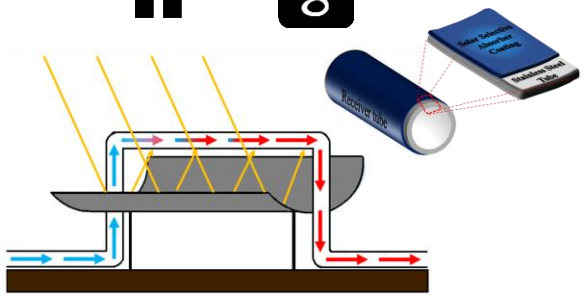
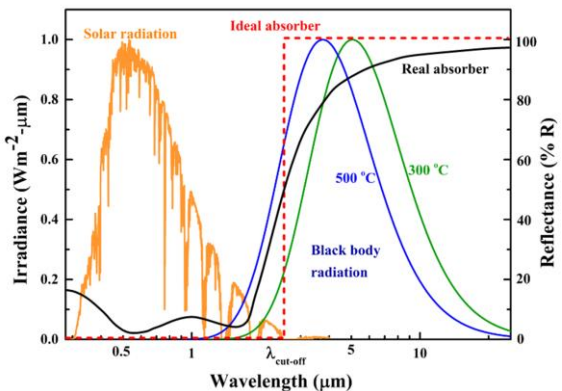
*"**Ranjith Kumar Poobalan**, is an Assistant Professor in the Department of Metallurgical Engineering and Materials Science at the Indian Institute of Technology Indore, India. He did Bachelor of Science in Physics at Madras Christian College (MCC), Tambaram, Chennai. Followed by Master of Science in Physics at National Institute of Technology Tiruchirappalli (NIT-T). He completed Ph.D from Materials Reseach Centre, Indian Institute of Science (IISc), Bangalore."*





His research is mainly focused on the development of thin films by Physical Vapour Deposition (PVD) techniques. The coatings are targeted for various applications like energy harvesting, photonics, and surface protection. Additionally, his group works on the synthesis of magnetic nanomaterials. At present his research work is focused in the following areas:

- ***Multilayer ceramic coatings for concentrated solar power application***
- ***Oxide based coatings for thermochromic windows application***
- ***Coatings for Thermal Control Application of Spacecraft***

Key words: Thin Films, Multilayer coatings, Protective coatings, Thermal coatings, Magnetic nanomaterials.

Prof. (Dr.) Rupesh S. Devan

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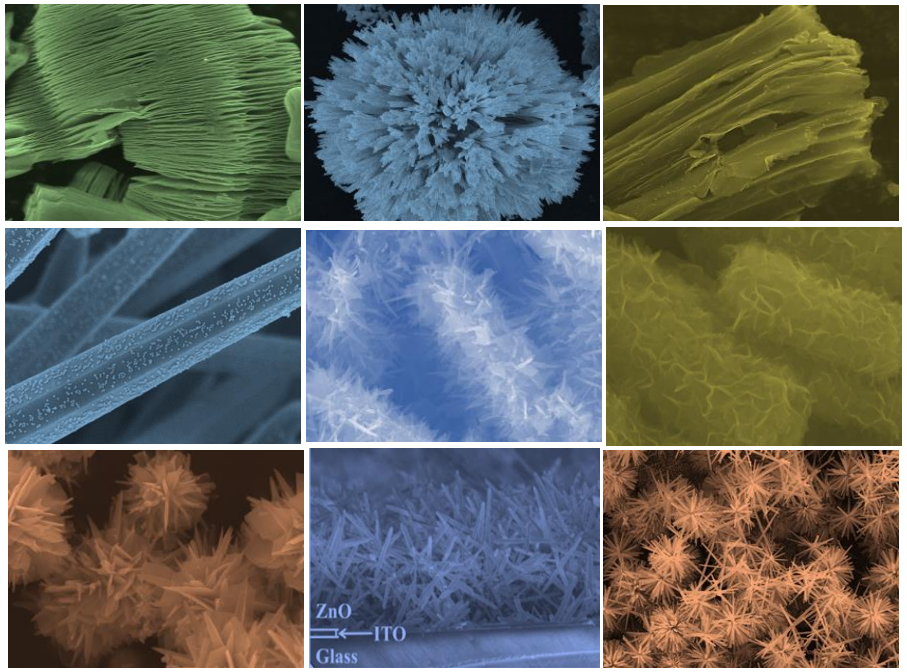
Rupesh S. Devan *is Professor in the Department of MEMS at IIT Indore. He is Adjunct faculty at CEVITS and Department of Chemical Engineering at IIT Indore, and Visiting Professor at National Dong Hwa University, Taiwan. He is recipient of DUO-India Professor Fellowship Award (Gov. of India & ASEM DUO, S. Korea) and INSPIRE Faculty Award (DST India). Since 2018, he has been serving as Editor of Chinese Journal of Physics (Elsevier, I.F.= 5.0). He is listed in the World Ranking of Top 2% most Influential Scientists by Stanford University (2021-24). He has published 2 books, 2 book chapters, 3 special issues, and >142 articles in SIC journals.*

16 Research Projects *(12 as PI & 04 as Co-PI) of* ***₹~4.70 Cr.*** *[SERB, NTTM, BRNS, CSIR, MST, CSR, etc.]* ***>142 Publications*** *with* ***average Impact Factor: ~5***

Nanoarchitecture Research Group

NRG works on the strategic development of nano-hetero-architectures of various energy-storage and photo-active materials with control over their dimensions and shapes for applications in supercapacitors, H_2 generation, water remediation, and desalination. His group is extensively involved in following research areas:



MXenes & Nano-hetero-architectures: Our group strategically grows MXenes and its nano-hetero-architectures of various materials with defined shapes and dimensions to fulfill requirements for application in energy storage and conversion.

Photoactive materials for H_2 generation & water treatment/remediation: We develop new photoactive materials and systematically study their functionalities and exploit them for photocatalytic green H_2 generation, degradation of pollutants, and desalination.

Energy storage Materials for solar and hybrid supercapacitors: We develop nano-hetero-architectures of different materials and study their impact/performance as electrode materials for solar and hybrid supercapacitors that typically compete with rechargeable batteries.

Keywords: MXenes, Metal dichalcogenides/oxides, nano-hetero-architectures, solar/hybrid supercapacitors, water splitting, water remediation, desalination, etc.

Prof. Santosh S. Hosmani

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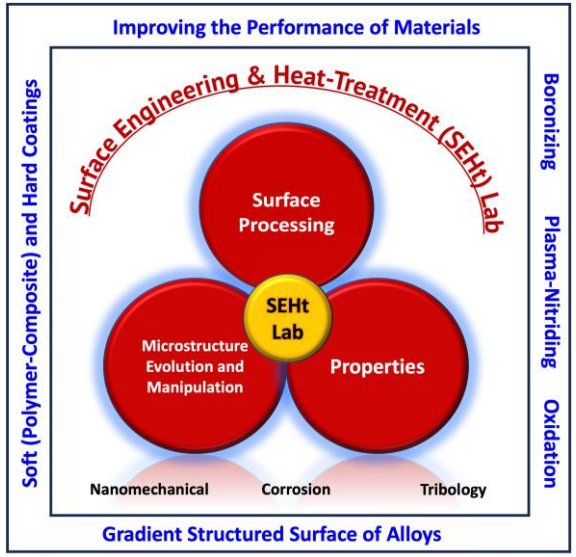
***Santosh Hosmani** is a Professor in the Department of Metallurgical Engineering and Materials Science at the Indian Institute of Technology Indore, India. He did a B.E. in Metallurgical Engineering from REC (currently NIT) - Nagpur and an M.Tech. in Process Metallurgy from IIT-Bombay. He received a DAAD scholarship for doing M.Tech. research at the University of Stuttgart (Germany). He did his PhD work at the Max-Planck Institute for Metals Research, Stuttgart (Germany). He was a post-doctoral scientist at MPI, Stuttgart and CWRU, Cleveland (USA). He has had about 18 Years of Post-Ph.D. experience.*

The **SEHt** Group, headed by Prof. Hosmani, is dedicated to understanding the severe surface deformation and surface alloying of various ferrous and nonferrous alloys. This group attempts to study the effect of surface engineering on the microstructures and properties (mechanical, tribological, and corrosion) of the alloys. Further, this group focuses on coatings to enhance the tribological properties of alloys.



Severe Surface Deformation of Alloys: This research area correlates the process parameters, microstructure, and properties (like corrosion, oxidation, tribology, biocompatibility, etc.) of severely surface-deformed and post-treated stainless steels, Mg-, and Ti-alloys.

Coatings: This area emphasises the deposition of soft (polymer and composite) and hard coatings on metallic substrates and investigates the influence of coatings parameters and substrate conditions on tribological performance.

Surface Alloying: In this study, the role of boronizing and nitriding of stainless steel and Ti-alloys on microstructure evolution and manipulation of properties is focused.

Key words: Surface Engineering, Severe Surface Deformation, Gradient Structured Surface, Surface Alloying, Coatings, Tribology, Microstructure-Property Correlation, and Physical Metallurgy

Dr. Sumanta Samal

*"**Sumanta Samal** completed his B.Sc. in Physics (Hons) at M.P.C. (A) College, North Orissa University, Odisha in 2005, M.Sc. in department of Physics at Utkal university, Odisha in 2007 and M.Tech. in department of Metallurgical and Materials Engineering at National Institute of Technology Rourkela, India in 2009. He earned his doctorate in department of Materials Science and Engineering from Indian Institute of Technology Kanpur, India in 2014, followed by three years of Institute Post-Doctoral research experience in the department of Metallurgical and Materials Engineering at Indian Institute of Technology Madras, India. He joined as Assistant Professor in the department of Metallurgy Engineering and Materials Science (MEMS), Indian Institute of Technology Indore, Indore, India in April, 2017. He is currently working as Associate Professor in the department of MEMS, Indian Institute of Technology Indore, Indore, India from November, 2022. His research and teaching interests include solidification, physical metallurgy, phase field simulation for microstructural evolution, phase transformations and phase equilibria in materials"*

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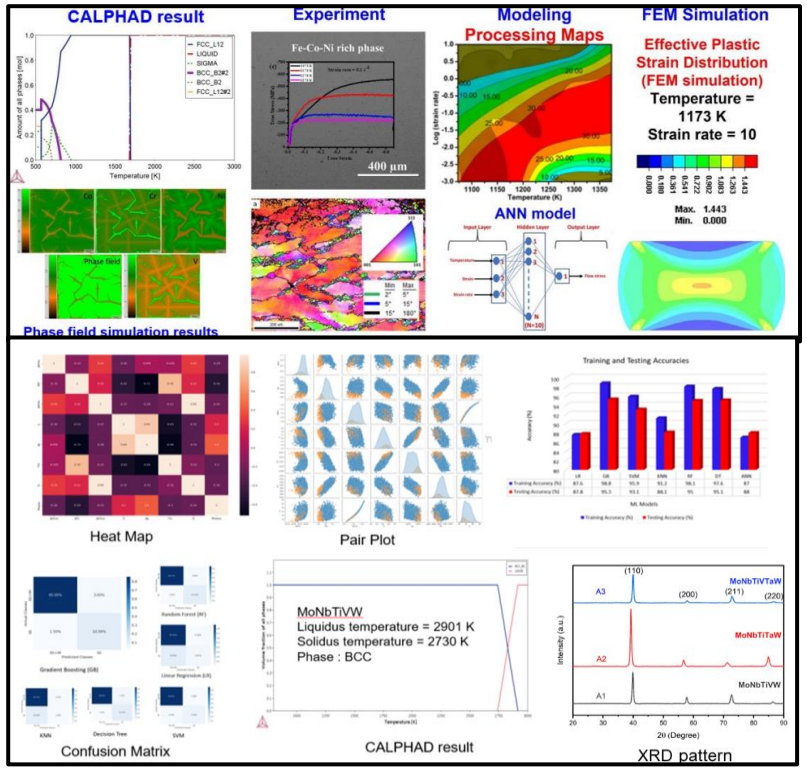

Research Areas:

Solidification: Experiments and Simulation: The non-equilibrium response of multicomponent alloys is investigated using undercooling as a control parameter. The segregation behaviour of the alloy is predicted using phase field simulation at different undercooling temperatures. The phase selection kinetics and magnetic behaviour of undercooled alloys have been understood w.r.t. undercooling.

Material design for high temperature applications: Refractory high entropy alloys (RHEAs) with BCC structure and high temperature stability have been developed using machine learning (ML) algorithms, thermodynamic simulation and experimental techniques which will open up new possibilities for high temperature structural applications.

Phase equilibria: Materials for the future: Novel alloys with unique microstructure (consisting of single-phase, eutectic, or bimodal eutectics, or ternary eutectics or peritectic-eutectic microstructure) have been designed and developed by integrated approach and subsequently, the phase equilibria of developed alloys have been understood. The hot deformation behaviour of developed materials at different temperatures and strain rates is understood and processing maps are generated using multiple model parameters to identify workability regimes.

Key words: Solidification, Phase equilibria, Undercooled alloys, Materials design: multicomponent/high entropy alloys, phase field simulation, Machine learning

Dr. Sunil Kumar

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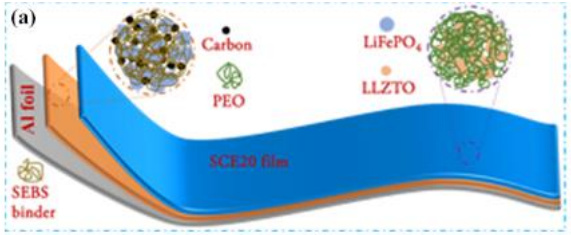
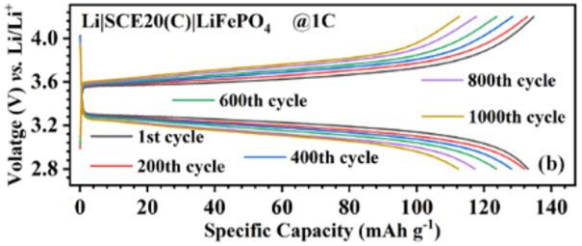
*"**Sunil Kumar**, is an Associate Professor in the Department of Metallurgical Engineering and Materials Science at the Indian Institute of Technology Indore, India. He has a Master's in Physics from Delhi University in 2004 and a Ph.D. from Indian Institute of Science Bengaluru (2012). Dr. Kumar was an ERASMUS-MUNDUS fellow at UPC Barcelona (Spain) and a Research Fellow at the National University of Singapore (2012-2014).*

His Research Group (**Solid State Ionics Lab**) is involved in experimental research and primarily focuses on the design and development of functional materials for electrochemical energy storage applications. Briefly-

Cathodes for Li/Na-ion Batteries: Develop battery cathode materials for Li/Na batteries as a means to have safer, cheaper, and better-performing electrochemical energy storage systems. The focus is on developing new compositions in NASICON-type and layered oxide materials.



Solid Electrolytes: Systematically investigate and address the fundamental questions related to Li^+ and Na^+ conduction and interfacial phenomenon and associated impact on the charge/discharge capacities, columbic efficiency, electrochemical stability, and cyclability of rechargeable alkali metal batteries.



Fabrication of Pouch-type Battery Cells: Scaling up the fabrication of developed cathodes with identified anode materials in a multi-layer optimized full-cell configuration.

Keywords: Electrochemical Energy Storage, Layered Oxides, Cathodes, Li-ion Batteries, Na-ion Batteries, All-Solid-State batteries, Solid Electrolytes, Electrochemical Impedance Spectroscopy, Electroceramics.

Dr. K. V. Vamsi

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*"**Vamsi** is an Assistant Professor in the Department of Metallurgical Engineering and Materials Science at IIT Indore, India. His academic journey began with a B.E. in Metallurgical Engineering from Andhra University College of Engineering. He earned his M.E. and Ph.D. in Materials Engineering from IISc Bangalore. His postdoctoral research at the University of California, Santa Barbara, focused on understanding the deformation pathways and thermodynamics in Superalloys, FCC, and Refractory Multi-principal element alloys (MPEAs) and High-entropy Alloys (HEAs).*

His professional journey also includes roles at TCS Research, Tata Steel R&D, and Ispat Industries Ltd. "

VAMSI Research Group tackles fundamental deformation-related issues by integrating physics-based models with underlying phenomenology. This is achieved by employing atomistic simulations, computational thermodynamics, and analytical modelling. Within the group, they explore the following key research areas:

Understanding Deformation Mechanisms: Unravel the intricate mechanisms underlying material deformation and develop a mechanistic approach to alloy design.

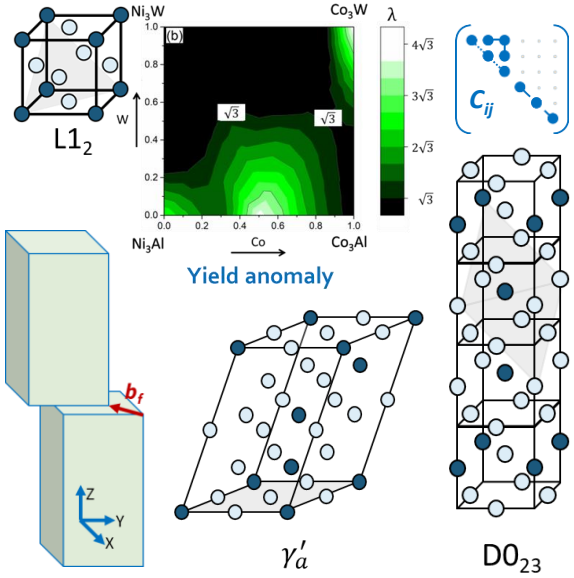
High-Throughput Exploration of Complex Composition Domains: Emphasis on the development of high-throughput methods and frameworks to explore uncharted composition domains within Multi-Principal Element Alloys (MPEAs), tailored for specific structural applications.

Integrated Computational Materials Engineering (ICME) Frameworks: Develop ICME frameworks that seamlessly integrate models from diverse processes and length scales.

Key words: Alloy design, Structure-property correlations, High-throughput methods, Materials Modelling, ICME, Deformation pathways, High temperature deformation.

VAMSI
Virtual Alloys Modelling, Simulation & Informatics
Research Group

Mechanistic Approach to Design



Dr. Vinod Kumar

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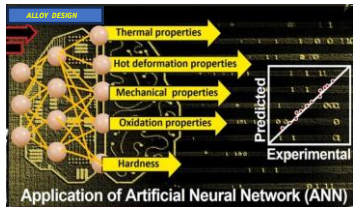
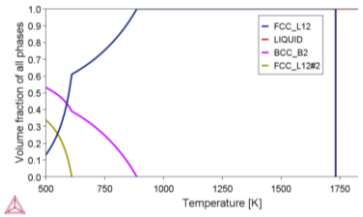
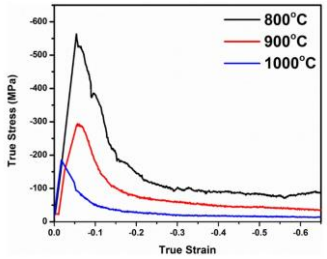
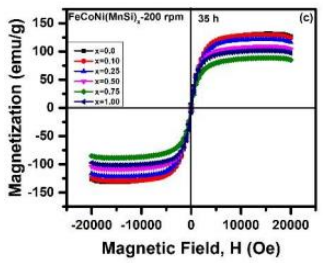
*"**Vinod Kumar**, is an Associate Professor in the Department of Metallurgical Engineering and Materials Science at the Indian Institute of Technology Indore, India. His academic journey began with a B. Tech. in Metallurgy and Materials Engineering from the National Institute of Foundry and Forge Technology, Ranchi in 2004. He did an M.Tech and PhD, in Materials Science and Engineering from the esteemed Indian Institute of Technology Kanpur. He completed his Ph.D. in 2012. Before joining IIT Indore, he worked as an Assistant Professor in the Department of Metallurgical and Materials Engineering at Malaviya National Institute of Technology Jaipur. He also served as the Head of the Department of Metallurgical Engineering and Materials Science at the Indian Institute of Technology Indore for a period of 3 years. (January 13, 2020 - March 30, 2023) "*

Non-equilibrium Advanced Materials and Engineering (NAME) Laboratory uses experiments and analytical theory to explore the materials-processing-structure-property relationships in structural metallic materials and energy materials and their development for required engineering application, with particular emphasis on the role of structural disorder and its effect on environmental degradation and mechanical properties. Our research also involves non-equilibrium processing for the development of energy materials and high entropy alloys of industrial relevance using a variety of tools as well as in developing new metal-matrix composites applications









Multicomponent Alloy Design, Development, and Application: Medium and high-entropy multicomponent alloys have been designed with the help of thermodynamic simulation using the thermo-calc software, followed by synthesis by the solidification processing technique for potential applications. Developed alloys are characterized using different techniques which include TEM, FESEM, and XRD. Mechanical, Magnetic, and Electrochemical properties are also studied.

AI- ML for properties prediction and for bio-medical application: Machine learning-assisted artificial neural network (ANN) modeling methods are incorporated for predicting material performance.

Heat Treatment and Powder Metallurgy

Key words: Alloy design, Structure-property correlations, AI-ML Modelling, Artificial Neural Network (ANN), Corrosion, Wear, High-Temperature Oxidation.

Dr. Vivek Verma

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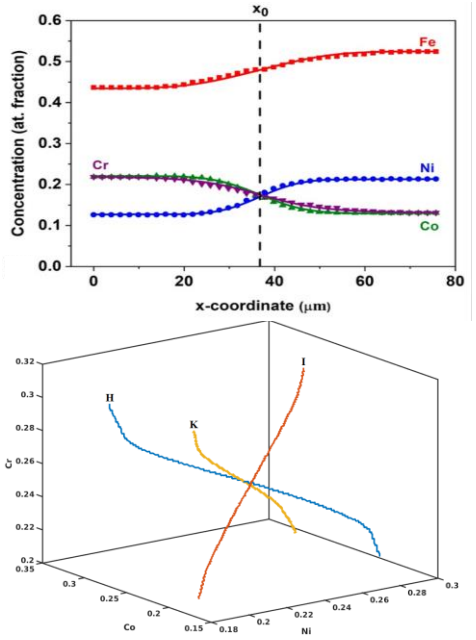


Diffusion Paths Quaternary System

*"**Vivek Verma**, is an Assistant Professor in the Department of Metallurgical Engineering and Materials Science at the Indian Institute of Technology Indore, India. His academic journey began with a B.Tech. in Metallurgical Engineering from National Institute of Technology Raipur in 2008. I continued to pursue higher studies at the esteemed Indian Institute of Technology Kanpur, earning an M.Tech. in Materials Science and Engineering in 2014 and a Ph.D. in Materials Science and Engineering in 2022"*

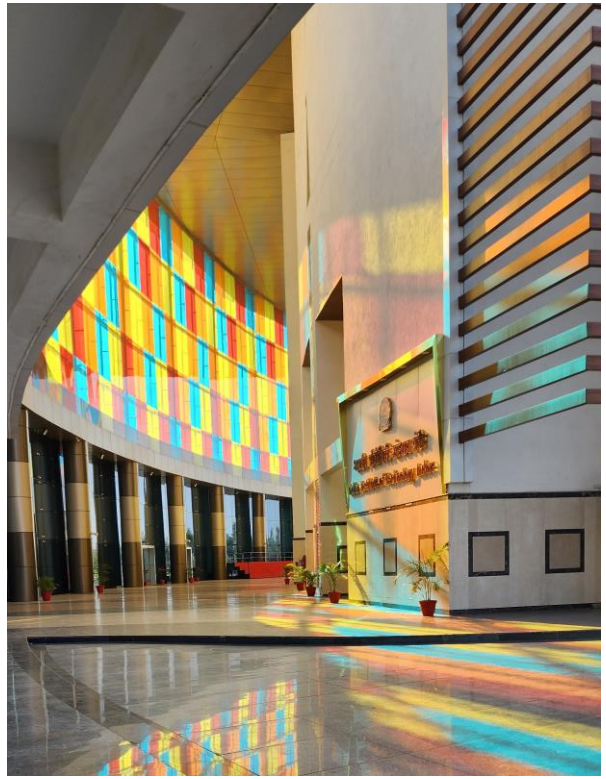
Phase Equilibria and Diffusion Kinetics Research Group aims to explore the correlation between composition, process, and property in multicomponent systems, leveraging this knowledge to pioneer novel materials and processes of technological significance. Our work primarily concentrates on exploring multicomponent diffusion and phase equilibria through experimental studies, supported by kinetic models and computational thermodynamics. Within the group, they explore the following key research areas:

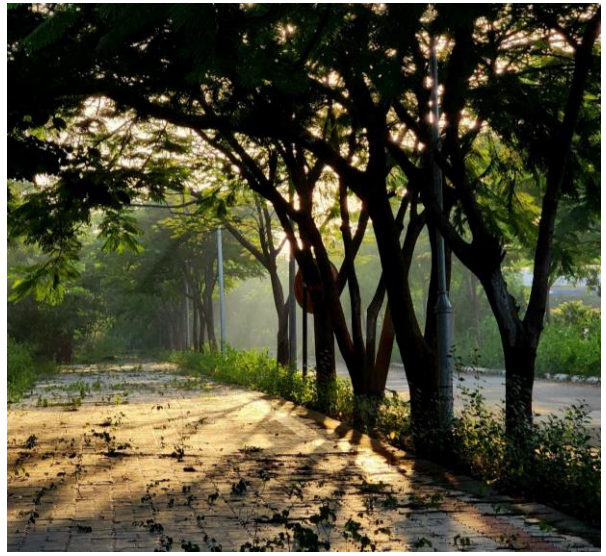
Understanding of Multicomponent Effects: Explore the pivotal role of diffusional interactions within multicomponent systems for the purpose of alloy design.

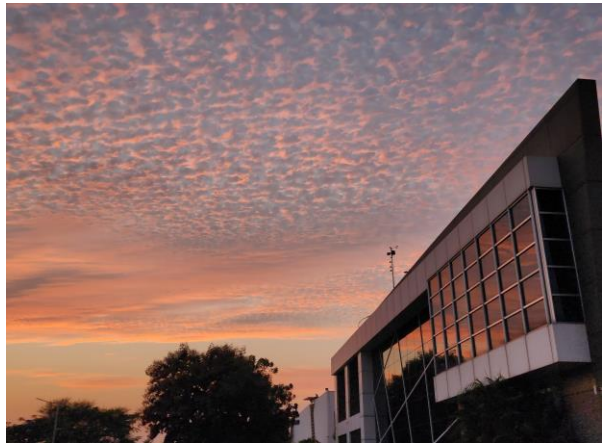
Exploring High-Throughput Approaches for Studying Multicomponent Diffusion: Prioritizing the advancement of high-throughput techniques and frameworks for analyzing multicomponent diffusion behavior within unexplored complex compositional spaces in Complex Concentrated Alloys (CCAs).

Modeling and Simulation: Employ experimental diffusion datasets for the modeling of kinetic mobilities and the simulation of industrially significant metallurgical processes.

Key words: Diffusion, Phase equilibria, Multicomponent systems, Structure-property correlations, High-throughput methods, Computational thermodynamics, Kinetic modeling and simulations.







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