Ph.D. Program
Centre for Research in Nanotechnology & Science (CRNTS)
Indian Institute of Technology Bombay
Topics for CRNTS Ph.D. Program (AUTUMN SEMESTER) (May 2025)
Candidates are encouraged to contact faculty members by e-mail directly in case they have any query.

Sr. No.	Name of Topic	Guide Name (Prof.)	Co-Guide Name (Prof.)	Educational Qualification Required	Category
1	Design and development of infrared and microwave dual band coating for stealth application	Karthik Sasihithlu, Energy Science & Engineering, ksasihithlu@iitb.ac.in	Desikan Ramakrishnan, Earth Sciences. ramakrish@iitb.ac.in	B. Tech./ M. Tech. in Materials Science and Metallurgical Engineering, Electrical and electronics engineering, Applied/Engineering Physics, Nanoscience and Engineering, Photonics/Optics, M. Sc. in Physics	TA/FA/SW/SF/IS/ EX/CT
2	Chemical upcycling of plastics by solar photothermal valorization	C. Subramaniam, Chemistry, csubramaniam@iitb.ac.in	Prof. Guruswamy Kumaraswamy, Chemical Engineering, guruswamy@iitb.ac.in	Masters/BTech in Chemistry,Physics, Materials Science and Engineering, Chemical Engineering	TA/FA/SW/SF/IS/ EX/CT
3	Machine learning assisted joint computational and experimental design and development of novel biochar based microbial fuel cells	Sudarshan Vijay, Chemical Engineering, sudarshan.vijay@iitb.ac.in	Indrajit Chakraborty, Department of Energy Science and Engineering, indra.esed@iitb.ac.in	BTech / B.E. / B.S. or similar degrees in either Engineering (Chemical/Materials/Mechanical/Civil) or Science (Physics/Chemistry/Applied Science). MTech / M.E. / M.S. or similar degree in either Engineering (Chemical/Materials/Mechanical/Civil) or Science (Physics/Chemistry/Applied Science)	TA/FA/SW/SF/IS/ EX/CT
4	Porous Transport Layers for Water Electrolyzers	Nagappan Ramaswamy, S.A.I.F.Nagappan@iitb.ac.in	Chandramouli Subramaniam, Chemistry, csubbu@chem.iitb.ac.in	Masters/BTech in Chemistry,Physics, Materials Science and Engineering, Chemical Engineering	TA/FA/SW/SF/IS/ EX/CT
5	Electrochemical Reduction of Carbon Dioxide	Nagappan Ramaswamy, S.A.I.F.Nagappan@iitb.ac.in	Srinivasan Ramakrishnan, Chemistry, sriniramk@iitb.ac.in	B.Tech. (Chemical Engineering/Materials Science/Energy Science and Engineering). M.Sc. (Chemistry)	TA/FA/SW/SF/IS/ EX/CT

6	Study of fluid flow for controlled assembly of colloidal particles in evaporating droplets	Sunita Srivastava, Physics, sunita.srivastava@iitb.ac.in	Abhijeet Kumar, abhijeet.kumar@iitb.ac.in	M.Tech in Material Science/Nanoscience and Nanotechnology or B.Tech in Engineering Physics/Material Science and Engineering/Mechanical Engineering/Chemical Engineering. M.Sc in Physics.	TA/FA/SW/SF/IS/EX/CT
7	Advanced Electron Microscopy of Molecular Beam Epitaxy Grown Quantum Dot Semiconductor Heterostructures	Abhinandan Gangopadhyay, Met.Engg & Mat.Science, abhinandan.g@iitb.ac.in	Subhananda Chakrabarti, Electrical Engineering, subhananda@iitb.ac.in	B.E./B.Tech./M.E./M.Tech. in Metallurgical Engineering, Electrical Engineering, Mechanical Engineering;, M.Sc. or equivalent degree in Physics, Materials Science	TA/FA/SW/SF/IS/EX/CT
8	Development of Graphene based materials for energy storage	Sumit Saxena, Met.Engg & Mat.Science, sumit.saxena@iitb.ac.in	venkatsailanathan Ramadesigan, Energy Science & Engineering, venkatr@iitb.ac.in	BTech/Tech in Chemical Engineering/Materials Science/Energy Science	TA/FA/SW/SF/IS/EX/CT
9	Defects in Semiconductor Nanodevice	Sandip Mondal, Electrical Engineering, 10001970@iitb.ac.in	Prof. M Maniraj, Physics, maniraj@iitb.ac.in	MTech/MSc (Materials Science or Electrical Engineering or Physics)	TA/FA/SW/SF/IS/EX/CT
10	Semiconductor Memory Technology for Artificial Intelligence	Sandip Mondal, Electrical Engineering, 10001970@iitb.ac.in	Prof. M Maniraj, Physics, maniraj@iitb.ac.in	MTech (Materials Science or Electrical Engineering)	TA/FA/SW/SF/IS/EX/CT
11	Development of Carbon quantum dots for electrochemical sensing of Heavy metals	Sumit Saxena, Met.Engg & Mat.Science, sumit.saxena@iitb.ac.in	venkatsailanathan Ramadesigan, department of energy science & engineering, venkatr@iitb.ac.in	BTech/Tech in Chemical Engineering/Materials Science/Energy Science	TA/FA/SW/SF/IS/EX/CT
12	Patterning of high k Materials for Meta optics	Shobha Shukla, Met.Engg & Mat.Science, sshukla@iitb.ac.in	Anindya Datta, Chemistry, adutta@iitb.ac.in	M. Tech. in Materials Science or Electrical Engineering or M. Sc. in Physics, Chemistry or Life Sciences	TA/FA/SW/SF/IS/EX/CT
13	Graphene based foam/membrane for water quality sensing and purification	Shobha Shukla, Met.Engg & Mat.Science, sshukla@iitb.ac.in	Lalit Kumar, department of energy science & engineering, lalit.kumar@iitb.ac.in	M. Tech. in Materials Science or Electrical Engineering or M. Sc. in Physics, Chemistry or Life Sciences	TA/FA/SW/SF/IS/EX/CT

14	Next-Generation Membrane Systems for Virus Removal and Antibody Recovery in Bioprocessing	Swatantra Pratap Singh, E.S.E.D., swatantra@iitb.ac.in	Asutosh Kumar, BSBE, ashutoshk@iitb.ac.in	M.Sc in Chemistry, Biochemistry /M.tech in Environmental Science/ Engineering, Chemical Engineering, Chemistry, Physics, Materials Science and Engineering / Biotechnology, Bio Engineeringor equivalent	TA/FA/SW/SF/IS/ EX/CT
15	Hybrid MOF-Graphene Membrane Separators for High-Performance Sodium and Lithium-Ion Energy Storage Systems	Swatantra Pratap Singh, E.S.E.D., swatantra@iitb.ac.in	Lalit Kamar, DESE, lalit.kumar@iitb.ac.in	M.Sc/M.tech in Environmental Science/ Engineering, Chemical Engineering, Chemistry, Physics, Materials Science and Engineering or equivalent	TA/FA/SW/SF/IS/ EX/CT

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Sr. No.	Name of Topic	Guide Name	Co-Guide Name	Category
1	Design and development of infrared and microwave dual band coating for stealth application	Karthik Sasihithlu, Energy Science & Engineering ksasihithlu@iitb.ac.in	Desikan Ramakrishnan, Earth Sciences ramakrish@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Design and development of infrared and microwave dual band coating for stealth application Abstract :In order to decrease the radar and infrared footprints of military and civilian targets, dual- band infrared radar stealth technology is a rapidly growing topic. Since radar and infrared waves have very different wavelengths and properties, implementing dual-band infrared radar stealth technology presents some significant obstacles. Stealth compatibility for materials with exceptional microwave absorption (MA) and low infrared emissivity is urgently required with modern military detection equipment advancement.			
2	Chemical upcycling of plastics by solar photothermal valorization	C. Subramaniam, Chemistry csubramaniam@iitb.ac.in	Prof. Guruswamy Kumaraswamy, Chemical Engineering guruswamy@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Chemical upcycling of plastics by solar photothermal valorization Abstract :The global annual production of synthetic plastics stands at about 400 million tons at this time. The vast majority of these materials are discarded after single-use - therefore, plastic pollution is one of the defining challenges of our time. One approach to address this problem is to recycle the plastics so that their effective use-life is increased, decreasing the need for fresh petrochemically derived monomer. Commonly, this takes the route of thermomechanical recycling, wherein waste plastic is melted and reprocessed. However, there are difficult technical challenges to this route. Post consumer plastic streams are often mixed, comprising different plastics like polyethylene and polypropylene. Separating these is challenging, and processing a mixed stream results in blends with poor mechanical properties. Even if a pure stream is available, chemical degradation results in poor properties for thermo-mechanically recycled plastics. Therefore, chemical recycling, viz. depolymerization of waste polymers to yield monomers or other value added chemicals is of great contemporary interest. Since most polymerization reactions are downhill in free energy, de-polymerization is energy intensive. Therefore, we propose to explore the utilization of solar photothermal routes to valorization of waste plastic. This project will combine the use of advanced carbon-based nanostructures to harness solar radiation, to generate high temperatures locally, that will be used to effect depolymerization of plastic. The heterogeneous nature of the photothermal agent and the plastic (reactant) would be engineered to optimize heat-transfer and direct the chemical depolymerization towards desired pathways. Our interest is mainly in commercially relevant commodity materials such as polyethylene and polypropylene - though other plastics such as polystyrene and polyethylene terephthalate might also be investigated. Students interested in this project should have a background in chemical engineering or chemistry or materials science and engineering. Strong motivation to learn new skills with a good common-sense is required. Some exposure to polymers is preferable but not mandatory. This project will involve development and fabrication of carbon structures that are optimized to absorb solar radiation, improving on motifs previously developed in Prof Subramaniam's group. These will then be combined with a process for processing plastic, to effect thermal depolymerization. The resultant products will be analyzed using advanced analytical tools (including separation using chromatography, spectroscopic characterization, etc). In-situ experimental techniques would be employed to understand reaction pathways and control them for achieving desired products and yield. Therefore, the student will have the opportunity to work on a problem of great current academic interest, and with important industry implications. S/he will be exposed to polymer chemistry, physics and engineering and to a wide swathe of experimental tools.			

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3	Machine learning assisted joint computational and experimental design and development of novel biochar based microbial fuel cells	Sudarshan Vijay, Chemical Engineering sudarshan.vijay@iitb.ac.in	Indrajit Chakraborty, Department of Energy Science and Engineering indra.esed@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Machine learning assisted joint computational and experimental design and development of novel biochar based microbial fuel cells Abstract :High energy density fuel cells are critical to the energy transition from fossil fuels to renewable and sustainable sources of energy. Conventional fuel cells use transition metal electrocatalysts (such as platinum) to convert energy stored in chemical bonds (such as the Oâ€“H bond of hydrogen) into electricity. While these transition metal electrodes deliver state-of-the-art performance, they are expensive, difficult to source and maintain.Biochar, which is obtained from the pyrolysis of biomass, is trivial to source. It is rich in carbon, nitrogen, oxygen and sulphur. These elements combine to form amorphous materials that have been shown to be active at generating electricity by converting oxygen to water through the oxygen reduction reaction (ORR). Substituting platinum based electrodes with biochar will significantly reduce the cost of device fabrication and maintenance.There are two key challenges with using biochar as an electrode for high energy density fuel cells. First, there is significant variability in the quality and composition of biochar due to the lack of standardization in biomass (from which it is produced). This variability translates into significant differences in the concentrations of carbon, nitrogen, oxygen and sulphur as well as varied amorphous phases and surface compositions. Second, biochar based materials are not stable for long durations under an electrochemical environment. These materials degrade under extreme potentials, leading to unstable electrodes.Both these challenges of lack of reproducibility and stability are solvable by replacing conventional fuel cells with microbial fuel cells. These devices use microorganisms to convert organic matter (present in the electrolyte) into electricity. Their composition, activity and stability under fixed electrochemical potential are tunable, offering pathways to precise design of high activity and electricity generation through ORR. Depositing these microorganisms on biochar (used as a substrate and not as a catalyst) provides standardization while offering additional tunability through changing the composition of biomass.A key challenge with using biochar electrodes with microbial fuel cells is allowing for seamless charge and proton transfer from the cathode. From a design standpoint, it is currently unclear as to which organic moieties, surface composition and functional groups on the biochar substrate lead to the most active and stable ORR in microbial fuel cells. Trial-and-error based methods of designing these electrodes is time consuming and unlikely to succeed given the vast tunability of these microorganisms and biochar composition.Computational tools such as density functional theory (DFT), molecular dynamics simulations and machine learning techniques coupled with electrochemical characterization tools such as cyclic voltammograms have paved the way towards developing robust design principles and elucidating mechanisms for charge transfer in ORR. A key focus of this project will be on applying these tools to design and develop an understanding of charge transfer mechanisms on biochar for applications to microbial fuel cells.In this project, we will design, develop and characterize novel biochar-based cathodes to perform ORR for microbial fuel cells. We will apply state-of-the-art machine learning methods to perform high-throughput computational investigations to determine the most stable and active biochar electrodes for charge transfer reactions in ORR. To verify the results of our high-throughput investigation, we will perform long-length and time-scale machine learning assisted molecular dynamics simulations and report the atomistic mechanisms of charge and proton transfer. Best performing candidates from the machine-learning assisted computational investigations will be synthesized and characterized. We will synthesize these biochar materials and perform systematic electrochemical characterization using cyclic voltammograms and Tafel analysis. Through these computational and experimental methods, we will develop comprehensive design principles to generate compositions of biochar capable of performing efficient charge transfer reactions in a microbial fuel cell.			

<table>
<tr><th>Sr. No.</th><th>Name of Topic</th><th>Guide Name</th><th>Co-Guide Name</th><th>Category</th></tr>
<tr><td rowspan="2">4</td><td>Porous Transport Layers for Water Electrolyzers</td><td>Nagappan Ramaswamy, S.A.I.F.
Nagappan@iitb.ac.in</td><td>Chandramouli Subramaniam, Chemistry
csubbu@chem.iitb.ac.in</td><td>TA/FA/SW/SF/IS/EX/CT</td></tr>
<tr><td colspan="4">Topic Name :Porous Transport Layers for Water Electrolyzers
Abstract :Electrolyzers are critical technologies for producing green hydrogen through the electrolysis of water wherein electricity is used to split water molecules into its individual chemical components namely, hydrogen and oxygen. The integration of water electrolyzers with renewable energy sources such as wind or solar power enables the generation of green hydrogen which plays a key role in carbon-free, sustainable energy economy. Hydrogen is a major chemical feedstock in various industries and a potential energy carrier. A global research effort is underway to decrease the capital cost of electrolyzers and hence the cost of hydrogen generated. The performance and durability of water electrolyzers need to be improved which in turn depend on improving the properties of several structural components of the electrolyzer.

At the core the electrolyzer are the catalysts for water splitting, membrane for ion transport and the Porous Transport Layer (PTL) for mass transport of reactants and products. Electrolyzer is fabricated by sandwiching an anode and a cathode catalyst layer in either side of the membrane. PTLs are composed of metal meshes and are placed on the back side of the catalyst layers. The PTL in water electrolyzer plays a crucial role in ensuring efficient reactant and product transport gas, water, and ion transport while maintaining structural and electrical integrity. Its primary functions include facilitating a) reactant water distribution to the catalyst layer, b) continuous hydrogen and oxygen product gas release, c) prevent gas bubble accumulation that could hinder mass transport, d) electrical conductivity between the catalyst layer and the current collector, ensuring efficient charge transfer with minimal resistance, e) maintain structural integrity, preventing electrode deformation and ensuring stable operation under varying pressure conditions and finally f) dissipate heat generated during electrolysis, preventing overheating and improving overall system durability.

During electrolyzer operation a few critical challenges related to the anode PTL causes major performance losses of the electrolyzer. These include the development of a resistive passivation layer due to the high anode potential, delamination of the catalyst layer from the PTL and inefficient mass transport leading to lower reaction rates and system inefficiencies.
Materials used for PTLs vary depending on the type of electrolyzer. In proton exchange membrane (PEM) electrolyzers, PTLs are often made of titanium due to its corrosion resistance in acidic environments, whereas alkaline electrolyzers typically use porous nickel-based structures. Optimizing the design, material properties and mass transport characteristics of the PTL is crucial for enhancing electrolyzer efficiency, durability, and cost-effectiveness.

Given the multi-faceted role of the PTL, this provides an exciting research and development opportunity requiring a good understanding of the chemistry, chemical engineering and materials science aspects of the problem. The project will take an interdisciplinary approach involving the fabrication, characterization and diagnosis of PTLs in water electrolyzers. A key aspect of the doctoral dissertation would be to analyze the structure-property relationship of the PTL in electrolyzers, the impact of the pore structure, and the key interfacial aspects. Understanding and optimising PTL structures ensures a balance between reactant delivery, gas removal, and maintaining a robust interracial structure leading to improvement in electrolyzer efficiency and longevity.</td></tr>
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5	Electrochemical Reduction of Carbon Dioxide	Nagappan Ramaswamy, S.A.I.F. Nagappan@iitb.ac.in	Srinivasan Ramakrishnan, Chemistry sriniramk@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Electrochemical Reduction of Carbon Dioxide Abstract :The electrochemical reduction of carbon dioxide (CO2) has garnered significant attention as a promising technology for mitigating the effects of climate change by converting CO2 into useful chemicals and fuels. This process involves the use of renewable electricity to drive the reduction of CO2 at the cathode of an electrochemical cell, with potential products including carbon monoxide, methane, formic acid, and various hydrocarbons. The efficiency and selectivity of CO2 reduction are influenced by multiple factors, including the choice of electrode materials, catalysts, electrolytes, and operating conditions. Recent advancements in catalyst design, particularly with metal-based catalysts and carbon-based materials, have led to improved product selectivity and increased Faradaic efficiency. Additionally, innovations in reactor design, such as gas diffusion electrodes and flow reactors, have enhanced the scalability and performance of the process. Despite these advancements, challenges remain in terms of overcoming energy inefficiencies, enhancing long-term stability, and achieving economically viable production rates. In this project, the aspiring doctoral candidate will study various aspects of CO2RR and identify new factors that influence the selectivity, yield and efficiency. Some of these factors include homogeneous catalyst, electrocatalysis, electrolyte selection and operating conditions such as voltage and temperature. CO2 reduction plants are proposed to be placed near industrial flue gas sources where the concentration of CO2 is higher and energy consumption of CO2 capture is lower. In such cases, the presence of various impurities in flue gas sources such as sulfur compounds, nitrogen oxides and volatile organic compounds become critical to CO2 RR as it may change the reduction pathways and mechanisms. Further, the choice of electrolyte is also influences the product distribution as it preferentially stabilizes intermediates with various studies being carried out in aqueous and non-aqueous electrolytes. Finally, the durability of the catalyst needs to be understood as it determines the longevity of the reactor.One challenge with studying CO2RR process is the use of appropriate analytical tools to understand the reaction intermediates, transition state structures and product distribution. This project will utilize various in situ analytical tools such as infrared spectroscopy, Raman spectroscopy, gas chromatography to analyze gaseous products and Nuclear Magnetic Resonance spectrometry to analyze liquid phase products. One cornerstone of the project will be to use Differential Electrochemical Mass Spectrometry (DEMS) which provides an online real time tool to quantify gaseous products and understand product yield and reaction kinetics. The electrochemical reduction of CO2 holds promise as a key component of sustainable energy systems, contributing to both carbon sequestration and the production of renewable chemicals. The prospective doctoral candidate will study electrochemical CO2 reduction reaction with keen attention towards the reaction pathways and mechanisms taking into account all these influential factors and identifying newer ones. Future research will focus on further improving the efficiency, scalability, selectivity and sustainability of the process, alongside integrating it with renewable energy sources to create closed-loop carbon cycles.			
6	Study of fluid flow for controlled assembly of colloidal particles in evaporating droplets	Sunita Srivastava, Physics sunita.srivastava@iitb.ac.in	Abhijeet Kumar, na abhijeet.kumar@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Study of fluid flow for controlled assembly of colloidal particles in evaporating droplets Abstract :Investigate the role of fluid flow in controlled and ordered assembly of colloidal particles in evaporating dropletsSunita Srivastava and Abhijeet KumarDepartment of Physics and Mechanical Engineering, IIT BombayAbstract			

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7	Advanced Electron Microscopy of Molecular Beam Epitaxy Grown Quantum Dot Semiconductor Heterostructures	Abhinandan Gangopadhyay, Met.Engg & Mat.Science abhinandan.g@iitb.ac.in	Subhananda Chakrabarti, Electrical Engineering subhananda@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Advanced Electron Microscopy of Molecular Beam Epitaxy Grown Quantum Dot Semiconductor Heterostructures Abstract :Molecular beam epitaxy grown GaAs based heterostructures self assembled InAs quantum dots capped by novel III V ternary or quaternary alloys are useful for optoelectronic device applications. The optical response of these heterostructures is dependent on various intertwined factors such as the size and shape of the dots, elemental segregation and strain. This project aims to correlate nanoscale structural and chemical information obtained using advanced transmission electron microscopy techniques with optical properties, which can lead to development of new growth strategies for heterostructures with improved optical properties.			
8	Development of Graphene based materials for energy storage	Sumit Saxena, Met.Engg & Mat.Science sumit.saxena@iitb.ac.in	venkatsailanathan Ramadesigan, Energy Science & Engineering venkatr@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Development of Graphene based materials for energy storage Abstract :The aim of the project would be to develop graphene based materials to be used as electrode for supercapacitors. This would involve materials characterizations including electrochemical characterization			
9	Defects in Semiconductor Nanodevice	Sandip Mondal, Electrical Engineering 10001970@iitb.ac.in	Prof. M Maniraj, Physics maniraj@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Defects in Semiconductor Nanodevice Abstract :The revolutionary impact of advanced semiconductor physics on our daily lives remains unabated. We continually interact with computational, memory, and imaging devices where a large number of electrons are pushed around various defect states at every nanosecond inside semiconductors. As these technologies are rapidly evolving from traditional circuit boards to flexible electronics, new materials, physics, and processing technologies are being explored to improve their functionality and efficiency. This brings unique experimental challenges to evaluate the fundamental interaction of defects with electrons in novel semiconductors. In this project, we will first design a prototypical MIS capacitive device architecture to illustrate the electron trapping in memory devices fabricated at low temperatures. Unlike the conventional measurement system, we will then focus on the challenges in measuring the defect state in semiconductors and our approach to probing the defect state during charge pumping operations. References: IEEE Trans. on Electron Devices 68, 3 (2021) IEEE Electron Device Letters 41, 5 (717 - 720) (2020) Semiconductor Science and Technology 35, 10LT02 (2020)			

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10	Semiconductor Memory Technology for Artificial Intelligence	Sandip Mondal, Electrical Engineering 10001970@iitb.ac.in	Prof. M Maniraj, Physics maniraj@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Semiconductor Memory Technology for Artificial Intelligence Abstract :Biological neural systems can learn and forget information which is one possible mechanism for the stability and lifelong learning of neural circuits. Emulating such features in electronic devices is essential for advancing neuromorphic electronics for Artificial Intelligence. In this project, we will explore memory devices using oxides to illustrate learning behavior. We will examine the transient memory and forgetting dynamics by controlling the state of the nano memory devices. Using examples of prototypical flash neno-mamory devices, we will present our vision for a neuromorphic platform utilizing NAND flash memories. Our studies will inform the design of electronic hardware in emerging Artificial Intelligence and can in the future be extended to brain-machine interfaces. References: Science vol 375, No 6580 (2022) Advanced Intelligent Systems 2200069 (2022)			
11	Development of Carbon quantum dots for electrochemical sensing of Heavy metals	Sumit Saxena, Met.Engg & Mat.Science sumit.saxena@iitb.ac.in	venkatsailanathan Ramadesigan, department of energy science & engineering venkatr@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Development of Carbon quantum dots for electrochemical sensing of Heavy metals Abstract :Heavy metal contamination is one of the severe problems and requires effective sensing. This project aims for sensing of heavy metals using electrochemical techniques.			
12	Patterning of high k Materials for Meta optics	Shobha Shukla, Met.Engg & Mat.Science sshukla@iitb.ac.in	Anindya Datta, Chemistry adutta@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Patterning of high k Materials for Meta optics Abstract :High K Materials are of great importance for next gen computing devices. Towards this goal, we propose to pattern high K materials such as HfO_2 using two-photon laser lithography. Dimentions of the order of few hundred nanometers with high aspect ratios are expected to be achieved here. Extensive characterization using spectroscopy and microscopy will be performed to qualify these patterned nanostructures. Final applications in the field of metasurfaces and metaoptics will be explored.			

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13	Graphene based foam/membrane for water quality sensing and purification	Shobha Shukla, Met.Engg & Mat.Science sshukla@iitb.ac.in	Lalit Kumar, department of energy science & engineering lalit.kumar@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Graphene based foam/membrane for water quality sensing and purification Abstract :Graphene is 2D material with multiple functional group. This makes it attractive for trapping and detection of multiple analytes after suitable modifications. Here we propose to synthesize graphene from the agri-waste materials from the already optimized recipe developed in the NEMO lab. Integration of these foams with solution casted membranes will be used for trapping of pollutants. Graphene based inks with suitable modification will be used for sensing the analyte. A sensor integrated purifier system will be developed through this project.			
14	Next-Generation Membrane Systems for Virus Removal and Antibody Recovery in Bioprocessing	Swatantra Pratap Singh, E.S.E.D. swatantra@iitb.ac.in	Asutosh Kumar, BSBE ashutoshk@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Next-Generation Membrane Systems for Virus Removal and Antibody Recovery in Bioprocessing Abstract :Membrane separation technology plays a crucial role in biopharmaceutical processes, particularly in virus clearance, virus concentration, and antibody purification. The separation of viruses and antibodies is essential in vaccine production, monoclonal antibody (mAb) manufacturing, and gene therapy.The project will focus on the development of advance membranes for better permeability and slectivity			
15	Hybrid MOF-Graphene Membrane Separators for High-Performance Sodium and Lithium-Ion Energy Storage Systems	Swatantra Pratap Singh, E.S.E.D. swatantra@iitb.ac.in	Lalit Kamar, DESE lalit.kumar@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Hybrid MOF-Graphene Membrane Separators for High-Performance Sodium and Lithium-Ion Energy Storage Systems Abstract :The development of high-performance separators is critical for advancing sodium-ion (Na-ion) and lithium-ion (Li-ion) battery technology. This study focuses on the fabrication and optimization of hybrid metal-organic framework (MOF)-graphene hollow fiber membrane separators to enhance battery efficiency, safety, and longevity. The incorporation of MOFs provides high ion selectivity and thermal stability, while graphene enhances mechanical strength and conductivity, facilitating improved ion transport. The hybrid membrane architecture offers superior electrolyte wettability, reduced internal resistance, and enhanced cycling stability compared to conventional polyolefin separators. Characterization techniques, including SEM, XRD, FTIR, and electrochemical impedance spectroscopy (EIS), will be employed to evaluate structural, morphological, and electrochemical properties. The performance of the developed separators will be tested in both Na-ion and Li-ion battery systems to assess ionic conductivity, rate capability, and capacity retention. This research aims to provide a scalable and efficient separator solution, contributing to the development of next-generation energy storage systems with higher safety and performance.			