Materials Science Programme
Indian Institute of Technology Kanpur

SESSION 2025-2026

PLACEMENT BROCHURE

Student Placement Office

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VISIT US at https://www.iitk.ac.in/msp/

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WELCOME MESSAGE FROM THE HOD

Materials Science Programme

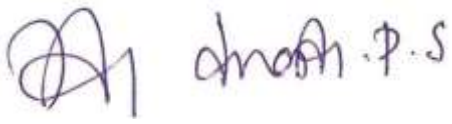
Indian Institute of Technology Kanpur

"It is clear that the strength of even the largest engineering structure depends in part upon chemical and physical events happening upon a molecular scale and so we shall not only have to let our ideas range freely up and down the scale of physical dimensions from the very big to the very small, but we shall also have to jump backwards and forwards from the ideas of chemistry to those of engineering. In the current phrase materials science is 'interdisciplinary'."

-- From "The New Science of Strong Materials or Why You Don't Fall Through the Floor" by J E Gordon (1963)

The interdisciplinary program on Materials Science continues to keep the spirit of the above-mentioned wise words alive. While these lines were written many decades ago, the ever-expanding inroads of materials into technology have necessitated continued rejuvenation of education and research training in the domain of materials science, engineering and technology. Every student and participating faculty of MSP aims to bring to fruition the spirit of inter-disciplinarity, wherein technical problems are viewed with more than one lens. Students with a wide range of training in their undergraduate degrees-typically from Chemistry and Chemical Engineering, Electrical Engineering and Physics, Mechanical Engineering and Instrumentation-are inducted into MSP and first-year courses are designed for cross-pollination of strengths and viewpoints of different departmental ecosystems. Each course is typically taught by two faculty from two different backgrounds. Students graduate to their second phase in training by taking up research challenges at the interface of different disciplines Such an evolution of students' technical competence makes them ideally suited to wrestle with the many facets of the contemporary industrial material ecosystem, which invariably comprises multidisciplinary teams. We have aspired to inculcate the spirit of lifelong learning in students and we hope such an aptitude will be gainfully employed in your technical troubling environment.

We look forward to your feedback on your technological needs so that we can strategize the training of the next generation of interdisciplinary interlocuters!



Dr. Raj Ganesh S .Pala
Professor and Head,
Materials Science Programme
Indian Institute of Technology Kanpur

About Us





The Interdisciplinary program in Materials Science at IIT Kanpur was established in July 1971 as an early degree program aimed at promoting collaboration across different fields of research and technology. This approach contributes to advancing and enhancing material qualities for several applications, including electronic devices, semiconductors, mechanical systems, nanotechnology, energy storage, stealth technology, and sensing capabilities. Our students engage in a demanding curriculum that includes practical laboratory exercises to characterize different materials' properties. These exercises involve the use of advanced techniques such as Scanning Electron Microscopy (SEM), Raman Spectroscopy, Transmission Electron Microscopy (TEM), X-Ray Diffraction (XRD), X-Ray photoelectron spectroscopy (XPS), and various other materials characterization techniques. The combination of interdisciplinary knowledge acquired by students throughout their course work and their specialized and in-depth subject expertise gained through Ph.D. study makes them strong candidates for both industry application and academia. GATE scores are the selection criteria for this program.

Courses Offered

MATERIALS ENGINEERING

- **Semiconductor processing methods**
- Solidification.
- **Powder processing**.
- **Crystal growth.**
- Heat treatment.
- **Non destructive evaluation.**
- **Processing of glasses and polymers.**
- Novel processing methods.
- **Thin films.**
- Surface phenomena and **corrosion**.
- **Composites.**

MECHANICAL PROPERTIES of MATERIALS

- Stress & strain tensors & elastic constants.
- Effect of structure on elastic behaviour.
- **Viscosity and viscoelasticity in polymers**.
- Dislocations and plastic deformation of metals and ceramics.
- **Creep, brittle fracture in ceramics and glasses.**
- Fatigue.
- **Mechanical testing**.
- **Strength and engineering design with brittle solids.**

STRUCTURAL AND MAGNETIC PROPERTIES of MATERIALS

- Crystal structure, bonding of atoms & crystal chemistry.
- **Equilibrium thermodynamics, phase equilibria, phase transformations.**
- Dia–, para–, ferro–, ferri–, and antiferro–magnetism.
- Anisotropic effects.
- Magnetic domains, magnetostriction.
- **Measurements of magnetic properties.**
- Soft and hard magnetic materials and their technology.

CHARACTERIZATION of MATERIALS

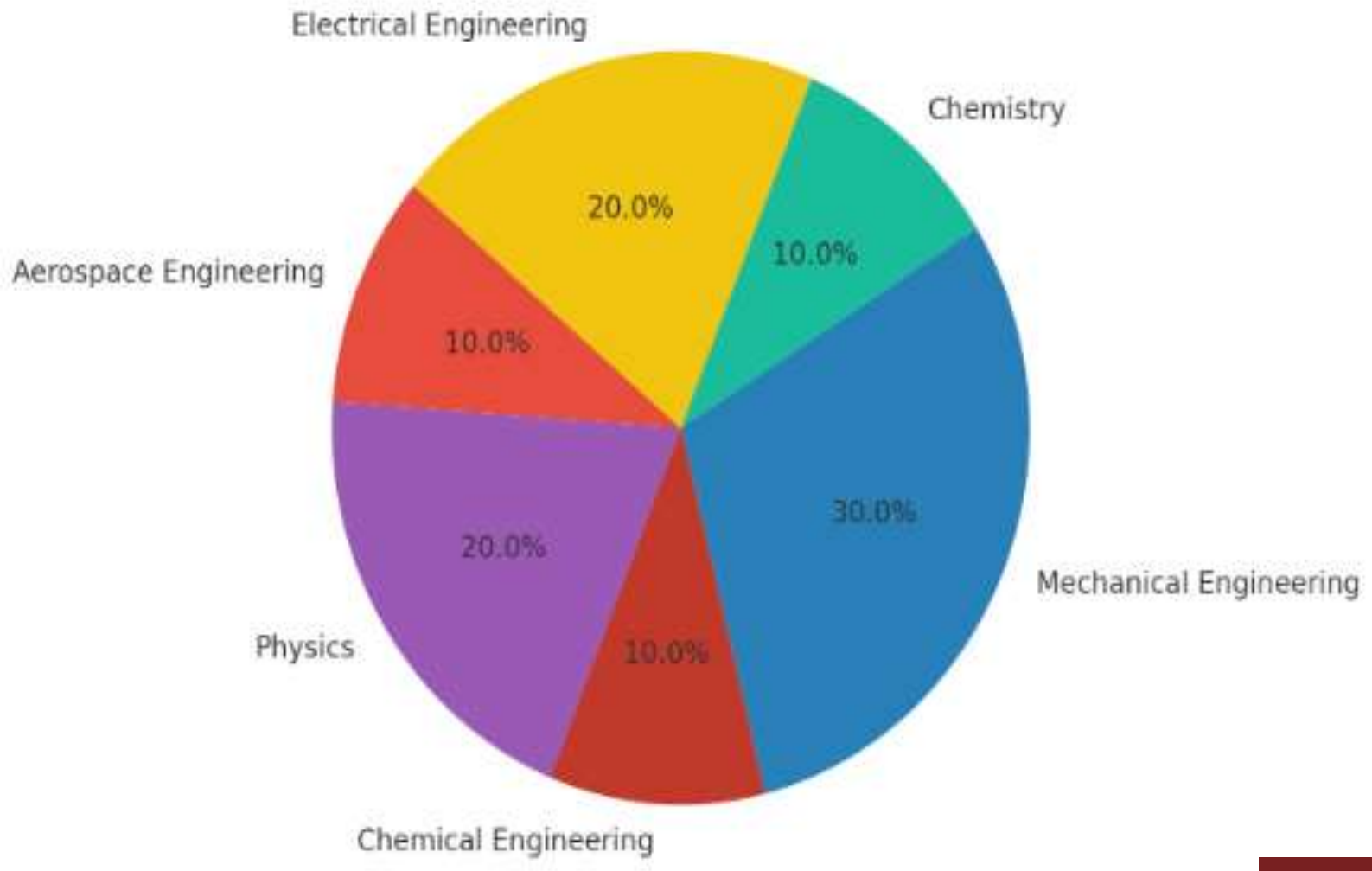
- Data and Error analysis.
- Crystallography.
- **XRD**.
- **Spectroscopic techniques**–
  - IR, Raman, Microwave.
- Magnetic Measurements.
- **Optical and electron microscopy**
- **Electrical characterization techniques**–
  - Hall effect, Resistivity etc.
- Laboratory sessions.

ELECTRICAL AND DIELECTRIC PROPERTIES of MATERIALS

- Free electron theory
- Metallic conduction
- Energy bands
- **Brillouin zones**
- Temperature dependence of metallic conductivity
- Semiconductor materials & doping effects
- P–N junctions
- **MOS field effect transistors**
- Di–, ferro–, and piezo–electric materials
- Semiconductor technology
- **Linear Dielectrics**
- **Non-Linear Dielectrics**
- Ionic Conductivity: Point Defects in Crystals
- Diffusion: Mechanism
- Measurement of Conductivity
- **Microwave Dielectrics and Applications**

- Engineering polymers
- High performance polymers and composites
- Materials selection in mechanical design

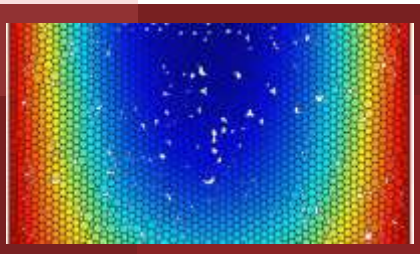
Students' Demography



Research Areas

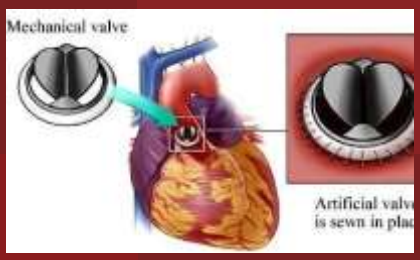
Physics Based Process Modelling of Hot Isostatic Pressing (HIP):

Influence Of hydrostatic Pressure And temperature On consolidation/density distribution.



Innovating Heart Valve Design With Advanced Simulation Techniques:

Our comprehensive approach integrates Ansys simulations, including central composite design and finite element analysis, to optimize heart valve functionality. Coupled with Computational Fluid Dynamics, our studies include detailed stress analyses and calibration studies, ensuring robust performance and reliability for cardiovascular health applications.

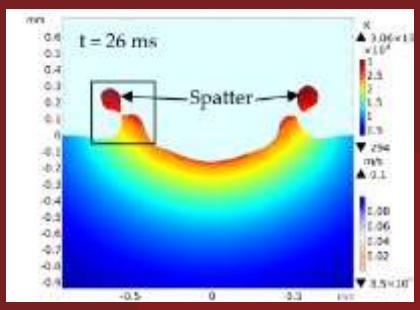


P-type NiO Thin Film Deposition Using RF Sputtering:

This research work is on NiO thin film deposition using RF Sputtering and controlling its doping. Basically this work is based on developing wide band gap semiconductors that are the next generation of power electronics. In this a film of p-NiO will get deposited that will integrate with n-Ga2O3 as pn-diode and will act as a rectifier.

Elevate Aerospace Resilience With Cutting-edge COMSOL Simulations of Laser Damage Potection:

This research utilizes advanced COMSOL multiphysics simulations to investigate the laser ablation of Al2O3 ceramic coatings. By combining numerical simulations with experimental data, we uncover key mechanisms of laser-induced damage, enabling the development of robust protective solutions for aerospace components.

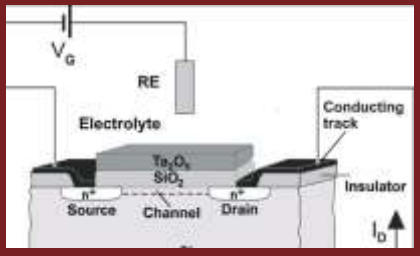


Printing of Bio-impedance Sensor on Textile:

Our groundbreaking research focuses on the development and integration of bio-impedance sensors directly onto textiles, revolutionizing the landscape of wearable technology. By leveraging advanced printing techniques, we seamlessly embed these sensors into fabrics, enabling continuous and non-intrusive health monitoring. This innovative approach not only enhances comfort and wearability but also provides accurate real-time data on physiological parameters such as hydration levels, muscle health, and cardiac activity.

ISFET Based Ion and Bio Sensors:

ISFETs (Ion-Sensitive Field-Effect Transistors) are solid-state devices used for ion sensing in solution. ISFETs operate based on the potential over the oxide-solution interface, allowing for pH sensing and biomolecule detection.



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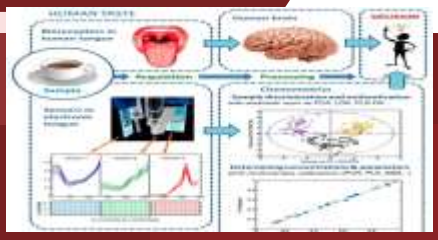
Research Areas

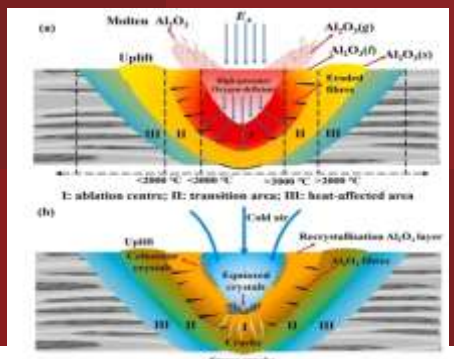
Electro-chemical Impedance analysis on Chemical Taste Sensing, Data Custering by Unsupervised Computer Learning Algorithm:

Classification of drugs, taste based classification of medicinal ingredients on the basis of electro-chemical reactions, data collection and clustering on the basis of principle component analysis and unsupervised learning algorithm.



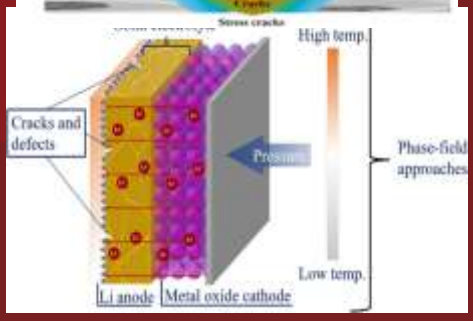
A Numerical Study towards design of composite laser ablation coating:

This thesis focuses on developing a 3D coupled thermal-structural simulation in Abaqus to study how ceramic materials respond to continuous laser irradiation. The simulation uses user-defined subroutines — DFLUX for applying a spatially varying heat flux and USDFLD for temperature-driven element deletion , to mimic the process of laser-induced material removal. The objective is to analyse heat transfer, stress development, and ablation behaviour in candidate ceramics under extreme thermal loading, with relevance to aerospace thermal protection systems.



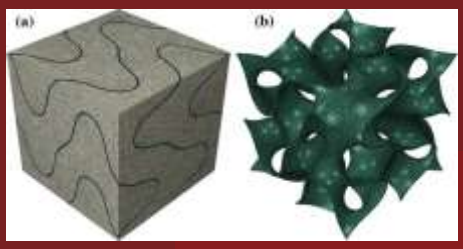
Advanced Phase Field Simulation of Fracture Mechanism for Enhanced Durability of Li-ion Solid State Batteries Using Multiphysics software MOOSE:

Our cutting-edge project leverages the multiphysics software MOOSE to conduct phase field simulations of the fracture mechanisms in Li-ion solid state batteries. By incorporating polymer matrix-based composite solid state electrolytes and utilizing grand potential-based modeling, we aim to significantly enhance the durability and performance of these batteries. This innovative approach addresses critical industry challenges, paving the way for more reliable and efficient energy storage solutions.



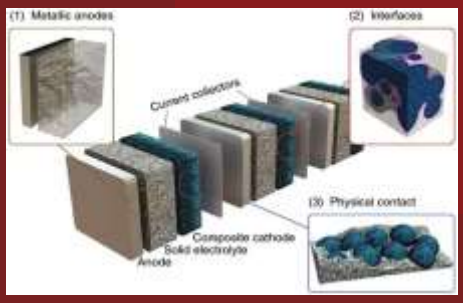
Numerical Modelling of The Micro-structure and Failure of the 3D Pinted Preforms of The Metal-ceramic Composites:

This research deals with 3D printed metal preforms in which Fe models of the units cells fdm software units cells and TPMS structure unit cells will be created and validated with experimental results. Thermo-mechanical stress tensor and thermal conductivity tensor are being used for finding the optimization wall thickness. Simulation will be performed in ABAQUS.



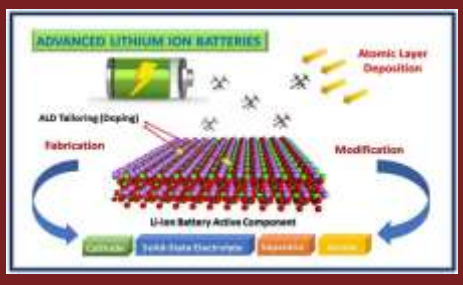
Phase Field Modeling of EEI in Composite Solid State Electrolytes with Nanofibers in a Viscoelastic Matrix Using MOOSE:

This study investigates the temporal evolution of electrode-electrolyte interphase (EEI) in composite solid-state electrolytes embedded with nanofibers within a viscoelastic matrix. Utilizing the Multiphysics software MOOSE and phase field simulation, the research provides insights into the complex interactions and mechanical properties governing the stability and performance of these advanced electrolyte materials.



Novel Materials for Solid State Battery Electrodes:

This research focuses on the development and optimization of solid state battery electrodes, aiming to enhance energy density and cycling stability. this work focuses on investigating novel materials and architectures to improve performance and safety in solid state batteries. This includes the synthesis and characterization of advanced electrode materials, with an emphasis on scalability and industrial applications. Through this research, the end goal is to contribute in this field by exploring innovative solutions to address current challenges in electrode design and functionality.



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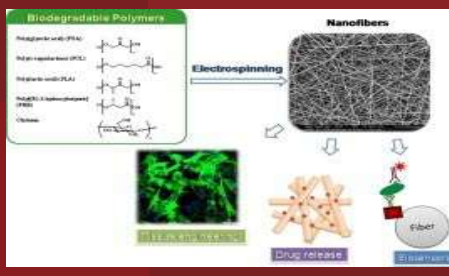
Research Areas

Synthesis of Electromagnetic Interference Shielding Materials and SImulation by Using CST Microwave Software:

This research on electromagnetic shielding materials utilizes advanced characterization techniques such as XRD, SEM, TEM, Raman spectroscopy, EDS, and UTM for precise evaluation and optimization. With EMI shielding effectiveness measured across a broad frequency range and simulations conducted using CST Microwave Studio, this project aims to develop innovative solutions for wearable electronics, flexible devices, defense equipment, and medical instruments, offering significant advancements for industry partners.

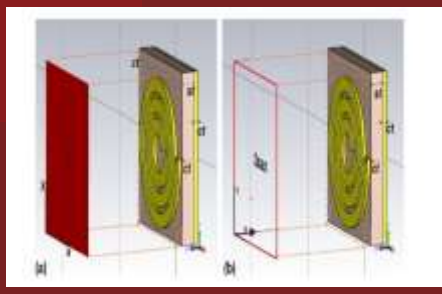
Electrospinning of Polymers:

This research deals with pioneering electrospinning research to develop nanofibrous polymer materials with exceptional properties for transformative applications in energy, filtration, and biomedicine.



Design, Simulation, And Experimental Realization Of a Metamaterial Absorber Using Nanocomposites:

This interdisciplinary research integrates computational electromagnetic simulation using CST Microwave Studio with material synthesis and characterization techniques. The objective is to develop a high performance, broadband, and polarization-insensitive absorber for potential applications in EMI shielding, stealth technology, and sensor design.

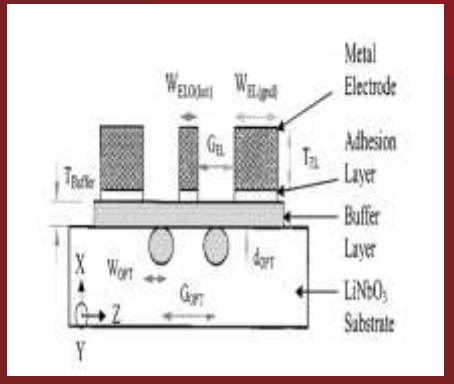


Biosensor For Milk Adulteration And Pesticide Analysis:

This project focuses on developing a cost-effective and highly sensitive biosensor for detecting adulterants in food, with a special emphasis on milk adulteration. Common contaminants such as urea, added salts, excess water, and pesticide residues will be targeted. The biosensor will utilize a combination of colorimetric spectrophotometric techniques and electrochemical analysis to enhance detection accuracy, sensitivity, and ease of use. The goal is to create a reliable, rapid, and affordable tool for routine testing, suitable for both laboratory and field applications in ensuring food safety and quality.

High-speed Electro-optic Modulators Based On Lithium Niobate For Fiber-optic Communication Systems:

The Research focuses on the design, fabrication, integration, and reliability of Lithium Niobate ($LiNbO_3$) modulators used in fiber-optic communication systems, particularly for data rates up to 40 Gb/s and beyond. Over the past decade, as the demand for telecommunications services and bandwidth has boomed, the need for and advantages of external modulation in fiber-optic transmission systems has been firmly established. In higher speed digital communication applications, fiber dispersion has limited system performance. Lithium niobate (LiNbO3) external modulators provide both the required bandwidth and the equally important means for minimizing the effects of dispersion.



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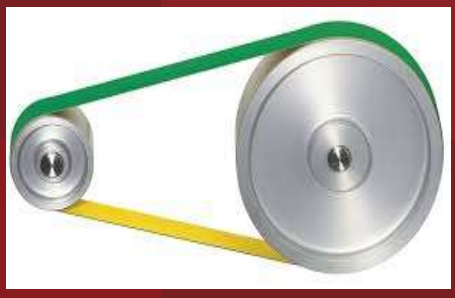
Research Areas

Optimization of Stainless Steel:

This study focuses on optimizing the performance of various stainless steel grades such as 304, 316, 2504, etc., using Taguchi-based Grey Relational Analysis (GRA). By applying GRA to experimental data, we aim to determine the best combination of alloying elements and process parameters that enhance mechanical and corrosion resistance properties for superior material performance.

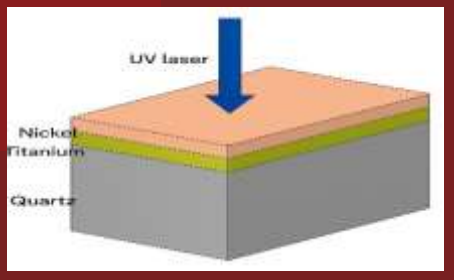
Performance Optimization of Power Transmission Belts:

This study focuses on optimizing the performance of power transmission belts by analysing key factors such as belt material, operating speed, load, and tension using Response Surface Methodology (RSM). The objective is to improve efficiency, reduce wear, and enhance service life, ensuring reliable and cost-effective performance in industrial applications.



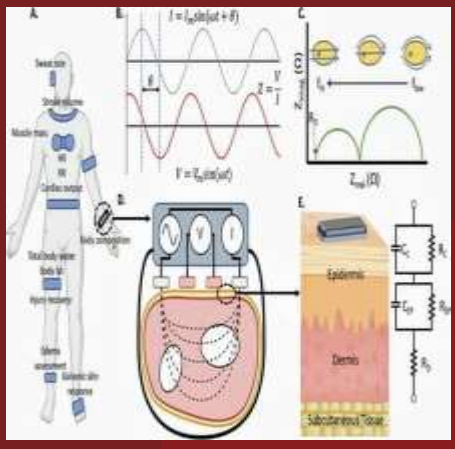
Lithography Free Fabrication Of P-n Junction Using Wide Band Gap Nio And Tio2 By Direct Laser Writing Method:

Conventional methods for fabrication of p-n junction are complex, costly, time consuming. In this work we are using laser to directly oxidize Nickel Titanium bilayer to get NiO (p-type) and TiO2 (n-type) junction.



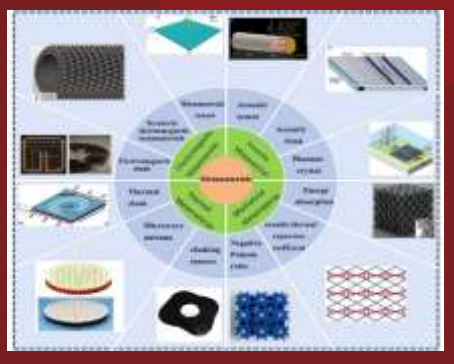
Development Of Tissue Mimicking Phantoms For Bioimpedance Sensing:

The project aims to develop anatomically and electrically relevant tissue-mimicking phantoms for evaluating bioimpedance-based sensing systems in two critical applications: skin hydration assessment and tumor characterization. The phantoms will be formulated using polymeric and ionic gel matrices embedded with tunable dielectric fillers to accurately replicate the complex permittivity and conductivity spectra of human tissues across a frequency range of 10 Hz to 1 MHz. For hydration sensing, multilayer constructs simulating the stratum corneum, dermis, and subcutaneous tissue will be fabricated to emulate hydration-dependent impedance variations. For tumor detection, heterogenous phantoms incorporating inclusions with elevated conductivity and permittivity will model malignant growths within healthy tissue analogs. These phantoms will enable controlled, repeatable testing of wearable bioimpedance sensors and support algorithm development for signal interpretation in physiological and pathological conditions.



Design and Simulate the Metamaterial Inspired RF Sensor using nanomaterials:

This study focuses on the design and simulation of a metamaterial-inspired RF sensor utilizing nanomaterials to achieve enhanced sensitivity and miniaturization. Nanomaterials are incorporated to improve the sensor's performance in terms of frequency response and signal detection and HFSS software is used for the full-wave electromagnetic simulation, enabling optimization of the sensor geometry and validation of theoretical performance.



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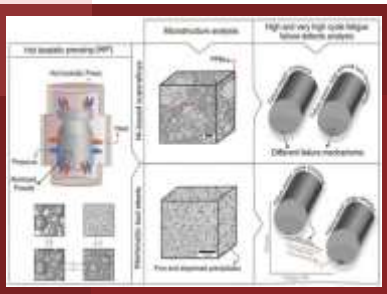
Research Areas

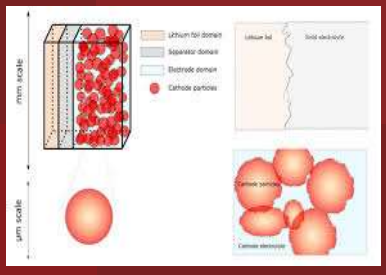
Development of a Discrete Particle Model for Hot Isostatic Pressing:

This thesis focuses on developing a 3D discrete particle model to simulate the hot isostatic pressing (HIP) process for powder materials. The model will capture particle-level compaction, densification, and microstructural evolution under high temperature and isostatic pressure. The objective is to analyze the powder consolidation behavior, pore closure, and final material density, which are critical for manufacturing aerospace components and other high-performance parts.



Interface Optimization In Solid State Batteries:

Solid-state batteries offer higher energy density, improved safety, and longer cycle life as compared to conventional lithium-ion batteries. However, the realization of their full potential hinges on overcoming critical interfacial challenges, particularly at the cathode-electrolyte interface, which plays a key role in overall performance. Poor physical contact and chemical instability, manifest as high interfacial resistance and continuous side reactions that eventually result in capacity degradation. My work is based on improving the compatibility and optimizing the cathode - electrolyte interface.



Recycling Of Photovoltaic Modules:

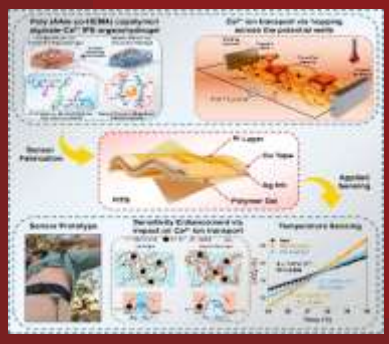
Recycling of photovoltaic (PV) modules is crucial for resource recovery and environmental sustainability. It involves separating and purifying valuable materials like glass, silicon, and metals from end-of-life or damaged solar panels

RF sensor:

RF sensing and imaging of dielectric materials and media for biomedical and humanitarian applications

Bio-based Conducting Polymeric Soft Materials In Wearable Sensors For Human-body Temperature Monitoring:

This research primarily focuses on designing and functionalizing conducting soft polymeric materials for bio-based flexible, wearable, and sustainable sensing applications. A key contribution of my doctoral work is the development of bio-based ionic and electronic conducting polymeric hydrogels and organohydrogels optimized for wearable temperature monitoring. My interdisciplinary research integrates materials engineering, polymer science, and charge transport phenomena to advance high-performance polymer nanocomposites and conductive soft materials for flexible and wearable applications.



MXenes in Electromagnetic Shielding Applications:

The usage of electrical gadgets, 4G and 5G technologies, and wireless communication systems has increased the electromagnetic (EM) waves, leading to EM pollution. These unnecessary EM waves interfere with near-susceptible electronic devices, resulting in malfunctions, reduced lifespan of devices, and sensitive information leakage. MXenes are emerging 2D materials used to mitigate EM wave pollution. As MXenes are novel, there is plenty of room to explore MXene types, their synthesis, and their application in EMI shielding.

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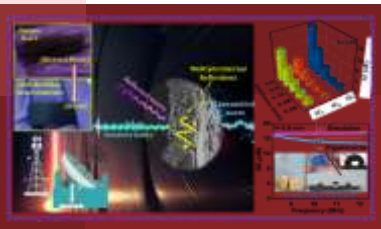
Research Areas

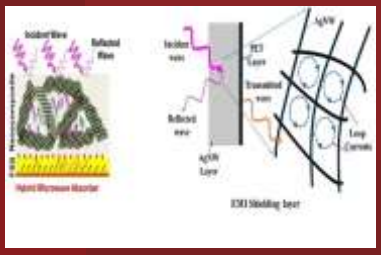
EMI Shielding:

Carbon based materials for flexible and lightweight EMI shieling composites



Studies on FSS Integrated Optically Transparent, Flexible and Structured Materials for Radar Absorption and EMI Shielding:

Development of Indium Tin Oxide based flexible optically transparent materials for radar absorption. Development of silver nanowire based optically transparent flexible thin film for EMI shielding. Simulation of absorber and EMI shielding structures in CST Microwave Studio. Equivalent electric circuit analysis of FSS based structures in ADS tool. Characterisation of materials through Raman, XRD and SEM and vector network analyser.



Sustainable supercapacitor using cost effective and non traditional materials:

The world is using more and more electrical energy every day. Because of this, we need better ways to store energy. Most current energy storage devices use metals like lithium, cobalt, and lead. These metals are not found in large amounts and their mining can harm the environment. This makes them a problem for long-term use. This research focuses on making a supercapacitor using materials that are easy to find in nature and safe for the environment. The goal is to create a device that can work for 20 to 30 years without needing to be recycled or replaced. This kind of supercapacitor can help meet the growing need for clean and long-lasting energy storage.

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Lab Facilities

OPTICAL SPECTROSCOPY

Experimental condensed matter physics with emphasis on using spectroscopy tools such as Raman scattering to probe the nanoscale dynamics in novel and interesting materials
Location : ACMS 107

THIN FILMS LABORATORY

Nano, electronic, magnetic recording and hydrogen energy storage materials, Thin films, Electron microscopy
Location : ACMS 108B

MICROWAVE MATERIALS PROCESSING LABORATORY

Microwave absorbers, Microwave sensors, Stealth technology, Dielectric properties
Location: ACMS 207A

Lab Facilities

MATERIALS SCIENCE INSTRUCTIONAL LABORATORY

Nano, electronic, magnetic recording and hydrogen energy storage materials, Thin films, Electron microscopy
Location : ACMS 210

ADVANCED NANOENGINEERING MATERIALS LABORATORY

Carbon nanotubes, Nanostructured materials, Functionally graded materials, Fuel cell, Solar cell, Li-battery, Polymer, Thermoelectric materials, Nanocomposites
Location : ACMS 208

Faculty list

Dr. Raj Ganesh S Pala
Professor and Head, PhD (Physical Chemistry), University of Utah
Research Interest : Electrochemical , Catalysis and Separations Engineering

Dr. Kamal K Kar
Professor, PhD, IIT Kharagpur
Research Interest : Materials for solar cell, fuel cell, lithium battery, high performance structural composites

Dr. Rajeev Gupta
Professor
PhD, IISc Bangalore
Research Interest : Experimental condensed matter physics

Dr. M. Jaleel Akhtar
Professor, PhD, University of Magdeburg , Germany
Research Interest : Microwave imaging and non-destructive testing , RF and microwave sensors

Dr. Sri Sivakumar
Professor ,Ph.D., University of Victoria, Canada
Research Interest: Synthesis and Characterization of Nanomaterials, Novel nano-catalyst

Dr. Siddhartha Panda
Professor
Ph.D., Chemical Engineering, University of Houston
Research Interest : Chemical sensors, Transport and reactions Microfluidics Micro/nano fabrication Semiconductor devices.

Dr. Y. N. Mohapatra
Professor
PhD, IISc Bangalore
Research Interest : Printable Electronics and nano patterning

Dr. Pritam Chakraborty
Associate Professor
PhD, The Ohio State University, USA
Research Interest : Solid mechanics to understand plasticity, fatigue, creep and fracture from a micro-structural length scale

Dr. Amit Verma
Associate professor
PhD, University of Notre Dame, IN, USA
Research Interest : Materials Growth for semiconductor device fabrication, characterization and modeling

Dr. Ashutosh Sharma
Professor
Recipient of the prestigious Padma Shri Award
PhD, State University of New York at buffalo
Research Interest: Soft nanofabrication, Mechanics, patterns and instabilities, Functional and nano-materials

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PhD, IIT Bombay
Research Interest: Structure and dynamics of Colloidal Glasses and Gels, Soft Matter, Rheology of Complex Fluids, Polymer Science and Engineering, PolymerNanocomposites

Dr. Rohit Medwal
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Research Interest : Spin Pumping, Spintronics, THz spintronics, Operando TEM, Nano magnetism

Distinguished Alumni

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Founder, Indimail

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