Ph.D. Program
Centre for Research in Nanotechnology & Science (CRNTS)
Indian Institute of Technology - Bombay

Topics for CRNTS Ph.D. Program (AUTUMN SEMESTER) (May 2024)

Candidates are encouraged to contact faculty members by e-mail directly in case they have any query.

Sr. No.	Name of Topic	Guide Name	Co-Guide Name	Category
1	Advanced biosensors for wastewater based epidemiology	Siddharth Tallur, Electrical Engineering stallur@iitb.ac.in	Kiran Kondabagil, Biosciences and Bioengineering kirankondabagil@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Advanced biosensors for wastewater based epidemiology Abstract :Join our interdisciplinary collaboration and take part in groundbreaking efforts to advance environmental surveillance technologies. Building upon our extensive work in wastewater monitoring for disease outbreaks, we are actively seeking a driven PhD student to lead the development of high performance and low-cost biosensors using nanomaterials and CRISPR-based methodologies. In our previous investigations, we have addressed the critical need for low-cost, high-efficiency assays suitable for large-scale testing, particularly in low- or middle-income countries (LMICs). Our studies have introduced innovative methods, such as paper dipsticks and PTFE membrane filters for concentrating and isolating nucleic acids from diverse microbial pathogens in wastewater samples. Additionally, our research has demonstrated the effectiveness of electrochemical DNA biosensors utilizing printed circuit board (PCB) electrodes in detecting pathogens like SARS-CoV-2. We are continuing to work on improving the sensitivity and specificity of this assay, and study its reliability for deployment in the field. As a PhD student within our team, you will have the unique opportunity to build upon these foundations, exploring new avenues to enhance sensor response through nanomaterial patterning on substrates for suitable functionalization and employing advanced techniques such as CRISPR to improve assay specificity. Your work will contribute directly to the development of cutting-edge technologies aimed at early warning systems for disease outbreaks and future pandemics. References: (1) https://doi.org/10.1016/j.scitotenv.2024.170347, (2) https://doi.org/10.1038/s41598-022-12818-w, (3) https://doi.org/10.1016/j.snb.2021.130169			

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2	Mg-Ni-MXene-reduced Graphene Oxide nanocomposites for hydrogen storage for automobile applications	Sankara Sarma V. Tatiparti, Energy Science & Engineering sankara@iitb.ac.in	Abhijit Chatterjee, Chemical Engineering achatter@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Mg-Ni-MXene-reduced Graphene Oxide nanocomposites for hydrogen storage for automobile applications Abstract :With the depleting fossil fuels and growing demand for renewable energy, hydrogen storage for fuel cell applications is emerging as a promising area of research, particularly in automobile sector. Recently, the honorable prime minister of India has set a target to make India a global Hydrogen hub by 2030.Magnesium hydride (MgH2) offers reversible, single-step hydrogen storage with 7.6wt% hydrogen capacity. However, it suffers from poor hydrogen sorption (ab/desorption) kinetics at near-ambient conditions. For example, bulk MgH2 releases hydrogen only at temperatures around 400 C. Moreover, Mg exhibits incubation periods up to several hours/days, during which it does not absorb any significant hydrogen. Hence, nanosizing and using suitable catalysts are used as strategies to improve its kinetics of hydrogen sorption. Nanosized Mg(H2) with reduced graphene oxide (rGO) and Ni as catalysts can demonstrate hydrogen release at ~215 C, as per our reports. However, this is higher than the operation temperature PEM fuel cells (80-120 C). Hence, it is needed to decrease this temperature further. Moreover, hydrogen absorption at PH2=1 bar is sought. MXenes are promising and emerging materials which can act as both hydrogen hosts and catalysts for hydrogen release. However, research in employing MXenes for hydrogen sorption is still in its nascent stages. In the present project, MXenes (e.g.Ti3C2Tx, where T=F-, OH-), rGO and Ni will be used as catalysts to synthesis novel Mg-rGO-Ni-MXene nanocomposites by ball milling. Hydrogen sorption in these nanocomposites will be studied and also will be attempted at the conditions of less than 5 bar hydrogen pressure and 80-120 C. X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), Electron density maps, X-ray photoelectron spectroscopy (XPS), Raman, FTIR will be used for characterizing these materials. Our earlier research shows that the MgH2 unit cell shrinks after H-uptake, in the presence of rGO and Ni, favouring H-release at lower temperatures. This was termed as structural catalysis in our work. Such structural catalysis will be explored in the Mg-rGO-Ni-MXene nanocomposites. Further, various interactions among Mg, Ni, C, MXene and H e.g. electron transfers, Fermi-level shifts, sp2-sp3 hybridization changes in C (from rGO) and their effect on hydrogen sorption will be probed and substantiated using computations techniques such as Density Functional Theory (DFT). The experimental and computational results will be used to design suitable materials that demonstrate hydrogen sorption at less than 5 bar hydrogen pressure and 80-120 C. The PhD student will learn various material synthesis techniques to synthesize nanosized Mg, MXenes and reduced graphene oxide and their nanocomposites. Several techniques like ball milling, Thermogravimetry, Differential Scanning Calorimetry and (non)isothermal hydrogen storage in indigenously developed Sieverts apparatus will be used during material synthesis and experimentation. The student will also gain exposure to various characterization techniques like XRD, SEM and TEM to understand the various phases and structure of the materials; XPS, Raman and FTIR to investigate the role of the catalysts and the Mg-Ni-C-MXene-H interactions. The student will also gain proficiency in using computational techniques like DFT for understanding some fundamental aspects in these materials.			
3	Development quantum sensor for biomolecular sensing	Kasturi Saha, Electrical Engineering kasturis@iitb.ac.in	Abhijit Majumder, Chemical Engineering abhijitm@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Development quantum sensor for biomolecular sensing Abstract : In this project we aim to develop a novel benchtop quantum sensing device measuring ultralow concentration of biomolecules and for probing cellular environment in situ using Nitrogen Vacancy centers in diamond. The work will also involve development of variety of assays for biomolecular sensing. Further we wish to augment a confocal microscope with quantum sensing capabilities such as relaxometry and coherent measurements for implementing nano-MRI.			

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4	Development quantum sensor and imager	Kasturi Saha, Electrical Engineering kasturis@iitb.ac.in	Sumiran Pujari, Physics sumiran@phys.iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Development quantum sensor and imager Abstract :In this project we aim to develop a state-of-the-art microscope for imaging magnetic fields at the micron scale investigation of variety of condensed matter problems at cryogenic temperatures using Nitrogen Vacancy centers in diamond. The project will also involve the development of hybrid quantum devices with coupling to cavities. This will involve studying the dynamics of spins coupled to photons at both room temperature and low temperature. Further, quantum sensing protocols for AC sensing will also be developed.			
5	Micro- and nano-plastics in the environment and its removal	Swatantra Pratap Singh, E.S.E.D. swatantra@iitb.ac.in	Prof. Lalit Kumar, DESE lalit.kumar@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Micro- and nano-plastics in the environment and its removal Abstract :Micro- and nano-plastics (MP & NP)are critical emerging pollutants which are widely distributes in the environment. Recently, MP, and NP have gained awareness of the potential and growing risks of biological effects in the ecosystem. However, at present the understanding of micro- and nanoplastics are limited due to limited analytical methods and its integration with different contaminants. In the propose study we propose addressing the insufficiencies of analytical methods, and its interaction with contaminants with experiments and quantum chemical modeling, and further evaluating different biological and nanomaterials-based technology for the removal of micro- and nanoplastics.			
6	Catalyst development for sustainable conversion of methane to higher hydrocarbons.	Sonali Das, Chemical Engineering sonali.das@iitb.ac.in	Debabrata Maiti, Chemistry dmaiti@iitb.ac.in	TAP/PS
	Topic Name :Catalyst development for sustainable conversion of methane to higher hydrocarbons. Abstract :Methane is a greenhouse gas that is often flared in current industrial practice. In light of the current climate change issues and changing energy landscape, the direct one-step conversion of methane to higher hydrocarbons using renewable energy sources is a much sought after goal. This project aims at the development of a new sustainable process and catalysts for the low temperature direct conversion of methane to higher hydrocarbons. The work will involve the synthesis and characterization of new nanostructured catalysts, lab-scale reactions and testing of developed catalysts, reaction kinetics, and operating parameter optimization.			

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7	Metal Oxide-MOF-Graphene based all solid state flexible asymmetric supercapacitors for wearable applications	Sankara Sarma V. Tatiparti, Energy Science & Engineering sankara@iitb.ac.in	Smrutiranjan Parida, Metallurgical Engineering Materials Science paridasm@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Metal Oxide-MOF-Graphene based all solid state flexible asymmetric supercapacitors for wearable applications Abstract :Flexible energy storage devices are gaining popularity due to their flexibility, shape conformability, light weight. Hence, such devices are used in portable/wearable electronics, non-flat surfaces, flexible displays etc. If the electrodes are made of different materials these devices are called asymmetric devices. Flexible asymmetric supercapacitors (FASC) should possess high energy/power densities, long cycle life (100,000 cycles), small size, wider range of operation voltage (1.5-3 V). In this project novel Metal Oxide-Metal organic Framework (MOF)-Graphene-based FASCs will be designed and developed. Nanostructured Metal oxides Eg. FeOx, MnOx, NiOx and CoOx and MOFs based on linkers such as benzene tricarboxylate (BTC) will be synthesized by thermal, chemical (microwave) routes and will be used as negative electrodes. $FeMoO_4$ will be synthesized through chemical route. Reduced Graphene Oxide (rGO) and graphene will be synthesized chemically and electrochemically for use as positive electrodes. $FeMoO_4$-rGO composites will be fabricated to be used as positive electrodes. Non-aqueous electrolytes such as ethyl methyl imidazolium chloride (EMIMCl), Butyl methyl imidazolium tetrafluoroborate ($BMIMBF_4$) will be used for enhancing the operation voltage. For imparting flexibility, polythene, paper based supports will be used. The nanostructural features in these materials will be characterized by SEM and TEM. The phase analysis will be conducted using XRD. Various bonds, defects in the nanoscale and various inter-elemental interactions will be probed by FTIR, Raman and XPS, respectively. The mechanisms of charge storage in these devices will be understood by designing equivalent electrical circuits.The PhD student will learn various material synthesis techniques e.g. microwave synthesis, and electrochemical exfoliation for synthesizing nanostructured metal oxides, MOFs and reduced graphene oxide. The student will also gain hands-on experience in analytical techniques like Thermogravimetry and differential Scanning Calorimetry for thermal analysis of these materials. The student will use cyclic voltammetry, chronoamperometric and chronopotentiometric techniques to study the electrochemical behaviour of the electrode materials. The student will gain knowledge on FASC device assembly and characterization. FASC device characterization will be conducted by the student using techniques such as Galvanostatic Charge/Discharge (GCD) to estimate the capacitance, energy and power densities. Eventually, these data will be used to develop Ragone plots for comparing the performance of the present device with those published in the literature. The student will gain exposure to various characterization techniques like XRD, SEM, TEM, XPS, Raman and FTIR to study various phases and structures of the materials.			
8	Focused Ion Beam (FIB) based Defect Engineering for tuning optical and electrical properties of 2D graphene-like materials	Rakesh G. Mote, Mechanical Engineering rakesh.mote@iitb.ac.in	M Aslam, Physics m.aslam@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Focused Ion Beam (FIB) based Defect Engineering for tuning optical and electrical properties of 2D graphene-like materials Abstract :Focused Ion Beam (FIB) has emerged as a nanofabrication tool capable of resist-free, mask-less, and site-specific patterning. Recently controlling defects in the materials, in the form of implantation or formation of patterns like nano-holes/channels, arrays, edges, is gaining wide attention in order to engineer exotic optical properties as required by next generation application in hybrid optoelectromech and quantum devices. The project aims to systematically introduce the material defects using FIB techniques. The ion-matter interaction at the nanoscale is to be investigated in generating the defects deterministically for materials like van der Waals (vdW) materials, transition metal dichalcogenides (TMDs), etc. The FIB process is to optimized based on understanding of the ion bombardment effects and the desired spatial accuracy. The approach involves numerical studies (molecular dynamics, monte-carlo methods, etc.), FIB experimentation and advanced material characterization (SEM/TEM, AFM, etc.). The performance of such defect-engineered materials will be assessed for novel applications in integrated photonics, nanoscale/quantum sensing, quantum emitters, nanofluidics, etc.			

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9	Developing droplet-microfluidic method to fabricate soft nano-carriers for dual drug delivery	Venkata Ramana Gundabala, Chemical Engineering venkatg@iitb.ac.in	Sunita Srivastava , Physics sunita.srivastava@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Developing droplet-microfluidic method to fabricate soft nano-carriers for dual drug delivery Abstract :Nanomaterials have emerged as potential candidates for research studies in all areas of science including biomedical applications such as drug delivery, diagnosis, and therapeutics. Liposomes (LP) have been considered promising and versatile drug vesicles. LPs are essentiallycomposed of phospholipids that self-assemble to form vesicular structures in which thelipid bilayer surrounds an aqueous core. The interior of lipid bilayer and the aqueous core has been used as a carrier for hydrophobic and hydrophilic drugs respective. Compared with traditional drug delivery systems, liposomes exhibit better properties, including site-targeting, sustained or controlled release, protection of drugs from degradation and clearance, superior therapeutic effects, and lower toxic side effect. The challenges in the use of liposomes encapsulation, prepared by thin film rehydration, ethanol injection and double emulsion methods is the size polydispersity arising from inhomogeneous chemical and mechanical conditions during the mixing of bulk phase. Microfluidics has been used for manipulating micro- and nanoscale self-assembled systems with fine control over particle size and speed using a variety of fluidic materials and features. Microfluidic directed formulation of liposomes and encapsulation of proteins and drugs, has emerged as a promising alternative, which ensures precise control over the synthesis parameters, high uniformity, reproducibility, and ease of integration. Typically, a three channel microfluidic device is used for hydrodynamic focusing for the controlled self-assembly of monodisperse liposome. The streams of lipids dissolved in isopropyl alcohol is hydrodynamically focused and sheathed between two oblique aqueous buffer streams in a microfluidic channel. The laminar flow in the microfluidic channel enables controlled diffusive mixing at the liquid interfaces causing the lipids to be insoluble and self-assemble into vesicles. Microfluidics enable precise and reproducible control of the flow conditions and hence reproducible fluidic mixing on the micrometer length scale. Using this technique, the liposome size is tunable over a mean diameter of 50 nm to 150 nm by adjusting the aqueous to solvent volumetric flow rate ratio. Other existing microfluidic methods for preparation of lipid nanoparticles (LNPs) include, T or Y junction, hydrodynamic flow focusing, and staggered micromixers. The former two methods usually yield LNPs with poor monodispersity, with micromixers providing much better monodispersity. However, all these current approaches are based on 2D microfluidics that result in major drawbacks such as ineffective mixing, possibility of clogging, and being expensive. These designs generate small size liposome nanoparticles (< 200nm) which limits the drug loading capacity and its application for gene therapy. In the past decade, as new drug delivery systems are emerging, encapsulating and delivering dual drugs for various diseases has garnered major attention. Dual drug delivery through a single drug delivering system can reduce drug resistance and non-specific cell toxicity, and can promote synergistic drug activity. In this project, the student will develop a droplet-based microfluidic approach to generation of double emulsion droplets that carry lipid nanoparticles to be used as dual drug (hydrophilic and hydrophobic) delivering vehicles. The generation of dual drug delivery system is achieved through controlled coalescence of the single and double emulsion droplets. The coalescence results in formation hydrophilic drug carrying LNPs in the aqueous shell with an intact hydrophobic drug carrying solvent core. The proposed approach is expected to provide a facile, continuous, and cost-effective route to efficient delivery of both hydrophobic and hydrophilic drugs, hitherto a challenging proposition. The liposome nanoparticles present in the shell of the generated Dual Drug Delivery System (DDDS) will be characterized using the fluorescence based imaging and high resolution synchrotron based small angle x-ray scattering (SAXS) characterization techniques. The in-situ measurements shall unravel the self-assembly mechanism during the formation of the nanoparticle-lipid complexes for improved structural stability. These studies shall allow further gaining insight into the involved dynamic structural transitions, mechanisms, and kinetics during the generation of self-assembled nanostructures (including drug nanocarriers) at different reaction times (ranging from fractions of seconds to minutes). Using the newly designed microfluidic platform the student will test the loading of hydrophilic and hydrophobic drugs into the LNP carrying double emulsions, for cancer treatment. Photo thermal and MTT essay studies will be performed for drug release and efficacy measurements.			

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10	Bioinspired assembly in model nanoparticle-membrane systems for investigating nanoscale interaction	Sunita Srivastava, Physics sunita.srivastava@iitb.ac.in	Venkat Gundabala, Chemical Engineering venkatg@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Bioinspired assembly in model nanoparticle-membrane systems for investigating nanoscale interaction Abstract :Nanoparticle have shown tremendous potential for wide range of applications including sensing, imaging and drug delivery. Due to their unique physicochemical properties, nanoparticles exhibit distinctive behaviors when in contact with cellular membranes. In this project, we will focus on understanding fundamental mechanism governing nanoparticle-membrane interactions, how nanoparticles traverse through biological barriers, interact with lipid bilayers, and influence membrane integrity, permeability, and functionality. Furthermore, this research aims to elucidates the potential applications of these interactions, ranging from advanced drug delivery systems to novel imaging techniques and beyond.			
11	Marangoni Flow-driven Self-propelled Liquid Crystal Droplets as Micro-carriers on Structured Surfactant Media	Mithun, Met.Engg & Mat.Science mithunc@iitb.ac.in	Sayantan Dutta, Chemical Engineering sayantan.dutta@iitb.ac.in	TAP/PS
	Topic Name :Marangoni Flow-driven Self-propelled Liquid Crystal Droplets as Micro-carriers on Structured Surfactant Media Abstract :Artificial micro-swimmer or active matter is a rapidly growing field investigating how living systems and synthetic materials can exhibit emergent behaviors when composed of energy-consuming components capable of producing motion and work. Active matter includes a wide range of biological phenomena, such as cell motility and intracellular transport, as well as synthetic systems like self-propelled particles and microrobots. To have an understanding of the fundamentals behind the self-propulsion of a technologically relevant system, i.e., active emulsion droplet atop a surfactant containing water bath. Using emulsion droplets composed of two immiscible liquids, such as oil and water, and stabilized by a surfactant, it is possible to lead them to become self-propelled under appropriate conditions. This allowed the droplets to move in a controlled manner and to transport a molecular payload to specific locations. Understanding and tunability of self-propelling droplets atop a surfactant containing a structured aqueous bath can contribute to understanding the self-propelling active emulsion droplets and particles. This area is rich in physical challenges that deal with mimicking the biological collective phenomena, such as motion in bacterial colonies, and at the same time advanced experimental studying of rheology, patterning instability, and phase transitions in systems far from thermodynamic equilibrium.			
12	Graphene Composites for Energy Storage Applications	Sumit Saxena, Met.Engg & Mat.Science sumit.saxena@iitb.ac.in	Venkatsailanathan Ramadesigan, DESE venkatr@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Graphene Composites for Energy Storage Applications Abstract :Graphene is a wonder material and has been exploited for a wide variety of applications including energy storage. Recent advancements have been made in development of graphene based nanocomposites for energy storage. This project aims at developing novel nanocomposites using metal oxides for energy storage applications			

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13	MOF based sensors for water	Shobha Shukla, Met.Engg & Mat.Science sshukla@iitb.ac.in	Sanjog Nagarkar, Chemistry nagarkarss@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :MOF based sensors for water Abstract :Water pollution has lead to urgent need for developing sensing devices capable of quickly sensing the pollutants instantly. Sensing of various pollutants is one of the most important areas of research in current times. Various materials have been explored however the discovery of new materials systems have generated quest for better and more compact sensing platforms. MOFs are very interesting materials systems and provide and opportunity to develop novel class of sensor platform. This project will involve development of novel platforms for detection of pollutants in water			
14	Development of nanoscaffolds for stem cell studies	Shobha Shukla, Met.Engg & Mat.Science sshukla@iitb.ac.in	Abhijit , Chemical Majumdar	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Development of nanoscaffolds for stem cell studies Abstract :Scaffolds play an extremely important role in study of cell growth. The morphology and surface properties play a ver important role. In this project material system will be identified and optimized to fabricate nanoscaffolds for cell growth studies			
15	Development of Stimulus Responsive MOFs for energy storage	Sumit Saxena, Met.Engg & Mat.Science sumit.saxena@iitb.ac.in	Sanjog Nagarkar, Chemistry nagarkarss@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Development of Stimulus Responsive MOFs for energy storage Abstract :timulus-responsive â€œsmartâ€• materials that respond to applied stimuli in a predictable and controlled manner are attractive for the development of intelligent technology. These stimulus responsive smart MOF can be used to develop smart energy storage solutions. In this project the potential candidate will develop novel Stimulus responsive MOFs for developing smart energy storage devices			

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16	Development of Framework Solids for Clean Water Technologies	Prof. Sanjog S. Nagarkar, Chemistry nagarkarss@iitb.ac.in	Prof. Shobha Shukla, MEMS sshukla@iitb.ac.in	TA/FA/SW/SF/IS/EX/CT
	Topic Name :Development of Framework Solids for Clean Water Technologies Abstract :A clean and sustainable supply of water is important for health and the environment. The uneven distribution of water across geography, and changes in weather (Rain, Temperature, Humidity) patterns, limit the overall availability of water while rapid urbanization and industrialization lead to the rapid contamination of available water. Thus, technologies to remove contaminants and monitor the levels of contaminants for safe use are crucial for a sustainable future. The typical contaminants are hydrocarbons, dyes, antibiotic or organic pollutants, salts, and heavy metals. Considering the physical and chemical properties of these contaminantsâ€™ membrane technology offers great advantages such as compactness, robustness, ease of scalability, and energy efficiency over conventional methods. At present, membrane technology is an industry of ~25 billion USD and growing. Considering the fact that a major part of India is facing water scarcity and access to clean water the technological development toward clean and sustainable water supply is highly relevant.Membrane permeability and selectivity are crucial parameters to ascertain the efficiency of the membrane however both parameters typically show an inverse relationship. Thus, it is important to have uniform and ordered pore size, and narrow pore size distribution, to realize high selectivity while an affinity of permeant with membrane and a thin active layer for high permeability.Nano-porous framework solids such as Metal-Organic Frameworks (MOFs), Covalent Organic Frameworks (COFs), Polymers with Intrinsic Microporosity (PIM), etc. are known for their crystalline nature, high surface area, high porosity, modular pore size/shape, and readily tunable surface properties. These unique features render these materials an ideal candidate for the development of membranes with high permselectivity. Additionally, the host-guest-dependent modulation of physic properties (Optical, electrical, magnetic, etc.) makes them ideal candidates for sensing contaminants.The primary focus of this research is to design and synthesize porous framework solids for water treatment with a focus on heavy metal removal, oil-water separation, removal of antibiotic or organic pollutants, and desalination. Through this project, we aim to develop new membrane materials with tailormade performance toward target contaminants.			
17	Functionalized Halide perovskite nanocrystals for white light emission	Aswani Yella, Met.Engg & Mat.Science aswani.yella@iitb.ac.in	Chandra M R Volla, Chemistry chandra.volla@iitb.ac.in	TAP/PS
	Topic Name :Functionalized Halide perovskite nanocrystals for white light emission Abstract :Perovskite nanocrystals (PNs) have received much attention as luminescence materials in the field of electrochemiluminescence (ECL). However, as one key factor for determining the optoelectronic properties of the surface state of PNs, the surface passivation layer of PNs has enormous difficulty in simultaneously meeting the requirements of high ECL efficiency, conductivity, and stability. In this project, an effective surface modification strategy using small moieties will be used to solve such issue. The small molecules are chemically anchored onto the surface of PNs via the Lewis interaction between Ï€ electrons of the ring and the empty orbit of Pb2+. Benefiting from the above interaction, the electrochemical impedance of PNs can be decreased greatly without the loss of light-emitting efficiency. Moreover, the stability of PNs under O2 exposure will be studied after functionalization.			