NCMST 2024

11th National Conference on
Recent Trends in Materials Science and Technology

June 25-27, 2024

PROCEEDINGS

In association with

MRSI Thiruvananthapuram Chapter

Organized by

Department of Chemistry
Indian Institute of Space Science and Technology
Department of Space, Govt. of India
Valiamala P.O, Thiruvananthapuram 695 547, Kerala

National Conference on

Recent Trends in Materials Science and Technology

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Department of Chemistry

Indian Institute of Space Science and Technology

Government of India, Department of Space

Valiamala P O, Thiruvananthapuram - 695 547, Kerala

FOREWORD

Department of Chemistry, IIST has been conducting the series of the National/International conferences (NCMST/ICMST) every year. The first conference of NCMST/ICMST series, the “International Conference on Recent Trends in Materials Science and Technology (ICMST)-2010”, was jointly organized by IIST and Materials Research Society of India (MRSI), Thiruvananthapuram Chapter in 2010. After the huge success of ICMST-2010, in the subsequent years, Department of Chemistry conducted the national and international conferences in collaboration with MRSI and Society of Polymer Science India (SPSI), Thiruvananthapuram Chapter. The current conference NCMST-2024 which is being organized in association with MRSI, Thiruvananthapuram Chapter is the eleventh edition in the series and focusses on the theme - 'Materials for Sustainability. The conference aims at presenting current research in the area of Materials Science and Technology and would highlight the latest advances and strategies for the design and development of novel materials and processes with an emphasize on sustainable environment and energy. About twenty plenary lectures, spread over the themes such as nanomaterials, polymers, composites and blends, advanced sustainable materials, recycled materials by eminent experts would deliberate on recent trends in the respective areas. Young researchers will also be given opportunity to present their work. Nearly one hundred and fifty researchers will be presenting their work as posters. A few student delegates will be given opportunity for oral presentation also.

I sincerely thank Director, IIST for the support rendered towards organizing this conference. I thank all the members of MRSI, Thiruvananthapuram chapter for their encouragement in organizing the conference. I take the opportunity to thank all my colleagues from IIST to have absorbed the concept of the conference and provided whole hearted support and participation in organizing the event. I am confident that NCMST -2024 will be a memorable and rewarding experience to all the delegates

Dr. Kuruvilla Joseph

Coordinator, NCMST-2024

भारतीय अंतरिक्ष विज्ञान एवं प्रौद्योगिकी संस्थान
(वि.अ.आयोग अधिनियम 1956 की धारा-3 के अधीन मानित विश्वविद्यालय घोषित)
भारत सरकार, अंतरिक्ष विभाग, वलियमला पोस्ट, तिरुवनंतपुरम 695 547 भारत

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
(A Deemed to be University u/s 3 of the UGC Act, 1956)
Government of India, Department of Space
Valiamala P. O, Thiruvananthapuram 695 547 India

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MESSAGE

I am happy to know that Department of Chemistry, Indian Institute of Space Science and Technology is organizing National Conference on Recent Trends in Materials Science and Technology (NCMST-2024) during June 25-27, 2024. The influence and impact of materials in our day today life is all pervasive. Invention of novel and smart materials have greatly influenced the growth of technologies in aerospace, communication, automobiles, medicine etc. and have positively contributed to the endeavors for improving the quality of life. However, scientific community is still in search of newer and smarter materials to meet the future technological challenges.

Therefore, it is heartening that Indian Institute of Space Science and Technology (IIST), the premier institute offering high quality education at under graduate, post graduate and doctoral levels in areas with special focus to space sciences, space technology and space applications is organizing such an important conference on materials science and technologies. I am sure that this conference, would provide an excellent platform to debate in detail on various issues of materials science and focus on advanced developments in materials, including novel materials for space applications. The young researchers, scientists, technologists and industrialists across the country, who are participating in the Conference would be greatly benefitted by the stimulating discussions and exchange of information. No doubt this conference would pave the way to define new directions for the future growth of technologies in the area of material science and for meeting the critical demands of the Nation.

I convey my very best wishes to the organizers and all the participants.

(Dr. B N Suresh)
Chancellor, IIST

June 20, 2024

भारतीय अंतरिक्ष विज्ञान एवं प्रौद्योगिकी संस्थान
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डॉ. उण्णिकृष्णन नायर एस / Dr. Unnikrishnan Nair S
निदेशक / Director

MESSAGE

I am very happy that Department of Chemistry, IIST, is organizing a National conference on Recent Trends in Material Science and Technology (NCMST-2024), during June 25--27, 2024. Development of novel and smart materials have greatly influenced the growth of technologies in areas such as aerospace, communication, automobiles and medicine and have positively contributed to the endeavors for improving the quality of life. Still, there exists, ample opportunities to be explored for advancements towards achieving innovative materials to meet the challenges of ever expanding endeavors of the human kind. Different classes of metals namely, polymers, composites, ceramics and metals are used in space applications. For use in space applications, materials especially, polymers and composites must meet certain special requirements such as capability to function in hard vacuum, very low out-gassing to prevent contamination of surrounding components, resistance to extremely harsh ultraviolet radiation, resistance to on-orbit charged particle radiation and resistance to erosion from atomic oxygen. In the current scenario, development of sustainable materials and processes assume great importance, whatever be the field of application. The ambitious space missions like Gaganyaan, Bharatiya Antariksha Station and interplanetary manned missions would require novel biocompatible materials and technologies to ensure sustainability of the missions and safety of the crew. High temperature materials are another important class of materials with great significance in applications in rocket engine components and air breathing propulsion. I sincerely hope that our scientists and researchers will be successful in developing materials which can satisfy the high and conflicting demands of aerospace applications. Towards this, it is highly essential that effective communication and collaboration should be established between academia and industry. In these contexts, this national seminar holds immense significance and sure that it would provide opportunity for students, researchers and industrialists to come together for fruitful deliberations.

I sincerely welcome all the renowned speakers and the delegates to IIST and wish the conference a grand success.

(Unnikrishnan Nair S)

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11th National Conference on

Recent Trends in Materials Science and Technology – 2024

25-27 June 2024 | **Venue:** ***Multipurpose Hall*, Students Activity Center (SAC), IIST Thiruvananthapuram**

Programme Schedule

DAY 1: June 25, 2024		
08:00 – 09:15	*Registration*	
09:30-10:30	**Inaugural Function**	
10:30 – 11:05	**PL-01**	**J. Asir Packiaraj, Director, IPRC Mahendragiri**
11:05 – 11:30	**- Tea -**	
Session 01		
11:30 – 12:05	**PL-02**	**John Philip, IGCAR Kalpakkam** *Role of Science and Materials on Technological Development*
12:05 – 12:25	IL-01	**Shaiju S Nazeer, IIST Thiruvananthapuram** *Infrared Spectroscopy as a tool for cancer diagnosis* **Chandra Sekhar Rout, Chungbuk National University, Korea** *MXene-TMDs based hybrids for Supercapacitor applications*
12:25 – 12:35	CL-01	**Roshbe S Calolsa, VIT Vellore** *Investigating Ag-Doped PDMS Nanocomposite as a High-Performance Encapsulant for Photovoltaic Devices*
12:35 – 13:40	**Lunch Break**	
Session 02		
13:40 – 14:15	**PL-03**	**Sirshendu De, IIT Kharagpur** *Polymeric hollow fiber membranes: Spinning and their applications*
14:15 – 14:50	**PL-04**	**Dona Mathew, VSSC Thiruvananthapuram** *Telechelic polymers: Design opportunities*
14:50 – 15:00	CL-02	**Saisree S, CSIR-NIIST Thiruvananthapuram** *An Electrochemical Sensor Based on Bio-derived Graphene Quantum Dots as an Electronic Tongue for Acrolein; a Carcinogen in Foods*
15:00 – 15.10	CL-03	**Venu Sreekala Smitha, CWRDM Calicut** *Isotopically Labeled Fluorescent Carbon Dots Embedded Silica-based Nanocomposites as Tracers for Hydrogeological Investigations*
15:10 – 15:20	CL-04	**Rini Ganguly, Sathya Sai University, Karnataka** *Resistive Switching in all-Perovskite Core-Shell Nanocrystals with type-I band Alignment: A step towards high density memory*
15:20 – 15:45	**Tea Break**	
Session 03		
15:45 – 16:20	**PL-05**	**Manual Stephen, CSIR-CECRI** *Reformulation of liquid electrolytes for extreme fast charging of lithium- ion batteries*
16:20 – 16:55	**PL-06**	**Subodh G., Univ of Kerala** *Design and Development of Ferrite-Decorated Multifunctional Carbonized Cotton Fabrics for Efficient Electromagnetic Interference Shielding*
16:55 – 17:05	CL-05	**S. Gunasekaran, CECRI Karaikudi** *Electrodeposition of Ni-Mo alloy from sulfamate electrolyte as a cathode for water splitting applications*
17:05 – 17:15	CL-06	**Annmary Tomy, IIST Thiruvananthapuram** *$Ni(OH)_2$- MoS_2 Nanocomposite Modified Glassy Carbon Electrode for the Detection Of Dopamine and α- Lipoic Acid*
17:15 – 17:25	CL-07	**Athira Murali, SCTIMST Thiruvananthapuram** *Processing, Optimization, and Physico-chemical Characterization of 3D Printed EVA/HA composite for Bone Tissue Engineering*
17:30 – 19:00	**Poster Session 1, Venue**	

DAY 2: June 26, 2024		
Session 04		
09:30 – 10:05	**PL-07**	**A Ajayaghosh, SRM Chennai** *The Chemistry of Superhydrophobic Nanocomposites for Energy Saving*
10:05 – 10:40	**PL-08**	**Benny K George,** *formerly* **VSSC** *Understanding carbon materials using Raman spectroscopy: A tutorial*
10.40 – 10.50	CL-08	**Ashitha George, CSIR-NIIST Thiruvananthapuram** *Enhanced Piezoelectricity from Self-Polarized PVDF Infiltrated Nylon 11 Aerogels with Highly Oriented Polymer Crystals*
10:50 – 11:00	CL-09	**Sujitha. A.S., CUSAT Kochi** *A paper-based composite electrospun nanofibers composed of gold nanoclusters for the real-time detection of cancer cells*
11:00 – 11:20	**Tea Break**	
Session 05		
11:20 – 11:55	**PL-09**	**S Sampath, IISc Bangalore** *Mono-, Di-, Tri-valent Ion Storage and Rechargeable Batteries*
11:55 – 12:30	**PL-10**	**Pramod Gopinath, CUSAT** *Aggregation Induced Emission - Role of alkyl chain length*
12:30 – 12:40	CL-10	**S. Maheswari, ARCI, IITM Research Park** *Utilization of recovered graphite from end-of-life batteries for energy applications*
12:40 – 13:40	**Lunch Break**	
13:40 – 14:30	**Poster Session -2**	
Session 06		
14:30 – 15:05	**PL-11**	**Rajan T P D, CSIR-NIIST Thiruvananthapuram** *Development of Advanced Metal Matrix Composites and Manufacturing Technologies for Structural and Functional Components*
15:05 – 15:25	IL-02	**Chandra Sekhar Rout, Chungbuk National University, Korea** *MXene-TMDs based hybrids for Supercapacitor applications*
15:25 – 15:35	CL-11	**Shaswati Jyoti, INST Mohali** *Exploring the Impact of Crystal Structure and Electrical Polarization on Electrocatalytic Oxygen Evolution in the Bi-Fe-O System*
15:35 – 15:55	**Tea Break**	
Session 07		
15:55 – 16:30	**PL-12**	**T Pradeep, IIT Madras** *Can water microdroplets make soil?*
16:30 – 17:05	**PL-13**	**Mahesh Hariharan, IISER Thiruvananthapuram** *Null Excitonic Interaction in Greek Cross (+) Aggregate*
17:05 – 17:25	IL-03	**Saritha A, Amrita Vishwa Vidyapeetham** *Surface engineering of nanofillers: An effective strategy to form versatile nanocomposites*
17:25 – 17.45		**Conference photo**
17:45 –	▪ ***Felicitation function*** ▪ ***Cultural Programme*** ▪ ***Dinner***	
DAY 3: June 27, 2024		
Session 08		
09:30 – 10:05	**PL-14**	**Subi Jacob George, JNCASR Bangalore** *Bioinspired Design on Dynamic and Adaptive Supramolecular Polymers*
10:05 – 10:40	**PL-15**	**Sreekala M S, MG University** *Green Nanotechnology - Innovations in Sustainable Polymer Nanogenerators*
10:40 – 11.00	**Tea Break**	
Session 09		
11:00 – 11:35	**PL-16**	**Reji Philip, RRI Bangalore**

11:35– 12:10	**PL-17**	**Sabu Thomas, MG University** *Circular Economy: New Opportunities in Sustainable Nano Materials and Polymer Bio-Nanocomposites*
12:20 – 12:40	**Valedictory Function**	
	Chief Guest	**S Sabu Thomas, MG University**
12.40 –	**Lunch**	
14:00 –		**Lab visit**

Plenary Lectures

01	***J. Asir Packiaraj***, Director, IPRC Mahendragiri
02	Role of Science and Materials on Technological Development ***John Philip***, Indira Gandhi Centre for Atomic Research, Kalpakkam, India
03	Title: Polymeric hollow fiber membranes: Spinning and their applications ***Sirshendu De***, IIT Kharagpur
04	Telechelic polymers: Design opportunities ***Dona Mathew,*** Vikram Sarabhai Space Centre, Thiruvananthapuram
05	Reformulation of liquid electrolytes for extreme fast charging of lithium- ion batteries ***Manuel Stephan***, CSIR- Central Electrochemical Research Institute,Karaikudi
06	Design and Development of Ferrite-Decorated Multifunctional Carbonized Cotton Fabrics for Efficient Electromagnetic Interference Shielding ***Subodh G***, University of Kerala, Thiruvananthapuram
07	The Chemistry of Superhydrophobic Nanocomposites for Energy Saving ***A Ajayaghosh***, SRM Chennai
08	Understanding carbon materials using Raman spectroscopy: A tutorial ***Benny K George,*** formerly VSSC
09	Mono-, Di-, Tri-valent Ion Storage and Rechargeable Batteries ***S Sampath***, Indian Institute of Science, Bangalore
10	Aggregation Induced Emission - Role of alkyl chain length ***Pramod Gopinath***, Cochin University of Science and Technology, Kochi
11	Development of Advanced Metal Matrix Composites and Manufacturing Technologies for Structural and Functional Components ***T.P.D. Rajan***, CSIR -NIIST, Thiruvananthapuram
12	Can water microdroplets make soil? ***Thalappil Pradeep***, Indian Institute of Technology Madras

13	Null Excitonic Interaction in Greek Cross (+) Aggregate ***Mahesh Hariharan**, IISER Thiruvananthapuram, Kerala*
14	Bioinspired Design on Dynamic and Adaptive Supramolecular Polymers ***Subi Jacob George***, JNCASR Bangalore
15	Green Nanotechnology - Innovations in Sustainable Polymer Nanogenerators ***Sreekala M S***, MG University, Kottayam
16	Nonlinear optical behaviour of novel materials ***Reji Philip***, RRI Bangalore
17	Circular Economy: New Opportunities in Sustainable Nano Materials and Polymer Bio-Nanocomposites ***Sabu Thomas***, MG University, Kerala
Invited Lectures	
01	Infrared Spectroscopy as a tool for cancer diagnosis ***Shaiju S Nazeer***, Indian Institute of Space Sciences and Technology, Trivandrum
02	MXene-TMDs based hybrids for Supercapacitor applications ***Chandra Sekhar Rout,*** Jain Global Campus, Bangalore Chungbuk National University, Republic of Korea
03	Surface engineering of nanofillers: An effective strategy to form versatile Nanocomposites ***Saritha A,*** Amrita Vishwa Vidyapeetham, Amritapuri,Kollam
Contributory Lectures	

01	Investigating Ag-Doped PDMS Nanocomposite as a High-Performance Encapsulant for Photovoltaic Devices ***Roshbe S Calolsa***, VIT Vellore
02	An Electrochemical Sensor Based on Bio-derived Graphene Quantum Dots as an Electronic Tongue for Acrolein; a Carcinogen in Foods ***Saisree S***, CSIR-NIIST Thiruvananthapuram
03	Isotopically Labeled Fluorescent Carbon Dots Embedded Silica-based Nanocomposites as Tracers for Hydrogeological Investigations ***Venu Sreekala Smitha***, CWRDM Calicut
04	Resistive Switching in all-Perovskite Core-Shell Nanocrystals with type-I band Alignment: A step towards high density memory ***Rini Ganguly***, Sathya Sai University, Karnataka
05	Electrodeposition of Ni-Mo alloy from sulfamate electrolyte as a cathode for water splitting applications ***S. Gunasekaran***, CECRI Karaikudi
06	$Ni(OH)_2$- MoS_2 Nanocomposite Modified Glassy Carbon Electrode for the Detection Of Dopamine and α- Lipoic Acid ***Annmary Tomy***, IIST Thiruvananthapuram
07	Processing, Optimization, and Physico-chemical Characterization of 3D Printed EVA/HA composite for Bone Tissue Engineering ***Athira Murali***, SCTIMST Thiruvananthapuram
08	Enhanced Piezoelectricity from Self-Polarized PVDF Infiltrated Nylon 11 Aerogels with Highly Oriented Polymer Crystals ***Ashitha George***, CSIR-NIIST Thiruvananthapuram
09	A paper-based composite electrospun nanofibers composed of gold nanoclusters for the real-time detection of cancer cells ***Sujitha. A.S***, CUSAT Kochi
10	Utilization of recovered graphite from end-of-life batteries for energy applications ***S. Maheswari***, ARCI, IITM Research Park

11	Exploring the Impact of Crystal Structure and Electrical Polarization on Electrocatalytic Oxygen Evolution in the Bi-Fe-O System ***Shaswati Jyoti***, INST Mohali

National Conference on

Recent Trends in Materials Science and Technology – 2024

Poster sessions

Poster Session 1 **25 June 2024: Tuesday: 17:30-19:30 Hr**
Posters: 01 – 54

		Raji R, P. S. Anjana,, N. Gopakumar	
11	SN011	One Pot Synthesis of Hybrid Boron Nitride-Nitrogen doped Graphene Quantum Dots for Electrochemical Sensing of Pb (II) ions *Dhrishya V, Saisree S, Archana V S, Dr. K Y Sandhya*	68
EMERGING GREEN PROCESSES (EP)			
12	EP001	Biodegradable PHB/CNT@MgCl2 Aerogels for Solar-Driven Atmospheric Water Harvesting Applications. *Akhila N S, Amal Raj R B, E. Bhoje Gowd*	69
13	EP002	Experimental Studies on Diesel Engine Fuelled with CeO2 Nanoparticles Dispersed in Mustard and Mahua Biodiesel *Uppuluri Satya Sai Tejaswi*	70
14	EP003	Development of Eco-Friendly Biodegradable Films from Iota-Carrageenan for Sustainable Food Packaging Applications. *Angel Raju, VishnuVaarthanan G, Keerthi, Balasubramanian N*	71
15	EP004	Highly recyclable AC-TiO2 composite for organic dye degradation. *Archana V S, Dhrishya V, Sandhya K Y*	72
16	EP005	Synthesis of poly(amidoamine)- heterocycle conjugates: Towards a green approach *Chithra R. Nair, K.G. Sreejalekshmi*	73
RECYCLED MATERIALS (RM)			
17	RM001	Thermal insulting robust carbon composite foam panels with a periodic array of pores from used cloth for Efficient EMI shielding *Raji S, K. Prabhakaran*	74

ENERGY MATERIALS (EM)

Poster Session 2 **26 June 2024: 13:40-14:30 Hrs**
Posters: 01 – 55

POLYMER AND BLENDS (PB)

METAL AND ALLOYS (MA)			
50	MA001	Post-Processing Effects on Microstructure and Mechanical Properties of Wire Arc Additive Manufactured Mild Steel Plates. *Akash Biradar, Rishabh Prasad, Hrithik Ray, Vidit Bhushan Kohad, Rijesh M*	161
51	MA002	NF3 Plasma Etching Process for Substrate Surface Treatment in Diverse Applications *Zeel Raval, H. L. Swami, Vrushank Mehta, Hiral Joshi and Rajesh Kumar*	162
52	MA003	Study of correlation between prior β-grain size and tensile properties of β-quenched Zr-2.5%Nb alloy. *Aishwarya Upadhye, Arnomitra Chatterjee, A. K. Bind, Apu Sarkar and R.N. Singh*	163
53	MA004	Influence of anodic oxidation on the surface morphology and electrochemical behaviour of oxide film on AZ31 Mg alloy *Simi. V. S, S.Arun Kumar and A. Srinivasan*	164
54	MA005	Development of Sustainable Functional graded Metals with Solid State Ultrasonic Additive Manufacturing *Rahul Naidu*	165

National Conference on
Recent Trends in Materials Science and Technology
25-27, June 2024

Abstracts-Lectures

S

New Opportunities in Sustainable Nano Materials and Polymer Bio-Nanocomposites

Sabu Thomas
Mahatma Gandhi University, Priyadarshini Hills P. O. Kottayam, Kerala, India -686 560,
Chairman, TrEST Research Park, Trivandrum, Kerala, India
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Green chemistry started for the search of benign methods for the development of nanoparticles from nature and their use in the field of antibacterial, antioxidant, and antitumor applications. Bio wastes are eco-friendly starting materials to produce typical nanoparticles with well-defined chemical composition, size, and morphology. Cellulose, starch, chitin and chitosan are the most abundant biopolymers around the world. All are under the polysaccharides family in which cellulose is one of the important structural components of the primary cell wall of plants. Cellulose nanoparticles (fibers, crystals and whiskers) can be extracted from agro waste resources such as jute, coir, bamboo, pineapple leafs, coir etc. Chitin is the second most abundant biopolymer after cellulose, it is a characteristic component of the cell walls of fungi, the exoskeletons of arthropods and nanoparticles of chitin (fibers, whiskers) can be extracted from shrimp and crab shells. Chitosan is the derivative of chitin, prepared by the removal of acetyl group from chitin. Starch nanoparticles can be extracted from tapioca and potato wastes. These nanoparticles can be converted into smart and functional biomaterials by functionalization through chemical modifications (esterification, etherification, TEMPO oxidation, carboxylation and hydroxylation etc) due to presence of large amounts of hydroxyl group on the surface. The preparation of these nanoparticles includes both a series of chemical as well as mechanical treatments; crushing, grinding, alkali, bleaching and acid treatments. Transmission electron microscopy (TEM), scanning electron microscopy (SEM) and atomic force microscopy (AFM) are used to investigate the morphology of nanoscale biopolymers. Fourier transform infra-red spectroscopy (FTIR) and x-ray diffraction (XRD) are being used to study the functional group changes, crystallographic texture of nanoscale biopolymers respectively. Since large quantities of bio wastes are produced annually, further utilization of cellulose, starch and chitins as functionalized materials is very much desired. The cellulose, starch and chitin nanoparticles are currently obtained as aqueous suspensions which are used as reinforcing additives for high performance environment-friendly biodegradable polymer materials. These nanocomposites are being used as biomedical composites for drug/gene delivery, nano scaffolds in tissue engineering and cosmetic orthodontics. The reinforcing effect of these nanoparticles results from the formation of a percolating network based on hydrogen bonding forces. The incorporation of these nano particles in several bio- based polymers have been discussed. The role of nano particle dispersion, distribution, interfacial adhesion and orientation on the properties of the ecofriendly bio nanocomposites have been carefully evaluated.

Can water microdroplets make soil?

Thalappil Pradeep
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We demonstrate that common mineral particles spontaneously break down into nanoparticles within milliseconds when encapsulated in charged water microdroplets. In our experiments, micrometer-sized minerals such as quartz and ruby were transformed into nanoparticlesranging from 5 to 10 nanometers using electrospray-generated aqueous microdroplets. These droplets were then deposited on a substrate, facilitating the characterization of the nanoparticles. Simulations suggest that quartz experiences proton-induced slip that leads to particle scission, especially when reduced in size and exposed to an electric field. Additionally,the formation of silicate fragments was confirmed via mass spectrometry. This rapid weathering process could significantly contribute to soil formation, considering the widespread presence of charged aerosols in the atmosphere.

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The Chemistry of Superhydrophobic Nanocomposites for Energy Saving

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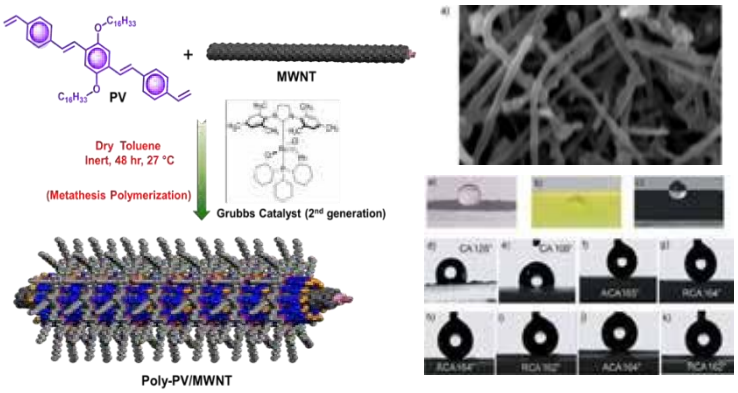
The science and engineering behind the natural superhydrphobic creations such as plant leaves, bird feathers, animal skins, etc. are inspiration for scientists to design artificial self-cleaning materials, which mimick the lotus leaf and rose petal like superhydrophobicity [1]. We have been exploring the possibility of a molecular self-assembly approach [2-4] to create superhydrophobic organic-inorganic nanocomposites and gels [5,6]. We have chosen π-conjugated molecules such as OPVs and carbon nanotubes to prepared hybrid materials. The strong π-interaction of OPVs with CNTs allows dispersion of the latter in organic solvents. This well-dispersed nanocomposite can be coated on surfaces of glass, metals and mica, resulting in water repellent self-cleaning surfaces with high water contact angle of ca. 165-170° with sliding angle < 2°. These coatings have binary surface topography with large amount of trapped air and very small contact angle hysteresis, which results in the easy rolling of water droplets with very low slide angle. Detailed TEM and AFM studies revealed that coatings of the OPV self-assembly on CNTs form a rough surface with nano and microsized topography which is responsible for the self-cleaning property. For practical application the nanocomposites should form a stable coating on surfaces. For this purpose, we attempted polymerization of the self-assembled molecules on the surface of the CNT using Grubb's metathesis approach, which resulted stable superhydrophobic coating. This coating has been used in aquatic vessels to improve their buoyancy and fuel efficiency [7]. Details of these studies will be discussed.



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Polymeric hollow fiber membranes: Spinning and their applications

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Hollow fiber membrane modules are becoming quite popular nowadays due to the higher filtration area in a small volume leading to a compact design. Hollow fibers are prepared through a process called spinning and that is basically extrusion of polymeric fibers through co-axial assembly, called spinneret. However, the spinnerets are difficult to fabricate and the spinning unit becomes expensive. In this talk, it is demonstrated how the spinning of hollow fibers can be done by indigenous technology making the spinning quite affordable. The fibers are spun with various grades starting from microfiltration, various cut-offs of ultrafiltration and even nanofiltration. The applications of various fibers ranging from fruit juice clarification, industrial wastewater treatment, textile effluent, and treatment of brackish water are presented in details.

Development of Advanced Metal Matrix Composites and Manufacturing Technologies for Structural and Functional Components

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Metal matrix composites (MMC) are one of the advanced materials widely used for aerospace, automotive, defence and general engineering applications. MMC can be tailored to have superior properties such as enhanced high temperature performance, high specificstrength and stiffness, increased wear resistance, better thermal and mechanical fatigue and creep resistance than those of unreinforced alloys. To fabricate such composites with ideal properties, the processing technique has to ensure high volume fraction of reinforcement incorporation, uniform distribution of the reinforcement and acceptable adhesion between the matrix and the reinforcing phase without unwanted interfacial reactions which degrades the mechanical properties. A number of manufacturing technologies such as stir casting/vortex method, powder metallurgy, infiltration, casting etc. have been developed to synthesize MMC employing a variety of alloy and the reinforcement's combinations. Among this squeeze infiltration process is widely used for making MMC with high volume fraction of reinforcements and offers many more advantages compared to other conventional manufacturing processes. The present paper describes various solidification processing techniques especially the compocasting, squeeze casting and infiltration techniques used for making the Al MMC and the evolution of microstructure and mechanical, physical, thermal and tribological properties attained. The paper also highlight the development of various engineering components of lightweight aluminium MMC for transport, strategic, energy and electronic sectors.

Telechelic polymers: Design opportunities

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Future demands for utilization of space and distant planets for benefit of mankind give enormous opportunities and challenges to polymer scientists. Polymers exhibit exceptional versatility which renders them highly demanded class of materials in space research. Distinct molecular features and architecture impart them wide range of properties and make them different from metals and ceramics. Emerging trends in the field of polymer science and technology related to aerospace applications involve development of specially tailored macromolecules having exotic features. Advanced polymeric materials having varied combinations of electrical, mechanical, thermal and/or structural properties are of high demand in aerospace industry. This invites transformation of basic and applied research into tailored products for space applications. Telechelic functional polymers invite a lot of interest due to their various applications such as cross-linking agents, precursors for the synthesis of multi block copolymers and a large number of branched and Crosslinked polymeric structures. The art in synthesis of telechelic polymers lies in the quantitative introduction of the desired functional group at the chain ends. The final molecular architecture is decided by relative reactivities of the groups, substitution effects and side groups. Properties of resultant polymers strongly depend on stoichiometry, side reactions and extent of conversion. The talk will be focussing on telechelic functionalization of thermoplastic and thermosetting polymers of importance to aerospace inndustry, by playing with the chemistry of chain ends. Phenolic resins find extensive application as ablative thermal protection systems in launch vehicles and spacecrafts and also play a decisive role in several compositions of adhesives, potting compounds, etc. Poly ether ether ketones are thermoplastic polymers, well known for their exceptional performance over broad service temperatures from 20 K to 750 K, rendering them much sought after material for spacecrafts. Notwithstanding their potential in the present chemical structures, telechelic functionalization of phenolic resins and poly ether ether ketones broadens scope for tailoring them in to customized molecular architectures with unprecedented, exotic features and improved processability.

Role of Science and Materials on Technological Development

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The synergy between science and technology is undeniable, with scientific advancements driving groundbreaking innovations. The rapidly evolving landscape of modern technologies presents a pressing need for new materials with exceptional properties. Durin my presentation, I will touch upon the significance of science in driving forward new technological developments. Additionally, I will delve into the pivotal role of materials in shaping the future and showcase some of our team's research on magnetic nanomaterials spanning the past two decades[1].

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Reformulation of liquid electrolytes for extreme fast charging of lithium-ion batteries

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Design and Development of Ferrite-Decorated Multifunctional Carbonized Cotton Fabrics for Efficient Electromagnetic Interference Shielding

Subodh G
University of Kerala, Thiruvananthapuram

Mono-, Di-, Tri-valent Ion Storage and Rechargeable Batteries

S Sampath
Indian Institute of Science, Bangalore

Aggregation Induced Emission - Role of alkyl chain length

Pramod Gopinath
Cochin University of Science and Technology, Kochi

Null Excitonic Interaction in Greek Cross (+) Aggregate

Mahesh Hariharan
IISER Thiruvananthapuram, Kerala

Bioinspired Design on Dynamic and Adaptive Supramolecular Polymers

Subi Jacob George
JNCASR Bangalore

MXene-TMDs based hybrids for Supercapacitor applications

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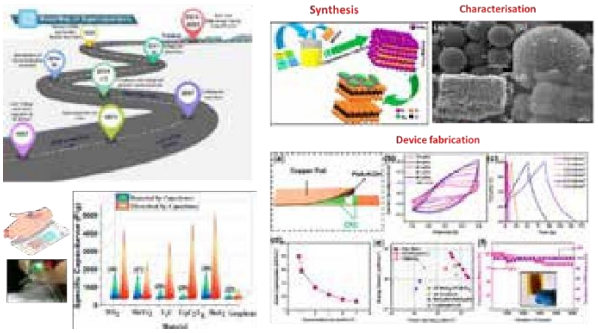
The synthesis and application of MXenes in supercapacitors represent a focal point of research in our laboratory, driven by the pursuit of high-performance energy storage solutions. MXenes, a class of 2D transition metal carbides, nitrides, and carbonitrides, have emerged as promising materials for supercapacitor electrodes due to their unique combination of properties. Our research endeavors begin with the synthesis of MXenes, wherein we employ various selective etching methods to exfoliate MAX phase precursors, yielding MXene nanosheets with tailored surface chemistry and structural properties and synthesizing hybrid with transition metal dichalcogens (MoS_2, VS_2, VTe_2 etc). This integration of TMDs and MXenes in hybrid structures offers a promising approach to develop advanced electrode materials with enhanced performance for energy storage devices, including supercapacitors and batteries. Our investigations aim to elucidate the influence of TMDs/MXene hybrid synthesis parameters, electrode architecture, and electrolyte composition on the energy storage performance of supercapacitors. Through systematic optimization, we strive to achieve superior electrochemical properties, including high specific capacitance, excellent rate capability, and long-term cycling stability. Overall, our research endeavors underscore the significance of MXenes/TMDs hybrid in advancing the frontier of supercapacitor technology, offering insights into materials synthesis, electrode design, and device engineering for high-performance energy storage applications.



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Infrared Spectroscopy as a tool for cancer diagnosis

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Cancer is one of the leading causes of disease associated deaths worldwide[1]. Early detection can improve the chances of survival in most patients. However, diagnosis at early stages can be challenging as precancerous conditions are usually asymptomatic. Excision/punch biopsy followed by histopathology is gold standard for cancer diagnosis[2]. It involves tissue staining and morphological pattern recognition. Even though it is an essential part of clinical diagnosis, histopathologic evaluation often remains time consuming and cumbersome. This technique is having limited statistical confidence due to inherent operator variability. Also, the dyes and chemicals used can be cytotoxic and may perturb small metabolites within the tissue. Therefore, a fast and robust method of detection based on molecular changes is needed for early and accurate diagnosis.Optical spectroscopic techniques such as fluorescence spectroscopy, infrared spectroscopy, and Raman spectroscopy and their imaging counterparts are the emerging diagnostic tool for cancer. These techniques have the capability to overcome problems associated with conventional diagnosis techniques. These spectroscopic techniques are promising tools for fast and realtime identification of disease progression and underlying causes. Spectral diagnosis is acheived by analysing the variation in protein-protein, protein–lipid, protein-nucleic acid interactions and conformational changes among various stages/grades of cancers[3].

I will be emphasizing regarding the application of infrared imaging as spectral pathology tool for diagnosis. Recent works on the differentiation and classification of different grades of lung fibrosis and oral cancer using infrared spectroscopic imaging will be specifically highlighted [4] [5].

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Surface engineering of nanofillers: An effective strategy to form versatile nanocomposites

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In this era of nanotechnology, nanomaterials are effectively utilized for the reinforcement of polymers like rubber and epoxy aiming at the tuning of mechano-thermal properties of polymers. Large aspect ratio, unique microspace structure, large surface area, and non-toxic characteristics make these materials effective over conventional reinforcing agents. In addition to these properties, a myriad of properties can be attained via the surface modification of the nanofillers and thus the composites can be utilized for advanced functional applications in various [1,2]. Surface-engineered nanomaterials are more suitable for the fabrication of polymer nanocomposites owing to the uniform dispersion of nanoparticles in polymers. Hence it serves as a path towards attaining enhanced mechanical, electrical, optical, and dielectric properties in nanocomposites. Among the various surface functionalization methods, polymer grafting is an effective technique[3]. The effect of polymer grafting onto the nanofillers via 'grafting to' and 'grafting from', the effect of biomolecules in the exfoliation of 2D fillers like TMDs, h-BN, graphene etc., and their subsequent utilization as fillers in polymer matrices helps in tailoring the properties of nanocomposites[2,4]. This ensures the formation of highly efficient hybrid materials with attributes including tunable wettability, self-cleaning ability, controllable catalysis, and controlled drug delivery.

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CL001

Investigating Ag-Doped PDMS Nanocomposite as a High-Performance Encapsulant for Photovoltaic Devices

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In the context of energy-efficient buildings, windows, and solar panels, infrared (IR) filters and screens play a crucial role. These filters are particularly beneficial for solar cells, as they prevent efficiency losses caused by heating. In contrast to previous studies on IR filters, our research demonstrates that adding silver nanoparticles (AgNPs) enhances the material's IR reflective properties while maintaining high transmittance in the visible region. Specifically, we fabricated a polydimethylsiloxane (PDMS) film with AgNPs using the doctor blade technique, resulting in a film approximately 100 μm thick. Remarkably, we observed no transparency loss across the 0.005 to 0.02 vol% loading of AgNPs in PDMS, indicating the potential application of this transparent film. Additionally, the contact angle of 112° for these films is comparable to pristine PDMS. Using a UV-Vis-NIR spectrophotometer, we measured greater than 7.66% weighted average reflectance in the NIR region and over 91.5% transmittance in the visible region. FTIR spectroscopy revealed insights into the precise role and influence of functional groups. Furthermore, thermal analysis (TGA) demonstrated that the films exhibit thermal stability up to 400°C, similar to pristinePDMS. Overall, the synergistic combination of silver nanoparticles and PDMS yields a hydrophobic infrared filter with enhanced optical characteristics and thermal resilience.

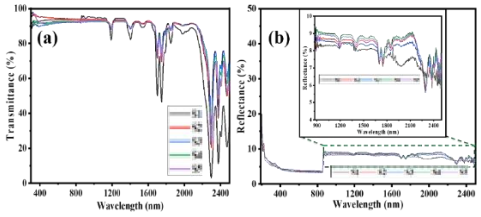

Figure 1. UV- Vis- NIR Spectrum (a) transmittance (b) reflectance of the composite film.

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CL002

An Electrochemical Sensor Based on Bio-derived Graphene Quantum Dots as an Electronic Tongue for Acrolein; a Carcinogen in Foods

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Food is one of the most essential needs of every living being, and good quality food is required for health excellence. Hence the quality of food that we are consuming is highly significant. Unfortunately, the quality of most foods that we are consumed daily are getting deteriorated through food processing and adulteration and that probably makes them carcinogenic to humans[1]. Studies have shown cancer to be a major cause of human mortality among the numerous diseases afflicting mankind. Cancer is a disease with multifactorial etiology that can result in death if not treated appropriately. Thus, through the detection of carcinogens in food can prevent a large variety of adverse health conditions for the global population[2]. Therefore, herein, exploring the electrochemical sensing technique for the detection of acrolein, one of the main carcinogens present in processed foods. Further, the development of an integrated electrochemical screen-printed sensor system can satisfy the need of a hand-held sensor for the real-time monitoring. Graphene quantum dots derived from the seeds of *Gloriosa Superba* is utilized for modifying the working electrode. The sensor exhibited lowest detection limit of 0.1 μM, being the lowest one reported hitherto. Further, the real-time applicability of the sensor also validated successfully.

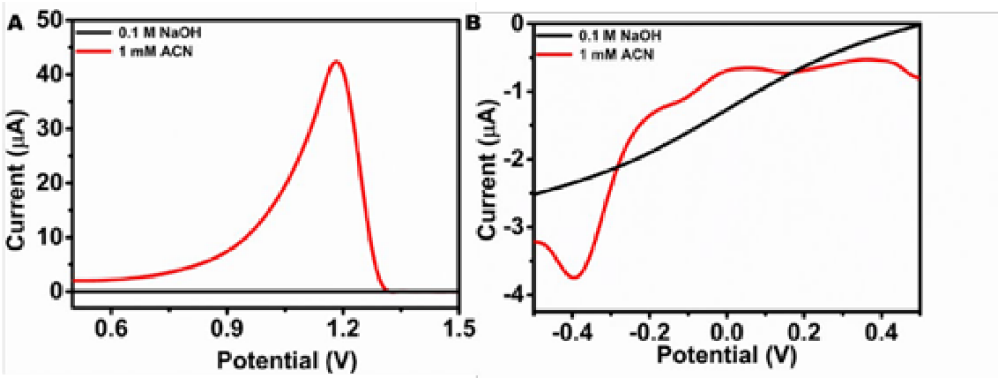

Figure 1. (A) and (B) The DPV responses corresponding to the oxidation and reduction of 1 mM acrolien in 0.1 M NaOH

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CL003

Isotopically Labeled Fluorescent Carbon Dots Embedded Silica-based Nanocomposites as Tracers for Hydrogeological Investigations

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Injected tracer technique using nanoparticles has evoked a lot of research interest in hydrogeological research as it encompasses a broad spectrum of applications in the field of water resources management.[1] The present work deals with the development of isotopically (^{13}C) labeled carbon dots embedded silica-based (CD-SiO_2) nanocomposites using a microwave-assisted co-polycondensation method. The synthesized nanocomposites have been characterized for their structural and morphological characteristics using various techniques. ^{13}C labeling of the nanocomposite was evident from the downshift of the D and G bands as observed in the Raman spectra.[2] Successful embedding of ^{13}C labeled carbon dots having a size of less than 5 nm in the SiO_2 structure was confirmed via the surface characterizations performed and the nanocomposite as such is showing interesting optical properties. The applicability of the nanocomposite as a hydrological tracer for groundwater studies was further evaluated through laboratory-scale continuous flow column experiments. The amount of the nano tracer regained was ~95.8% with a time of maximum detection as 8 minutes when injected through the sand column, and its increased lifetime with an increase in the travel time shows that the photoluminescence property of the material is not lost under experimental conditions which suggests its practical utility. Further, a mathematical model was developed that captures the trends in the nano tracer distribution and transport and hence can be used to simulate groundwater flow velocity and solute transport in aquifers. The current challenges faced in groundwater flow analysis such as huge time consumption/expenses can be resolved to a significant extent by employing the isotopically labeled nano tracer in hydrogeological studies.

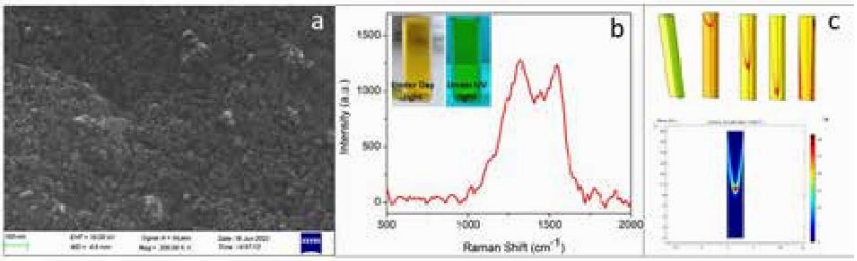

Figure 1. (a) SEM image of ^{13}CD-SiO_2 1:0.25 nanocomposite (b) Raman spectra of ^{13}CD-SiO_2 1:0.25 nanocomposite and (c) Model showing the transport of diluted species in a porous media (sand column) of length 20 cm and diameter 3 cm.

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CL004

Resistive Switching in all-Perovskite Core-Shell Nanocrystals with type-I band Alignment: A step towards high density memory

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Cs^+-based halides perovskites are popular among the researchers in material science due to its outstanding and tunable optoelectronic properties,[1] which make them suitable for a wide range of commercial applications such as LEDs and solar cells. Several methods have been proposed to make these systems less sensitive to environmental exposure. Among them, preparing core-shell structures–[2] coating perovskite nanocrystals with another perovskite material–has gained considerable attention. Such heterostructures with type-I band alignment at the junction not only increase the system stability and photoluminescence quantum yield, but also increase the charge trapping capability at each crystal site. This increased charge storage efficiency is a key requirement for memory-based devices. We have prepared an inorganic perovskite-based core-shell assembly in which $CsPbCl_3$ is at the core and Cs_4PbCl_6 forms the shell layer. Using Scanning Tunneling Spectroscopy, we have investigated voltage-controlled resistive switching in this system. We observed systematic control of non-invasive voltage pulsing over the high and the low resistive states of the nanocrystals;[3] this indicates that the system is suitable for high-density memory-based device fabrications.

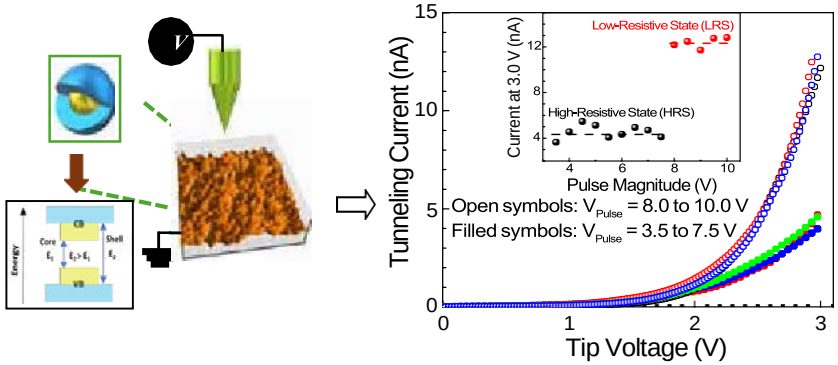

Figure 1. Schematic of the core-shell structure under scanning tunneling microscope: The tunnel current vs. tip voltage spectra of the sample jumps to a low-resistance branch (higher current branch) after applying a voltage pulse of 8V or higher magnitude. Filled symbols correspond to the high resistance state while open symbols represent the low-resistance state. Inset shows the variation in tunnel current at a bias of 3 V as a function of pulsing amplitude.

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CL005

Electrodeposition of Ni-Mo alloy from sulfamate electrolyte as a cathode for water splitting applications

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Water electrolysis is a flexible and environmentally beneficial method for producing high-purity hydrogen from primary energy sources other than fossil fuels. In order to compete with fuel-reforming hydrogen generation, which accounts for over 95% of global production, this technique must lower costs. The Ni-Mo alloys are well-studied as highly effective electro catalyst cathodes for hydrogen evolution. This alloy was prepared by the electrodeposition method because this technique is simple, low cost, scalability, and manufacturability. The electro-deposition of Nickel-Molybdenum (Ni-Mo) alloy coating on mild steel (MS) under different conditions, such as pH, Current density, and various Ammonium molybdenumcontent in the Nickel Sulphamate bath to achieve a higher percentage of Molybdenum in the coating as required for stable cathode for water splitting application. XRD analysis was used to determine the phase orientation and particle size for the Ni-Mo alloy deposits. The Ni-Mo alloy deposit shows polycrystalline nature and the preferential phase orientation of Ni-Mo (111) plane. It is also confirmed by XPS analysis. The grain size was found to be in the nano meter range by using Scherrer equation. From SEM analysis the Ni-Mo alloy deposits showed uniformly formed spherical like structure. The EDAX analysis of the Ni-Mo alloy deposits reveals that the current density increases the molybdenum content in the deposits found to decrease. The hardness of the deposits in the range of 500 to 580 HV with the changes in current density. AFM technique was used to analyze the surface topography and roughness measurement and it showed smooth surface. The Ni-Mo alloy deposit produced at 4 Adm^{-2} shows better electrocatalytic activity of both OER and HER during electrochemical studies.

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CL006

$Ni(OH)_2$- MoS_2 Nanocomposite Modified Glassy Carbon Electrode for the Detection Of Dopamine and α- Lipoic Acid

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Here, we report an electrochemical sensor realized using a nanocomposite consisting of nanosheets of nickel hydroxide and exfoliated MoS_2. The initial system of $Ni(OH)_2$ was able to detect dopamine, uric acid and α- lipoic acid. Further modification with MoS_2 was carried out and the system was able to detect dopamine and α-lipoic acid in phosphate-buffered saline (PBS) solution at pH 7.4. The nanocomposites were characterized using microscopic and spectroscopic methods. Further, electrochemical characterizations were carried out usingcyclic voltammetry (CV), electrochemical impedance spectroscopy (EIS) and differential pulse voltammetry (DPV). From the electrochemical analysis, it was found that $Ni(OH)_2/MoS_2$ composite in the ratio of 2:1 has better results in terms of electrochemically active surface area, impedance, analytical parameters and stability. The dynamic range for dopamine was 0.75 - 95 µM with a LOD value of 56 nM and for the α-lipoic acid, the linear range was 1 - 75 µM and the LOD was 51 nM.

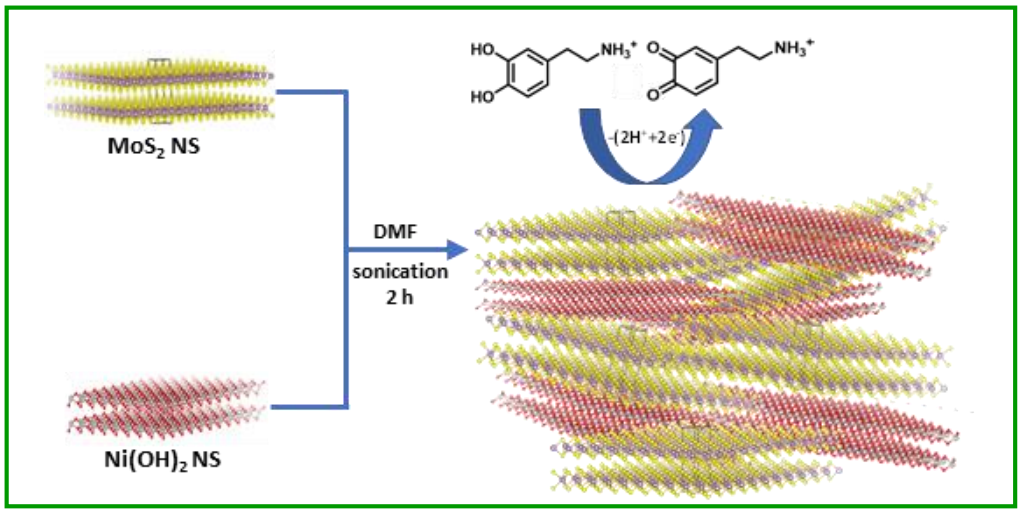

Figure 1. Schematic representation of electrochemical sensing

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CL007

Processing, Optimization, and Physico-chemical Characterization of 3D Printed EVA/HA composite for Bone Tissue Engineering

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Polymer composites are promising bone substitutes, alone or in combination with osteogenic cells, growth factors or signaling molecules.[1,2] The present work evaluates the design strategy of ethylene vinyl acetate-hydroxyapatite (EVA-HA) composite for its potential to be used as a bone tissue engineering construct. The composite was processed by melt mixing and fused granulate fabrication (FGF) printing to develop robust and bioactive bone scaffolds. Comprehensive characterization of the 3D printed composite was carried out using confocal microscopy, SEM, XRD etc to develop scaffolds that mimic bone's extracellular matrix in morphology, microstructure and mechanical properties. *In vitro* cell culture studies on the scaffolds demonstrate satisfactory biocompatibility and cell adhesion of MG-63 cell lines.

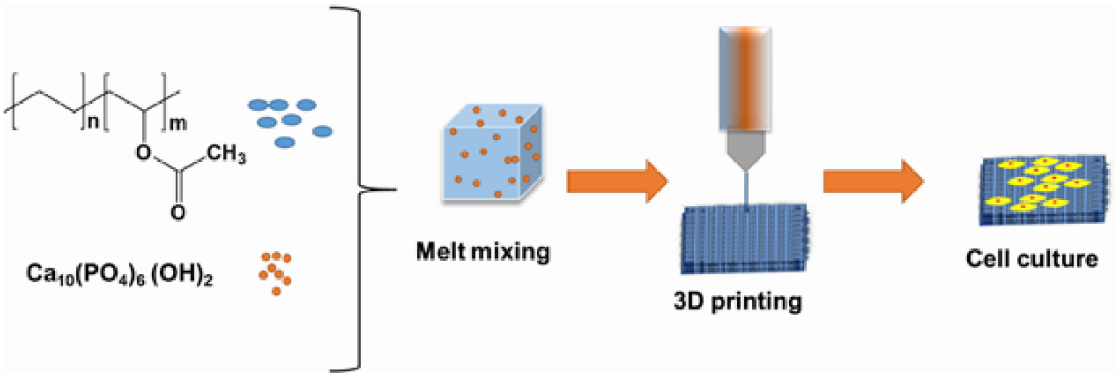

Figure 1. Schematic illustration of the overall process

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CL008

A paper-based composite electrospun nanofibers composed of gold nanoclusters for the real-time detection of cancer cells

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According to GLOBOCAN (Global Cancer Observatory) reports, in India, there will be a rapid hike in the number of cancer cases to around 57.5% in the year 2040.[1] The high levels of cancer occurrences and deaths arise due to the unavailability of proper cancer diagnosis and therapeutic techniques. In this work, a paper-based-composite-electrospun nanofibrous membrane composed of polyvinyl alcohol-gold nanoclusters (PVA-AuNCs)is used for the primary detection of cancer cells, which is developed using the ideology that hydrogen peroxide (H_2O_2) is more profoundly released by cancer cells than normal cells.[2]

The proposed prototype showed orangish-red emission (λ_{max}=647nm) withan average fiber diameter of 291±47nm and could detect H_2O_2 upto 47pM (R^2=0.998). In this prototype, the H_2O_2 release from cancer cells is evident without any activators like PMA and ascorbic acid. The photoluminescence (PL) quenching increased with higher concentration of cancer cells due to increased amount of H_2O_2 release. On the other hand, the quenching was approximately four times lessfor normalcells than forcancer cells. Further, we spiked different known concentrations of H_2O_2 in normal cells (NC) and observed a similar quenching phenomenon as that of the addition of H_2O_2in PVA-AuNCs nanofibers. Thus theprepared nanofibrous membranein this study may be potentially used for the primary diagnosis of cancer cells, which facilitates early treatment and cure for the disease.

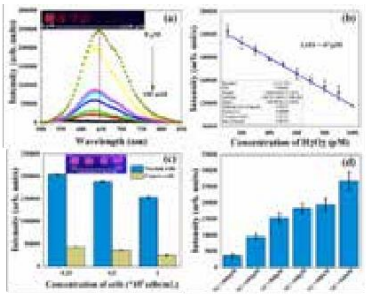

Figure 1. (a) PL emission spectra of PVA-AuNCs nanofibers with different concentrations of H_2O_2 (b) LOD plot (c) comparison of PL emission intensity of normal and cancer cells (d) spiking of H_2O_2 on normal cells.

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CL009

Utilization of recovered graphite from end-of-life batteries for energy applications

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Graphite is the state-of-the-art anode material for not only lithium-ion batteries but also for other primary and secondary batteries, due to its high electrical conductivity, reversible lithium storage capacity, short charge-discharge potential, ordered layer structure, broad potential plateaus, and excellent stability. However, the battery industry is struggling to find the suitable method to recycle the used batteries for further application.

Based on the above objective, this study establishes a strategy to reuse the lithium-ion battery's anode material as a raw material to improve the catalytic activity of electrocatalyst reaction. The recovered graphite from spent Li-ion batteries has been converted to graphene oxide and has been employed as a conductive additive with inhouse 20% Pt/C and evaluated as a catalyst for oxygen reduction reaction and its tolerance towards methanol in acidic medium. The prepared material was characterized by XRD, XPS and Raman spectroscopy. The Electrochemical studies were carried out by cyclic voltammetry and Liner sweep voltammetry. The recovered graphite material was compared with 20% Pt/C catalyst, showing improved methanol tolerance during the evaluation of ORR which is shown in Fig.1.

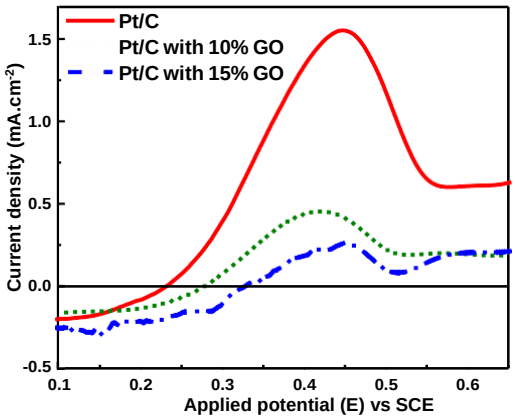

Figure 1. Comparative LSV of catalysts showing the effect of CH_3OH in 0.1M $HClO_4$.

CL010

Enhanced Piezoelectricity from Self-Polarized PVDF Infiltrated Nylon 11 Aerogels with Highly Oriented Polymer Crystals

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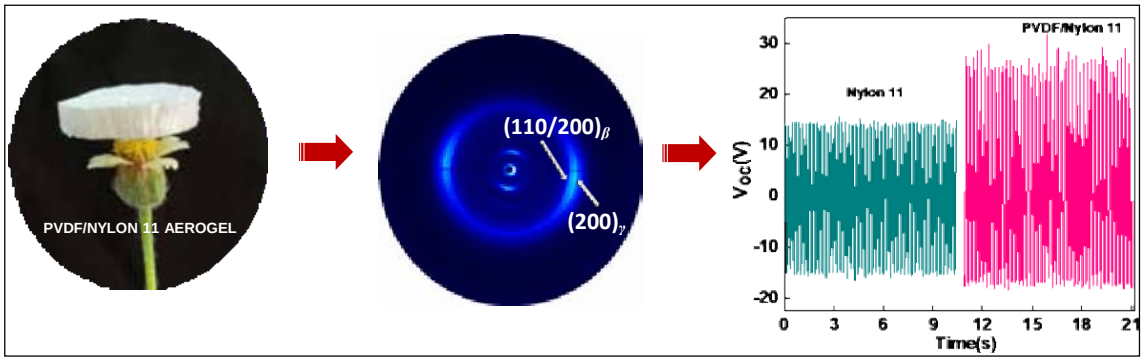
Piezoelectric polymers are attractive for energy harvesting applications due to their rapid processability and flexibility. Among these, PVDF and odd-nylons have garnered significant interest for their higher piezoelectric coefficient and thermal stability.[1,2] Realization of the piezoelectric phase with the preferred crystal orientation is paramount to achieve superior piezoelectric performance.[3] However, developing self-polarized piezoelectric polymers remained elusive under mild conditions. Herein, we demonstrate the preparation of an anisotropic PVDF/nylon 11 aerogel with polymer crystallite orientation by a vacuum-assisted infiltration method. Oriented nylon 11 aerogel was used as a template and PVDF solution was subsequently infiltrated into it under vacuum. The effective interaction with the oriented nylon 11 chains and the vacuum-assisted infiltration facilitated the orientation of PVDF crystals. The resulting PVDF/nylon 11 aerogels obtained after freeze-drying hosted the simultaneous orientation of two piezoelectric polymers within a single system. Both nylon 11 and PVDF crystallized into the polar γ and β forms, respectively. The piezoelectric nanogenerator fabricated using the PVDF/nylon 11 aerogel delivered an output voltage of ~ 45 V, surpassing that of bare nylon 11 and PVDF aerogels. This presents a practical strategy for developing self-poled polymers for efficient energy-harvesting applications.



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CL011

Exploring the Impact of Crystal Structure and Electrical Polarization on Electrocatalytic Oxygen Evolution in the Bi-Fe-O System

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The Electrocatalytic Oxygen Evolution Reaction (OER) is a limiting reaction in water splitting reaction for the generation of oxygen, involving 4 electron transfer and high overpotential. The efficiency of this reaction hinges on catalyst parameters like electronic configuration, crystal structure, morphology, and oxidation state, with crystal structures playing a pivotal role. This work focuses on investigating the impact of crystal structure variation within the Bi-Fe-O system on OER efficiency. Specifically, BiFeO3, Bi2Fe4O9, and Bi25FeO40, crystallizing in perovskite, mullite, and selenite structures respectively, are studied. In the first study, the OER performance of these structures is evaluated, revealing Bi2Fe4O9's orthorhombic structure to display the highest activity. Remarkably, after electrical polarization, Bi25FeO40 shows a fourfold increase in OER activity, indicating significant enhancement. Defects within crystal systems emerge as crucial determinants, prompting further investigation through Positron Annihilation Lifetime Spectroscopy (PALS) and Electron Paramagnetic Resonance (EPR) studies. Analysis of positron lifetimes reveals the presence of oxygen vacancies and defect clusters in BiFeO3, corroborated by EPR studies indicating oxygen vacancies.

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Abstracts-Posters

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SN001

DEVELOPMENT OF ADVANCED DUAL Fe(III)/Cr(VI) METAL SENSOR AND PHOTODEGRADATION CATALYST FROM INTENSELY FLUORESCENT N AND O DOPED GLIRICIDA SEPIUM CARBON DOT

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Herein, we are reporting an invention of a novel two-in-one specific metal sensor for sensing Fe (III) and Cr (VI) using bathochromic shift of photoluminescence spectral wavelength and as a catalyst for photodegradation of methylene blue (MB) under UV light in sunlight. This novel material; high quantum yield (61.2) intensely blue fluorescent N-doped carbon dot (CD), is achieved through a facile, green, environmentally friendly method from the green precursor *Gliricida Sepium* plant leaf. The synthesized CDs were nitrogen-self-doped, which was supported by XPS data containing 30% N, 34% C, and 36% O and confirmed with FT-IR. Morphology was analyzed using TEM and observed a uniform spherical size of 1.8nm. For metal sensing applications, Fe(III) and Cr(VI) ions were sensed on the basis of a strong bathochromic shift in the PL emission wavelength, which is a most useful and emerging method for specific metal sensing other than the most commonly used quenching mechanism. In the case of Fe(III) ion, the PL wave length shifted from 389.7nm to 406.5 nm, and Cr(VI) to 435nm with limit of detection 4µM. Synthesized CDs also act as an effective catalyst for photodegradation of organic pollutant dye, MB even in UV light of sunlight.

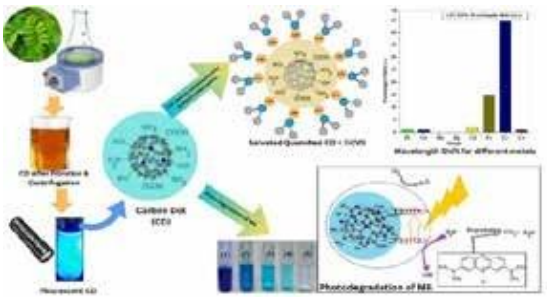

Figure.1: Schematic representation of synthesis and application of *Gliricida Sepium based CD*

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SN002

IoT based ammonia sensors using polyaniline/Gr films

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Polyaniline (PANI) the most studied conducting polymer for ammonia sensing at room temperature[1]. Graphene is a p-type semiconductor, both the graphene and the PANI haveπ conjugated electrons which helps in gas response[2]. To enhance its response, sufficient weight percentage of graphene is added. Here, we present the utilization of polyaniline/graphene (PANI/Gr) based composite films produced by in situ polymerization for ammonia sensing. The presented sample is tested towards 100 ppm of ammonia using the Keysight and the Arduino-based measurement. The pristine PANI sample showed a response of 1.9 to 2.2. The response of PANI/Gr composite diminishes at first and then increases with graphene concentration. Fig. 1(a) gives the response, and Fig. 1(b) gives the swift response and recovery time of the PANI_Gr_X sample. We report a maximum response of 2.4 (240%) for PANI_Gr_70.0 sample. The morphology of the prepared nanocomposite is studied using SEM, FTIR provides the importance of the chemical bond, and contact angle confirms its hydrophobic nature. It is also worth noting that the response measured by the ArduinoLeonardo board is almost comparable (within error limits) with measurements performed using KEYSIGHT Digital Multimeter 34465A. As a result, our prototype can be utilized for real-time measurements and offers an advantage in cost and compactness.

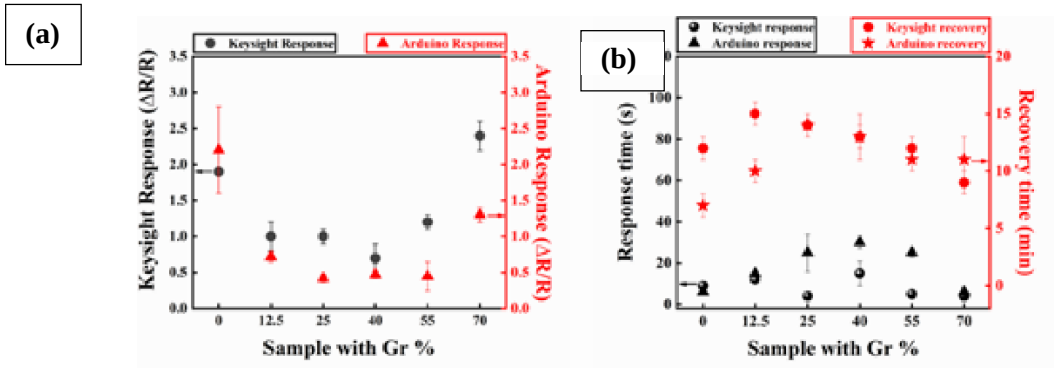

Fig 1: Response graph of PANI_Gr_X sample, (b) Response and recovery time of PANI_Gr_X sample.

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SN003

Halide perovskites@HNTs nanocomposite: A new frontier in the electrochemical detection of Tadalafil

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As halide perovskites have taken a central role in the evolution of semiconductor materials, they are setting new standards for performance and revolutionizing the energy sectors. Unfortunately, little light is shed on the material's electrochemical sensing capabilities. This work reports the synthesis and characterization of a novel double halide perovskite $Cs_2CaSnCl_6$ (HDP) integrated with halloysite nanotubes (HNTs) for the electrochemical detection of Tadalafil (TAD). HDP@HNTs nanocomposite is synthesized using a simple solvothermal method and is characterized using various techniques like SEM, TEM, UV-visible, FT-IR, TGA/DTA, XRD and BET analysis. The results obtained from these characterizations confirmed the successful formation of the nanocomposite, revealed the material's endurance to high temperatures and the availability of a large surface area for reaction. Electrochemical characterization techniques like cyclic voltammetry (CV) and linear sweep voltammetry (LSV) demonstrated a linear correlation with the concentrations of TAD. Computational analysis of the optimized TAD structure, molecular electrostatic potential (MEP) of TAD and calculations regarding the HOMO-LUMO molecular orbitals are all carried out using DFT/B3LYP method. The HDP@HNTs sensor is capable of achieving the lowest detection limit of 1.68 µM and the limit of quantification of 5.09 µM. From all the electrochemical parameters, the material showcased a remarkable sensitivity of 10.68 µA μM^{-1} cm^{-2}. Its reliability and stable performance even in the presence of real samples makes it a promising material for sensing applications. Thus, the reported framework contributes to the advancement in the development of sensors and enhanced healthcare outcomes.

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SN004

Cadmium-doped Titanium Dioxide Sensor Material for Electrochemical Sensing of CAP in different Environmental Samples

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The world is currently grappling with a significant challenge, marked by environmental pollution, amidst the abundance of energy and opportunities. Nevertheless, to overcome such adverse effects, scientific methodologies must be adapted, and among those, electrochemical sensors have emerged as a promising tool for the primary detection of various pollutants in real samples. Herein, we have developed the distinctive type of electrochemical sensor with Cd doped TiO_2 as sensor material for the detection of a nitroaromatic contaminant, chloramphenicol (CAP). Cd-TiO_2 was synthesised by the sol-gel, followed by a hydrothermal process to obtain the Cd-doped TiO_2 sensor material. Further, it underwent various characterization techniques like XRD, FT-IR, HR-TEM, and EIS. Moreover, to determine the detection facility, CV and LSV techniques were deployed. Proven results with a remarkable low limit of detection 3.5 nM and a linear concentration range were found to be 1 µm to 25 µm. Real sample analysis was conducted with different samples: milk, pond water, honey, sugarcane juice, and coconut water. The results obtained were accurate and could be chosen as best sensor material for the detection of CAP in real-world analysis.

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SN005

Fabrication of Non-enzymatic Electrochemical Sensor Based on Bi_2S_3-TiO_2/HNT'S composite for the Detection of organic pollutants in environmental samples

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In the current era of rapid population growth, there has been an increase in resource consumption and the subsequent release of organic pollutants into water bodies by various industries. To address this issue, we have developed a nanocomposite material, Bi_2S_3-TiO_2/HNTs, for electrochemical sensors capable of simultaneously detecting Nitrofurantoin (NFT) and 4-Nitrophenol (4-NP) contaminants. The nanocomposite material was synthesized using a one-pot novel Sol-gel method, and its structural morphology was characterized using techniques such as FE-SEM, FT-IR, HR-TEM, and XRD analysis. The electrochemical sensor exhibited a remarkably low limit of detection (3.2 nM for NFT & 3.5 nM for 4-NP) and a wide concentration range from 0 µM to 260 µM for both NFT & 4-NP, demonstrating their high sensitivity and accuracy for pollutant detection and further it is accessed to real-world application considering the pond and tap water as a real sample.

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SN006

Highly Sensitive and Flexible Gold Nanoparticles Based Humidity Sensor for Wearable Electronics: Adoptable for Advanced Smart Irrigation Systems

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Meticulous monitoring and measurement of humidity levels are integral to multiple industrial, agricultural, healthcare and environmental applications, that demands the advancement of wearable and flexible humidity sensors in the paradigm of internet of things.[1] In the present study, a resistive- type, highly sensitive gold nanoparticle-based humidity sensor was developed with large resistance variation up to 5 orders of magnitude in response to humidity change from 40 % RH to 95 % RH. The sensor exhibits excellent thermal stability (evaluated at different temperatures 25 ^{o}C to 50 ^{o}C), high flexibility (studied under different bending radii 12mm, 16mm, 20mm, 24mm), significant stability (> 6 months), and short response and recovery time (~206 ms/~280 ms towards respiration rate monitoring). Owing to its exceptional humidity sensitivity, the fabricated sensor demonstrates substantial potential in diverse fields, including but not limited to respiration monitoring, non-contact sensing, and soil moisture monitoring. Furthermore, its adaptability to data-driven technologies renders it well-suited for integration into advanced smart irrigation systems.

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SN007

Gold and Cerium Enhanced Colorimetric Paper based Device for Ultrasensitive and Multimodal Detection of Alzheimer's Disease Biomarker

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Alzheimer's disease (AD) is a progressive neurodegenerative condition characterized by the buildup of biomarkers like amyloid beta (Aβ) and Tau proteins in bodily fluids such as blood and cerebrospinal fluid (CSF). Aβ 42 and Aβ 40 are key diagnostic markers for AD in CSF.[1] Detecting these biomarkers in blood could enable early diagnosis without the need for invasive CSF collection. However, their low concentrations in blood require sensitive detection methods. To address this, dual-channel colorimetric paper strips were developed to simultaneously detect Aβ 42 and Aβ 40. Gold nanorods and cerium (AuNR-Ce) nanocomposite enable rapid detection within 20 minutes. The nanocomposite catalyzes the conversion of a substrate into a colored product, amplifying visual signals for sensitive detection. Employing in-house developed algorithms for image analysis, we performed quantitative assessment of Aβ 42/40 ratio which is an established parameter for AD diagnosis.[2] The method achieved a limit of detection of 76 pg/ml for both Aβ 42 and Aβ 40. Clinical sample analysis showed a decreased Aβ 42/40 ratio compared to controls, with strong correlation to ELISA analysis (R^2=0.966). This paper-based sensor holds promise for early AD diagnosis using blood plasma samples, with potential for clinical translation.

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SN008

Synthesis of ZIF-67-based composite for non-enzymatic electrochemical detection of glucose

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A copper-bottomed sensor for glucose is very important as the level of glucose in body fluid is very important in the diagnosis of Diabetes mellitus. The Metal-organic frameworks (MOF) have a crucial role in sensing due to their porosity, tunable pore size, surface area, etc. The present work focuses on the synthesis of non-enzymatic electrochemical sensor for the detection of glucose based on Cu-doped ZnO@ ZIF-67 (CuZ-67)- modified glassy carbon electrode (GCE). CuZ-67 was synthesized through a solvothermal process with controlled nucleation and growth of copper nanoparticles within the ZIF-67 framework resulting in a stable composite structure. The synthesized CuZ-67 was characterized using FT-IR, UV-visible spectroscopy, Photoluminescence (PL) spectra, BET, etc. The synthesized material exhibits excellent sensitivity towards glucose which is evaluated using Cyclic voltammetry (CV).

Keywords: ZIF-67, Non-enzymatic electrochemical sensor, Glucose sensor, Metal organic frameworks

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SN009

Machine Learning- Assisted Discriminative Detection of Vitamin B_{12} and Vitamin B_9 by Fluorescent $MoSe_2$ Quantum Dots

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In this study, we present a label-free and discriminative detection approach for vitamin B_{12} and vitamin B_9 using fluorescence assays. We synthesized highly fluorescent $MoSe_2$ quantum dots (QDs) through a hydrothermal process by introducing an intercalation agent (KOH). These $MoSe_2$ QDs exhibited a distinct blue emission at 355 nm, making them an excellent choice for our analytical purposes. The fluorescence characteristics of these $MoSe_2$ QDs were used to develop a sensor capable of detecting both vitamin B_{12} and vitamin B_9 by means of fluorescence quenching. Interestingly, we found that the quenching mechanisms for these two vitamins differed: vitamin B_{12} detection predominantly relied on Föster resonance energy transfer (FRET), while the identification of vitamin B_9 was primarily due to the inner filter effect (IFE). We employed an advanced technique called machine-learning techniques to discriminate these vitamins. This approach yielded an impressive accuracy rate of 93% in distinguishing between vitamin B_{12} and vitamin B_9.

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SN010

Unveiling dual mode non-contact optical thermometry application of Sm^{3+} doped Vanadate phosphor

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The demand for temperature sensors based on non-contact methods has heightened after the outbreak of the COVID-19 pandemic.[1] The non-contact thermometers realized through the fluorescence intensity ratio (FIR) of dual luminescent centers have ultra-high sensitivity due to the involvement of non-thermally coupled energy levels in FIR calculation.[2] In this work, we synthesized Sm^{3+} doped $LiCa_2Mg_2V_3O_{12}$ phosphors via solid-state route and studied their practical application in optical thermometry. The structural, morphological, optical, luminescence and temperature-dependent luminescence properties of phosphors are examined by X-ray diffraction (XRD), scanning electron microscopy (SEM), UV-Visible-NIR spectroscopy, photoluminescence spectroscopy (PL) and temperature-dependent photoluminescence spectroscopy (TDPL). The FIR calculations are done using the spectral modes $^6H_{5/2}/VO_4^{3-}$, $^6H_{7/2}/VO_4^{3-}$ and $^6H_{9/2}/\ VO_4^{3-}$. The mode $^6H_{9/2}/\ VO_4^{3-}$ has elevated absolute sensitivity (S_a) and relative sensitivity (S_r) values of 0.4418 K^{-1} and 1.6079% K^{-1} respectively (***Figure 1***). The thermochromic properties of phosphor manifest the high chromaticity shift (Δs = 0.1869) and the $S_a(x)$ and S_r(x) values determined based on CIE coordinates are 0.0011 K^{-1} and 0.2407% K^{-1} respectively. The high sensitivity of phosphor suggests that it can be usedas a potential candidate for temperature sensing.

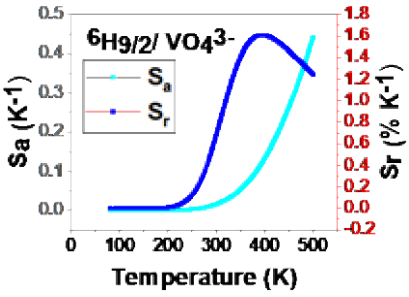

Figure 1. The S_a and S_r plot of $^6H_{9/2}/\ VO_4^{3-}$ mode.

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SN011

One Pot Synthesis of Hybrid Boron Nitride-Nitrogen doped Graphene Quantum Dots for Electrochemical Sensing of Pb (II) ions

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Continuous and rigorous evolution of environmental parameters is a major need of today's era. Evolution involves growth in all aspects, viz. industrial, economic and environmental, and so on, which also brings some backlogs as a reward. Drastic environmental changes are of major concern, which is a by-product of industrial growth. Among all, heavy metal ions are the most dangerous pollutants, causing severe threats to humans and the atmosphere. Besides, a few of them, viz. lead, mercury, cadmium, and arsenic, are recognized as highly toxic to humans even at low trace levels. In this present study, we developed a highly selective Hybrid Boron Nitride-Nitrogen doped Graphene Quantum dots (Hyb BNQD-NGQD) for electrochemical Sensing of Pb (II) ions, exhibiting selective and sensitive sensing ability towards Pb (II) ions. A high current response is shown by Hyb BNQD-NGQD towards Pb^{2+} ions sensing when compared with bare glassy carbon electrode. It showed an excellent and commendable selectivity towards Pb^{2+} ions in the presence of other interfering metal ions. The exemplary LOD value of 1×10^{-12} M is shown by it and was considered one of the main admirable abilities of the synthesized Hyb BNQD-NGQD. The study was also extended to real samples. It showed good current responses in real samples like wastewater.

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EP001

Biodegradable PHB/CNT@$MgCl_2$ Aerogels for Solar-Driven Atmospheric Water Harvesting Applications

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Water scarcity is one of the world's major problems, and atmospheric water harvesting (AWH) technology is emerging as a promising strategy for clean water production in arid regions, land-locked areas, and remote communities. The sorption-based AWH method, based on MOF derivatives, inorganic materials, and polymeric hydrogels, has been reported for harvesting water from the atmosphere. However, applications of these materials are heavily affected by their high cost, complicated preparation process and poor macrostructures. Herein, we synthesize fully biodegradable and sustainable PHB/CNT@$MgCl_2$ aerogels using the temperature-induced phase separation method for AWH. The experiments demonstrate that macroporous PHB/CNT@$MgCl_2$ aerogel is an effective AWH material in a broad range of sorption humidity and temperature [relative humidity (RH) from 90% to even lower than 30% and temperature of 50 to 25°C]. The results show that this macroporous aerogel can sorb water more than its own weight in 48 h at an RH of ~85%, 25 °C and release as high as the sorbed water via the photothermal effect (Figure 1). The strategy adopted here provides a way to design fully biodegradable and sustainable materials for efficient solar-driven atmospheric water harvesting applications.

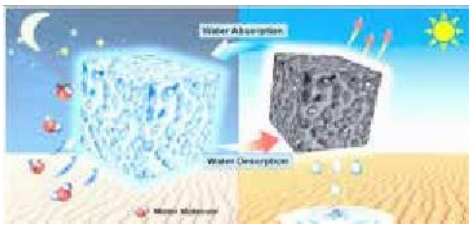

Figure 1. Moisture absorption-desorption kinetics of AWH aerogels (absorption during the night time and desorption during the day time)

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EP002

Experimental Studies on Diesel Engine Fuelled with CeO_2 Nanoparticles Dispersed in Mustard and Mahua Biodiesel

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The world faces the depletion of fossil fuels and rising petroleum prices. Biodiesels are considered as a promising option as they are clean renewable fuels. The addition of nanoparticlesis done to overcome disadvantages of biodiesels such as high viscosity and low calorific value, affecting performance and emission characteristics. Cerium oxide (CeO_2) nanoparticles stand out due to their benefits, which include large oxygen storage and good thermal properties, thus believed to have a great potential to become an additive for the diesel engine.[1] Very few works have been done with the combination of two different biodiesel blends with diesel and left a lot of scope in this area.

The present study brings out experimentation on a four stroke diesel engine using diesel, one litre B20 blend (20% biodiesel + 80% diesel) of mustard and mahua biodiesel by equal volume (MMB20) & 50 ppm CeO_2 nanoparticles dispersed in MMB20. The performance and emissions of diesel engine were investigated. The Biodiesels were prepared by Transesterification. The CeO_2 nanoparticles were synthesized by High Energy Ball Milling. The characterization of CeO_2 nanoparticles was done by X-Ray Diffraction, Field Emission Scanning Electron Microscopy and Energy Dispersive Analysis of X-Rays.[2] The Nanofuel was prepared by Ultrasonication. The effect of nanofuel on engine performance was discussed. The brake power and brake thermal efficiency were increased. Brake specific fuel consumption was improved and emissionssuch as CO, NOx and UHCs were reduced.[3]

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EP003

Development of Eco-Friendly Biodegradable Films from Iota-Carrageenan for Sustainable Food Packaging Applications

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There has been a growing interest in developing biodegradable polymers to combat pollution from petroleum-based synthetic polymers. Iota-Carrageenan based films exhibit several advantages such as good mechanical properties, emulsion stability and oxygen barrier. Carrageenan is readily available and low cost, making it a good candidate as a polymer matrix base material for active and intelligent food packaging films. However, its commercial application is limited due to high swelling and water solubility. Blending with a biopolymer such as sodium alginate with suitable amount of plasticizer is a good solution for the above stated problem. Films made from iota-carrageenan and sodium alginate possess strong mechanical properties, making them suitable for use in packaging applications. The extensive use of plastic packaging poses serious environmental challenges, making it imperative to transition to biodegradable films.

The aim of this study was to develop eco-friendly biodegradable film using polymer blends that could hypothetically improve the performance of film properties to meet industrial acceptability. The polymers studied are promising ingredients for the formulation of films, presenting good physical, optical and mechanical characteristics. Carrageenan-based functional packaging film was found to be useful for extending the shelf life of packaged foods and tracking spoilage. The proposed work has the potential to be commercialized, offering a sustainable alternative in the form of biodegradable films. The mechanical, thermal, barrier and antibacterial properties of modified carrageenan make it widely applicable for extending the shelf life of food products and monitoring its freshness.

Figure 1. IC/SA biodegradable film

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EP004

Highly recyclable AC-TiO_2 composite for organic dye degradation

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TiO_2, the versatile semiconductor, has already acquired a coveted position as a photocatalyst. Modification of the same to enhance efficiency is a topical subject. Herein we have synthesized a novel plastic-derived activated carbon TiO_2 composite processing high efficiency in adsorption-enhanced visible light photodegradation of organic dyes. It is found to be a solar regenerative recyclable catalyst that could act as a sustainable material for water purification.

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EP005

Synthesis of poly(amidoamine)- heterocycle conjugates: Towards a green approach

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Heterocycles are versatile building blocks in various fields, especially in pharmacology.[1] Different carriers are used to enhance the pharmacokinetic properties of the active small molecules[2], where poly(amidoamine) dendrimer (PAMAM) have played significant roles.[3] The current study focuses on the development of PAMAM dendrimer-azole heterocycle conjugates using PAMAM-guanylthiourea (PAMAM GTU) as the common synthon (Figure 1). Three members of the azole family, namely, oxadiazole, thiadiazole and thiazole were built on the PAMAM dendrimer following greener routes. Synthesis of 1,2,4-oxadiazole conjugate was achieved by the (3+2) annulation of PAMAM GTU in aqueous media using binucleophilic hydroxylamine hydrochloride in the presence of $AgNO_3$, whereas the oxidation of PAMAM GTU using H_2O_2 afforded PAMAM-1,2,4-thiadiazole conjugates. Besides, the 2-amino-1,3-thiazole ring was constructed on the periphery of PAMAM by the [4+1] ring closure of PAMAM-GTU in the presence of α-bromo carbonyl reagent *via* mechanochemical method. The photophysical characteristics of the synthesized conjugates were studied. The diversity of the reported synthesis method and the versatility of the GTU platform are demonstrated in this current study.

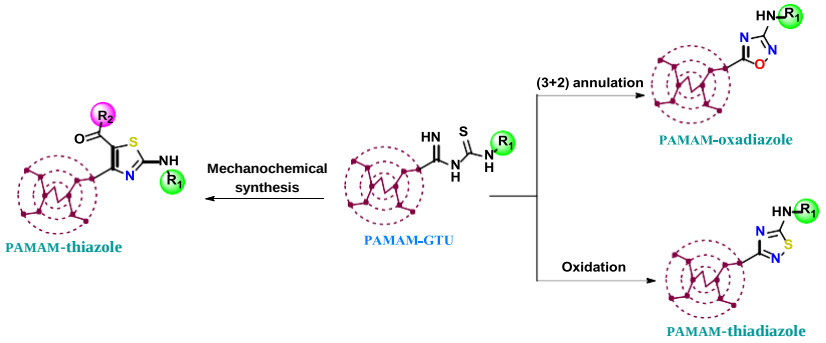

Figure 1. Scheme for the synthesis of PAMAM-based heterocycles

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RM001

Thermal insulting robust carbon composite foam panels with a periodic array of pores from used cloth for Efficient EMI shielding

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Thermally insulating materials with significant EMI shielding effectiveness are extremely important in the strategic sector. The persistence of discarded clothing globally poses an environmental challenge, with a significant portion ending up in landfills, contributing to the carbon footprint through their slow biodegradation process. Herein, robust carbon composite foam panels with a periodic array of pores in the z-direction and lamellar-type pores in the XY plane were fabricated from used cotton. The cotton fabrics are impregnated in concentrated sucrose solution followed by annealing at 225 ^{o}C and carbonation at 900^{o}C under Argon atmosphere to form a carbon sheet with a grid-like pore structure. The grid-like layers are bonded to each other using phenol-formaldehyde resin (PF), followed by curing and carbonization at 900^{o}C under Argon atmosphere to produce the porous carbon panels. The XRD and Raman spectra indicate the turbostatic nature of carbon panels, and the XPS spectrum shows the presence of oxygen-containing functional groups. The porous carbon panels are mechanically robust with adequate compressive strength, Young's Modulus, and Flexural strength of 0.50 to 3.56 MPa,3.42 to 137.37,1.47 to 13.67 MPa, respectively, when the PF concentration increases from 60 to 100 vol.%. It exhibits low density (0.45 to 0.57 g.cm^{-3}), excellent EMI shielding of nearly 77 dB at a 5mm thickness, low thermal conductivity (0.187 to 0.273 W.m^{-1}.K^{-1}), and fire resistance properties.

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AS001

Spectroscopic and magnetic properties of rare earth doped Ni-Co-Zn- spinel ferrite

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This article contains effect of rare earth doped ferrite sample, $Ni_{0.6}Co_{0.2}Zn_{0.2}Fe_{2-x}Pr_xO_4$, with (x = 0.00 to 0.100 in the step of 0.025), on the structural, magnetic and spectroscopic properties were investigated and were synthesized by using the micro-emulsion method. The stoichiometric elemental analysis of ferrite sample confirmed by using EDAX.[1] The XRD pattern clearly shows single phase cubic spinel structure and some secondary phase as increasing Pr^{+3} ions content. The SEM images conclude that the ferrite nano particles were in porous and fine micro structure.[2-3] The average particle size around 10–15 nm confirmed by TEM micrographs and SEAD pattern of shows the particles well crystalline in nature.[4] Magnetic measurements of ferrite nanoparticles were carried out with a Superconducting Quantum Interference Device (SQUID) Magnetometer.

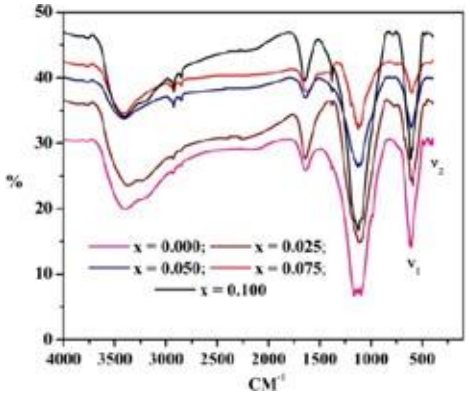

Figure 1. IR spectrum of $Ni_{0.6}Co_{0.2}Zn_{0.2}Fe_{2-x}Pr_xO_4$

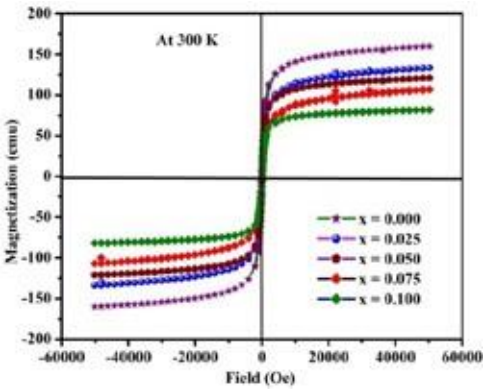

Figure 2. Variation of magnetization (M) with applied magnetic field (H) at 300K.

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AS002

$MgFe_2O_4@TiO_2$ core shell Nano particles for Environmental remediation

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With the appropriate surface modification or coating, nanomaterials featuring a magnetic core can be effectively utilized for the removal of heavy metals, radionuclides, hydrophobic compounds, pesticides, and organic contaminants. This versatility makes them a powerful tool in environmental remediation applications. The spread of a wide range of environmental contaminants in surface water has become a worldwide problem, affecting human health and the ecological environment. The development of $MgFe_2O_4@TiO_2$ core-shell nanoparticles represent a promising advancement in the quest for efficient and sustainable solutions to environmental pollution. The combination of magnetic separability, photocatalytic activity, antibacterial efficiency, and versatility in application makes this material a valuable asset in addressing contemporary environmental challenges.

These are promising potential in environmental remediation, particularly in the removal of toxic dyes such as methyl orange, as revealed by photocatalytic studies. The findings underscore the material's eco-friendly nature, its cost-effectiveness, and its high efficiency as a photo-catalyst, positioning it as a valuable asset for environmental cleanup efforts. These core/shell materials have been integrated into various devices, demonstrating superior performance over their plain core counterparts. Nevertheless, recent reports indicate that TiO_2@MgO-Fe_2O_4 core-shell structures display photocatalytic activity when exposed to UV light irradiation[1]. This discovery suggests that these materials hold potential for the treatment of organic contaminants in aqueous environments under sunlight, representing a significant advancement for practical applications. The material is found to be antibacterial againstgram positive and gram-negative bacteria.

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AS003

Electrochemical Corrosion and Mechanical Properties of DC Magnetron Sputtered Super Hard Coatings for Automotive Chain Pins

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In the automotive industry, the durability and reliability of chain pins are crucial for overallvehicle performance. Chain pins, which are integral to timing chains, operate under high-stress conditions and face significant wear and corrosion. To enhance their lifespan and functionality,advanced surface engineering techniques are employed. One such promising technique is the deposition of super hard coatings using DC magnetron sputtering. DC magnetron sputtering is versatile method for applying thin films of super-hard materials onto substrates. This process uses a direct current (DC) power supply to generate plasma, sputtering atoms from a target material that deposits onto the substrate and forms a coating. These super-hard coatings exhibit high hardness and wear resistance, which is essential for components in rigorous environments.The electrochemical corrosion resistance of these coatings is also crucial, especially in the automotive industry, where exposure to corrosive agents is common. Super-hard coatings from DC magnetron sputtering provide barriers against wear and chemical degradation, making them suitable for automotive chain pins. This study evaluates the electrochemical corrosion and mechanical properties of DC magnetron sputtered super hard coatings for automotive chain pins. Two tantalum nitride (TaN)-based bilayer coatings with chromium (Cr) and titanium (Ti) interlayers were deposited on SAE52100

AS004

Silk-based sustainable biocomposite scaffold for potential applications in tissue engineering: a study on process – property relationship

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The field of tissue engineering aims to create artificial tissues, and the domain heavily depends on synthetic polymers to develop necessary scaffolds. Amidst growing concerns on synthetic sources in view of sustainable development goals, efforts are on to develop tissue engineering scaffolds from green and sustainable sources. To this end, this work aims to develop an advanced biopolymeric composite scaffold from silk fibroin, a sustainable biopolymer, for potential applications in corneal tissue engineering. Here, we purified the silk fibroin polymer from cocoons, blended with three other bioactive additives, and subsequently prepared the films by following a simple solvent casting approach. The resultant films were subjected to systematic characterization studies to investigate the visual appearance, optical transparency, micro-cracks, ease of peeling, suture retention. For the biocompatibility assessment studies, model corneal cells were cultured on various biocomposite films and the cell viability and proliferation were analyzed. The incorporation of bioactive additives into silk fibroin films was found to have no effect on the optical properties of the films, however, there were noticeable changes in the micro-cracks, ease of peeling and suture retention in certain cases. The cell culture study findings indicated that the integration of bioactive additives into the silk fibroin films enhanced the cell viability and proliferation. This study suggests that advanced bio-composite scaffolds could be made from combining silk fibroin with bioactive additives and that the properties of the silk fibroin scaffold can be tuned with respect to physical aspects and cellular response. Having derived the silk fibroin and other bioactive additives from natural resources, this study is an attempt towards meeting sustainable practices in tissue engineering field.

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AS005

Exploring the Potential of Bioepoxy/Graphene Nanoplatelets Composites as Advanced Shape Memory Materials

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Shape memory polymers manifest an exceptional potential to remember their initial shape and regain it after being deformed by applying an external stimulus, like light, heat, electric field, pH change, magnetic field, etc. Shape memory polymer nanocomposites are an engrossing and expeditiously developing research area with noteworthy applicability across several fields. These materials integrate the advantages of nanofiller addition with the distinctive characteristics of shape memory polymers (SMPs). The inclusion of nanostructures can improve the shape memory effect by enhancing the receptiveness to stimuli, mechanical characteristics, thermal stability, etc. Shape-memory bio epoxy composites have great potential in various applications as they possess the advantages of being sustainable and biodegradable, along with their shape-memory efficiency. Bio epoxies are environmentally benign substitutes for conventional petroleum-based epoxy resins since they are made from renewable resources like plant-based feedstocks. The composites produced by introducing shape memory behaviour to these bio epoxies exhibit sustainable and practical attributes. This work throws light into the development of a bio epoxy nanocomposite cured with a biobased crosslinker incorporated with graphene nanoplatelets (GNPs) as a nanofiller. The developed systems have shown enhanced mechanical properties as well as excellent shape memory capabilities. This offers them an extensive variety of potential applications in numerous sectors, including biomedicine, sensors, smart textiles, aerospace, energy storage etc.

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MC001

Sustainable Strategies for Aircraft End-of-Life Management - An Overview

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The aim is to provide a comprehensive overview of the current status and development of aircraft end-of-life strategies. With the expansion of the aviation sector, the oversight of aircraft nearing the conclusion of their operational lifespan has emerged as a progressively pivotal issue. An overview of sustainable approaches to aircraft end-of-life management is presented in this article. This analysis scrutinizes the obstacles and prospects associated with guaranteeing ecologically sustainable and financially feasible methods for decommissioning, recycling, and repurposing aircraft components through an examination of present methodologies, emergent patterns, and prospective forecasts. Lifecycle assessment methodologies, technological innovations, and regulatory frameworks are crucial subjects. By conducting an extensive examination of pertinent scholarly works and case studies, the objective of this research paper is to enlighten policymakers, stakeholders in the aviation industry, and scholars regarding the dynamic nature of sustainable aircraft end-of-life management. There is no model to support concerning the aircraft end-of-life process considering all criteria of sustainability. A systematic, complete and qualitative framework to assist a process in taking a proper aircraft end-of-life is urgently needed.

Figure 1. Ways to use aircraft end-of-life for various purposes or Special Reuse Approaches

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MC002

Towards Sustainable Aluminium Production

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Extracting aluminium from its ore is highly energy intensive and produces significant greenhouse gas (GHG) emissions, including CO_2, CO, CF_4, /C_2F_6. It generates large amounts of solid waste in various extraction stages, including red mud residue, spent carbon anodes, and spent potlining, classified as hazardous waste.[1] The demand for aluminium is expected to increase, so there is a need to add sustainability to the production route. Thus, the vital ore source for sustainable green aluminium is aluminium scrap recovered from industrial and post-consumer waste.[2] Recycling aluminium significantly reduces 90-95% of the energy needed to produce primary aluminium, reducing GHG emissions and generating less solid waste. The paper addresses the challenges in primary production and the evolution of aluminium recycling in promoting a circular economy. In this regard, downcycling and upcycling scrap technologies have been explored to utilize aluminium scrap in various applications efficiently.[3,4] The paper summarizes the issues in the current recycling process and emphasises the production of new generations of more impurity-tolerant sustainable aluminium alloys.

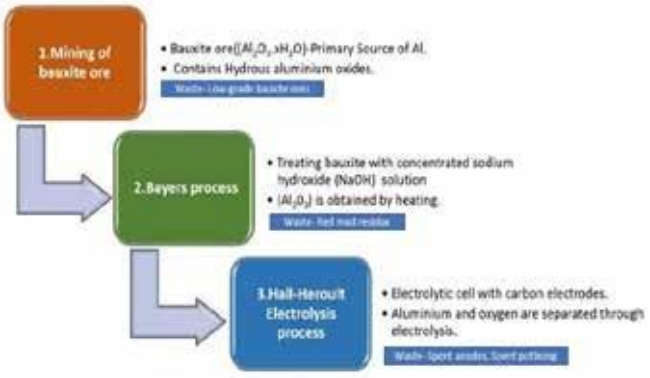

Figure 1: Schematic representation of primary aluminium production.

Figure 2: Schematic of aluminium circular economy.

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EM001

Implication of the *p*-Si/TiO_2 interface in hole-blocking and photodetection

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An effective strategy to mitigate surface recombination loss in Si solar cells involves passivating surface dangling bonds by applying a thin-layer of TiO_2 onto bulk Si. Besides, the *p*-Si/TiO_2 interface can induce hole-blocking and promote superior electron transport through the TiO_2 layer, facilitating electron extraction for efficient utilization. This study explores how intentionally introducing Ti^{3+} donor states in TiO_2 thin film network, by controlling O-vacancies through plasma pressure adjustments in the RF-magnetron sputtering chamber during growth, can alter the material's Fermi level, work function (ϕ), band bending, band offset, and fixed oxide charge density (Q_f) in the *p*-Si/TiO_2 heterojunction interface. The observed hole-blocking effect correlates with the photoresponsivity of the metal-oxide-semiconductor (MOS) structure. The optimum MOS device fabricated at a pressure of 30 mTorr possesses relatively low conduction band offset (ΔE_C ~0.20 eV), significant positive fixed oxide charge (+1.18 ×10^{11} cm^{-2}) and the interface trap density (1.03 ×10^{12} cm^{-2}), which enhance the transport of minority carrier electrons from the *p*-Si to the metal, resulting in a good photo responsivity ~0.158 AW^{-1} and photo gain of ~37.5 under white light illumination. Optimum hole-blocking and surface passivation characteristics of the TiO_2/*p*-Si interface may facilitate improving heterojunction Si solar cells.[1]

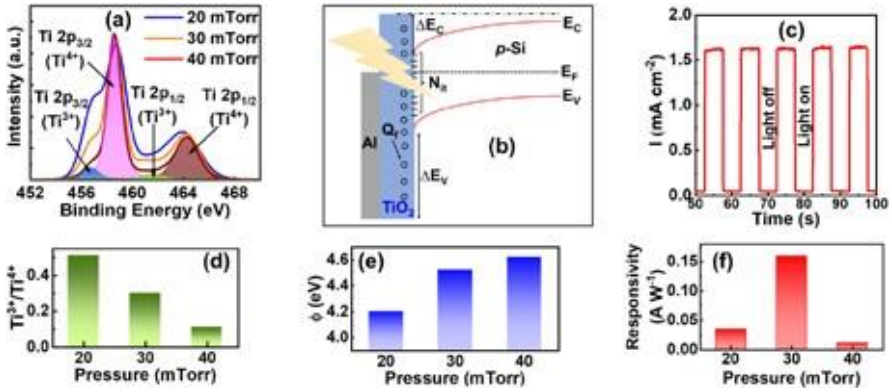

Figure 1. (a) Ti *2p* core level XPS spectra of the TiO_2 thin films demonstrating the Ti^{3+} donor states; (b) Schematic representation of MOS device; (c) Photo response characteristics of the device prepared at pressure of 30 mTorr, under white light of power ~10 mW cm^{-2}; (d), (e) and (f) Variation of Ti^{3+}/Ti^{4+}, work function, and photo responsivity with pressure, respectively.

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EM002

Structural, morphological, optical, and electrical properties of graphene/Copper (I) Thiocyanate (CuSCN) thin films for perovskite solar cell application

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During the last few years, research has significantly attracted *p*-type β-Copper(I) Thiocyanate (CuSCN) as a hole transport layer (HTL) for perovskite solar cells[1]. However, its moderate electrical conductivity can limit its efficiency in transporting charges within the cell, potentially reducing overall performance[2]. Graphene, an atomically thin two-dimensional carbonaceous material due to its exceptional electronic, electrical, and mechanical properties, is expected to improve the electrical properties of CuSCN thin films. In this work, we use the spin coating method to report on solution-processable CuSCN deposition with various concentrations of graphene as HTL on glass substrates at room temperature. The influence of graphene incorporation on structural, morphological, chemical, vibrational, optical, and electrical characteristics of deposited thin films was investigated through X-ray Diffraction (XRD), Fieldemission scanning electron microscopy (FESEM), Fourier-transform infrared spectroscopy (FTIR), Raman spectroscopy, Ultraviolet/Visible/Near Infrared Spectroscopy (UV-Vis-NIR), Four probe method, and Hall-effect measurements. The incorporation of graphene into CuSCN has been shown to enhance surface hydrophobicity, resulting in a higher water contact angle from 31.5 to 87.7. Therefore, the proposed work can facilitate both enhanced efficiency and stability at a low cost.

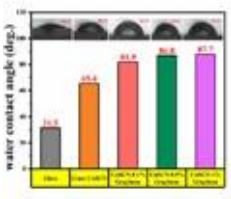

Figure 1. Water contact angle measurement on different ratios of graphene-CuSCN nanocomposite

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EM003

Optimizing Aqueous Zinc-Ion Batteries: Enhanced Performance with Efficient Electrolyte Additives

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Zinc (Zn) based anode materials are recognized as leading electrode systems in the advancement of aqueous battery technologies. However, the reversibility of Zn-ion plating/stripping and the stability of Zn-anodes are limited by dendrite formation, hydrogen evolution reaction (HER) and the corrosion of Zn-anodes. In this context, we investigated an electrolyte additive to restrict the free water molecule activity and for uniform the Zn-ion deposition for dendrite free long cycling Zn-anodes. Electrochemical and corrosion studies of the formulated electrolyte choices were carried out. V_2O_5 nanofibers are employed as the cathode material for assembling the full cell of aqueous zinc ion batteries (AZIBs). The assembled cell exhibits a high initial discharge capacity of 325 mAh g^{-1} at 0.1 A.g with better retention capacity and also shows better cyclability (91%) features over 300 cycles. This report envisages the enhancement of the electrochemical properties of AZIBs by deploying cost-effective, electrolyte additives for high-performance AZIBs.

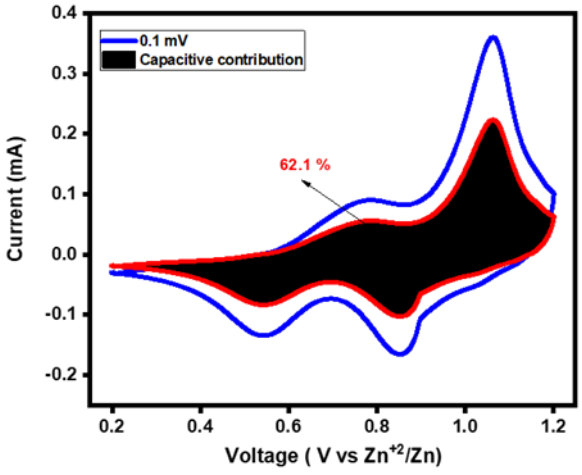

Figure 1. Capacitive contribution profile of AZIBs.

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EM004

Controlling OH* Adsorption on Co_3O_4 Equatorial Site via Ru Ion Doping for Efficient Water Oxidation

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Creating electrocatalysts for oxygen evolution reaction (OER) that are both incredibly robust and active in acidic and alkaline conditions are ideal.[1] Here, Ru^{3+} doped Co_3O_4 nanorods (Ru-Co_3O_4) from Co-based benzene tricarboxylic acid are employed as effective electrocatalyst for OER in acidic or alkaline medium. Doping of Ru^{3+} ions to Co_3O_4, improves electron transport over the exposed active metal sites. Further using in situ techniques, it was evident that OER proceeds with a low applied voltage. Additionally, Ru-Co_3O_4 15 drives 10 Ma cm−2 current density in acidic and alkaline media with a less overpotential of 292 and 365 Mv. Additionally, Ru-Co_3O_4 15 exhibits a high durability for 33 and 16.5 h, respectively, in alkaline (1 M KOH) and acidic (0.5 M H_2SO_4) media. The Ru-Co_3O_4 15 demonstrates optimal performance for OER at 1.55 V by adhering to Sabatier principle, for adsorption and desorption of reactant and product. Structural analysis indicates that Ru doping leads to increase in bond length between the Co and O (Co–O) next to Ru (1.95 Å) than the Co–O bond in Co_3O_4 (1.92 Å). This encourages selective adsorption of OH^- ions in the equatorial position of the dx^2-y^2 orbital with the least amount of energy.[2]

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EM005

Multipurpose Neutron Irradiation Facility for Nuclear and Space Application

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A neutron generator facility is recently commissioned at Institute for Plasma Research, it is having the yield of 10^{12} neutron per second [1,2]. This is a unique neutron source in India with high energy and high yield. This source is made with a D^+ ion accelerator and a tritium target. The source opens the door of various research application in India. The facility is much safer than giant fission reactors and provide the exclusive features of high flux and various energy range of neutron under one roof. This kind of features can be utilized for the nuclear and space applications. A utility of neutron radiography with fast and thermal both range of neutrons is also under development using this source which gives an immense opportunity for Indian manufactures to scan their critical components and identify existing defects. Neutron source facility also provides an enviourment for electronic component testing which are made for exposure of high radiation environment. The electronics present in space satellites and nuclear reactors can be tested and validated at lab scale for further use of harsh radiation environment. This work showcase the facility capability in numerous applications and utilization for various materials & components testing. It details out radiography facility design features, energy spectrum range, available set-up for material testing, and various other experiments being conducted at facility.

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EM006

Hierarchical Design of Polyaniline through Electro-Polymerization on Steel Electrode and Their Impact on Electro-Chemical, and Surface Properties

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This study probes into optimizing polyaniline (PANI) films through electro-polymerization on Steel 316 L for enhanced energy storage, integrating various analytical techniques. Incorporating different polymerization cycles (ranging from 5 to 20 cycles), surface wettability assessments, and thermal stability analyses, alongside evaluations of capacitance, corrosion performance, and structural morphology, the research provides a comprehensive understanding of PANI's properties. Results indicate a direct correlation between electro-polymerization cycles and charge storage capacity, with capacitance values increasing from 2.78×10-5 F/g at 5 cycles to 4.55×10-5 F/g at 20 cycles. This highlights the importance of hierarchical PANI morphology in boosting device efficiency. Molecular-level conductivity enhancements are observed, alongside insights into the influence of surface wettability on electrochemical behavior. Moreover, assessments of thermal stability, with weight loss percentages around 5 % at 500 ◦C temperature, and corrosion performance, with corrosion rates decreasing from 6.143 mm/year at 0 cycles to 0.045 mm/year at 20 cycles, shed light on PANI's suitability for practical applications. Overall, this study contributes to optimizing energy storage devices while advancing our understanding of PANI's multifaceted properties.

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EM007

CoCr-LDH/NiO Heterostructure on Nickel Foam: A Highly Efficient Catalyst for Water Splitting

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Researchers are working hard to create effective, affordable catalysts for electrocatalytic water splitting, which produces green hydrogen.[1] Here, a highly efficient heterostructure of CoCr-LDH on NiO on nickel foam (NF). In a 1 M KOH solution, the CoCr-LDH/NiO/NF catalyst exhibits good electrocatalytic catalytic towards OER and HER with an overpotential of 253 mV and 185 mV to reach a 50 mA cm^{-2} current density. Additionally, the OER and HER's long-term stability over a 60-h period demonstrates their resilience. In comparison to bare CoCr-LDH, the OER's turnover frequency value increased 1.85 times following the heterostructure creation. The heterostructure's strong intrinsic activity was demonstrated by the computed Faradaic efficiency values of 94.75% and 97.4 for the OER and HER, respectively. Furthermore, the heterostructure may attain a 10 mA cm^{-2} current density by functioning as both the anode and the cathode with just 1.57 V of cell voltage with a stability of 60 h. At the electrode/electrolyte interface, the catalyst's thin, broad, and modified surface promotes the diffusion of ions and gas molecules. Moreover, increased electronic conductivity is the consequence of electron transport from n-type CoCr-LDH to p-type NiO. This work contributes to the larger cause of the green hydrogen economy.[2]

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EM008

Develpment of Composite of Al-doped CdSe Nanoparticles on ZnO/FTO Photoanodes and Effects on Their Physico-chemical Properties

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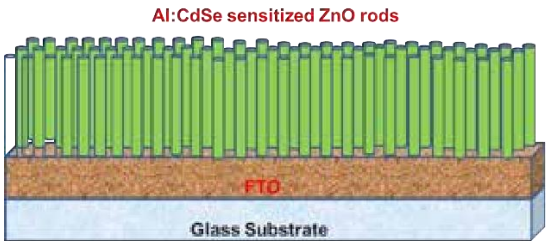
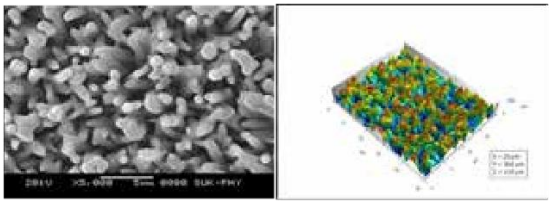
This study explores the impact of CdSe and Al-doped CdSe nanoparticle sensitization on ZnO-based photoanodes for photoelectrochemical (PEC) applications. SEM analysis reveals improved charge transport efficiency due to sensitized nanoparticle layers, while XRD confirms well-defined crystal structures. Current-voltage characteristics demonstrate enhanced PEC efficiency in Al-doped CdSe/ZnO/FTO photoanodes, with a maximum efficiency of 2.13%. Photovoltaic parameters show significant improvement post-aluminum doping, with shunt resistance (Rsh) of approximately 295 Ω and series resistance (Rs) of 32.6 Ω. Capacitance-voltage and spectral response studies elucidate the influence on flat band potential (Vfb) and optical absorption, with Vfb values of -1.05 V/SCE and -0.986 V/SCE for CdSe and Al-doped CdSe, respectively. FTIR analysis highlights stronger functional group intensities in Al-doped systems, indicating enhanced surface passivation. Surface free energy analysis shows improved hydrophilicity and charge transport properties with Al doping. Overall, this study provides insights into nanoparticle sensitization's role in enhancing ZnO-based photoanode performance for PEC systems.



fabricated photo electrode assembly



2D & 3D Surface Profile of 5 % Al: CdSe/ZnO/FTO photoelectrodes

EM009

High performance piezoelectric nanogenerator for efficient mechanical energy harvesting and smart noise detection via 2D fluorinated BN-PVDF nanofiber mat

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Electrospun polyvinylidene fluoride (PVDF) with high piezoelectric performance and mechanical endurance is a promising candidate for smart electronics[1]. We have fabricated a high performance piezoelectric nanogenerator (PENG) via incorporating fluorine functionalised boron nitride nanosheets (FBNNs) into the PVDF followed by the technique of electrospinning. Incorporation of 0.5 wt% FBNNs (ES P-0.5FBNNs) boosted the β-phase to 90% and crystallinity to 47% by the effective transformation of PVDF chains into all trans form[2]. The PENG (4 cm^2) could generate an open- circuit voltage of 55 V and a remarkable short- circuit current density of 15 mA/m^2 under 20 N force with a higher power density of 0.2 W/m^2 which is 2000 times higher than the bare electrospun PVDF. Owing to the superior performance and exceptional sensitivity to lower vibrations of the PENG, we developed a self-powered acoustic sensor capable of accurately detecting noises above 80 dB under various directions and higher ranges. Our sensor was also able to produce distinct electrical responses to different voice inputs.

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EM010

Development of PEDOT Enveloped GO-S Cathode material for High Power Li-S Batteries

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High Power Lithium-Sulfur (Li-S) batteries offer promising solutions for post lithium-ion energy storage systems due to their high energy density. However, challenges persist, particularly in the synthesis of sulfur-containing cathode composites. Graphene oxide is successfully synthesized via modifed Hummer's method, followed by melt diffusion of graphene oxide/sulfur and further oxidatively polymerized to PEDOT/GO-S.[1] The PEDOT/GO-S composites enhances electrochemical performance with higher initial capacity and better rate performance, attributing to the interlayer structure and the functional groups on graphene oxide.From XRD patterns the composites of GOS and PEDOT/GOS, many stropped peaks of sulfur beyond 45° seems to be diminishing and slight reduction in the intensity of the peaks indicating the effective composite formation. The shifting of vibrational D and G bands to a higher wavelength were observed by Raman and FTIR spectra confirming that there is a successful complex formation between graphene oxide and sulphur which could be effectively proved by the absorption peak around 1120 cm^{-1} due to C-S bond formation. In this, the Conducting Polymer nanostructures are believed to serve as a conductive matrix and an adsorbing agent, while the highly conductive GO will physically and chemically confine the sulfur and polysulfide within cathode. The PEDOT/GO@S composites with sulfur content of 65 wt% exhibit a reversible discharge capacity at various C rates, thereby suggesting the enhanced electrochemical behaviour with a cut down in polysulfide shuttling.

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EM011

Investigation of Zn-Ni-Co oxide and AC/rGO as electrode material for supercapacitor application

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Supercapacitor has matured significantly over the last decade and emerged with the potential to facilitate major advances in energy storage. It has gained significant attention due to their high power density, rapid charging capabilities, and prolonged cycling stability. In this study, we investigate the utilization of Zn-Ni-Co oxide and AC/rGO as electrode material for supercapacitors. Zn-Ni-Co oxide was synthesized by a hydrothermal method followed by a calcination process. The AC/rGO nanocomposites was synthesized by the sonochemical method. The structure and surface morphology of synthesized materials were characterized by XRD, Raman, HR-TEM and EDAX. An asymmetric supercapacitor is assembled successfully using Zn-Ni-Co oxide and AC/rGO as positive and negative electrodes respectively. The electrochemical behaviour of the as fabricated device is analyzed using cyclic voltammetry (CV), galvanostatic charge discharge (GCD), Electrochemical Impedance Spectroscopy (EIS). The energy and power densities, Coulombic efficiency stability, relaxation time constant and capacitance retention of the device were calculated.

Figure 1. Zn-Ni-Co oxide//AC/rGO asymmetric supercapacitor device

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EM012

Enhancing the Performance of Lithium-Sulfur Batteries through the Integration of Conductive Polymer-Coated Layered Double Hydroxide as an Innovative Sulfur Reservoir and Implementing Advanced Shuttle Effect Mitigation Strategies for Flexible Cathode Applications

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Lithium sulfur battery (LSB) is one of the promising and a lower cost alternative for Lithium-Ion batteries (LIB) due to their high theoretical capacitance (1675 mAh/g) and high theoretical energy density (2600 Wh/Kg), exceeding LIB. LSB requires Sulfur as a cathode material which is of lower cost and an abundant resource. Regardless of their theoretical values, their practical implementation is hindered due to their sluggish reaction dynamics (Polysulfide Shuttling) during charging and discharging. Layered Double Hydroxide (LDH) is an anionic clay 2D structure made by brucite like layers with counter anions. LDH can be served as highly effective adsorbent material and electrocatalyst due to their high chemical affinity towards lithium polysulfides (LiPSs), resulting form the high abundance of its hydrophilic hydroxyl groups. Additionally, their numerous sulphilic sites significantly enhance the kinetics of LiPSs conversion. The inherent structural properties of LDHs, such as their high surface area and tunable composition, further contribute to their catalytic efficiency. Moreover, their ability to maintain structural stability and prevent polysulfide dissolution makes them particularly advantageous in extending the lifespan and performance of lithium-sulfur batteries.[2] However, the limited electronic conductivity of LDH and sulfur constrains their use in LSB. To address this issue, the electronic conductivity of the electrode can be improved by incorporating them in a conductive polymer like polypyrole (PPy). PPy, due to its hydrophilic nature and interconnected pentabasic pyrrole rings shows excellent electronic conductivity.In this study we synthesized PPy coated Cobalt (Co)- Iron (Fe) LDH sulfur as a cathode material for LSB and studies like LiPSs adsorption and electrochemical studies are carried out.

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EM013

Scavenging Wind Energies and Facilitating Gesture Perception via a Styrene-Ethylene-Butylene-Styrene based Triboelectric Nanogenerator

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Many flexible and wearable devices urgently require stretchable power sources that can endure significant deformations, which are essential for the advancement of truly wearable self-powered gadgets. This research employs a stretchable thermoplastic elastomer to harvest energy from mechanical motion, wind, and skin-attachable self-powered gesture sensors using triboelectric nanogenerators (TENG).[1] The device, based on styrene-ethylene-butylene-styrene (SEBS), achieved an output of 0.228 W/m² from a 10 N force, with a linear response to the applied force. The manufacturability of SEBS ensures that the TENG developed is scalable, cost-effective, and simple to produce. The robust flexibility of SEBS also facilitated the creation of a flapping-style wind energy harvester, capable of collecting energy from both low and high-velocity winds, thereby overcoming traditional challenges such as material degradation and inefficiency with low-energy winds. Furthermore, for a self-powered gesture sensor to be effective, it must function based on the flexing actions during hand movements. The exceptional stretchability of SEBS makes it an ideal candidate for a self-powered hand gesture sensor, which has been developed and shown to be versatile and easily integrated with modern technologies.

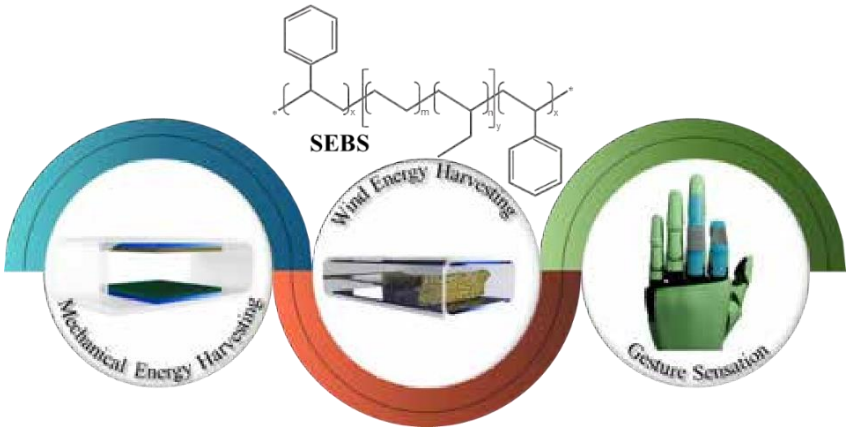

Figure 1. Schematic representing the application potential of SEBS based TENG for mechanical energy harvesting, wind energy scavenging and gesture sensation

References

1) Harris Varghese, Hasna M Abdul Hakkeem, Kanika Chauhan, Eshwar Thouti, Saju Pillai, Achu Chandran. *Nano Energy*. **2022**, *98*, 107339

EM014

The MnO_2/RuO_2/N-rGO and AC/rGO nanocomposite: Design and Fabrication as high energy asymmetric supercapacitor device

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Supercapacitor (SC) plays a vital role in the development of future energy storage technology. It stores charges by EDLC (physical) and Pesudocapacitance (electrochemical) and has high energy and power densities compared to commercial Li ion batteries. The positive and negative electrode materials of the SC decide the type of SC. The asymmetric supercapacitor (ASC) in which both positive and negative electrode materials are different, exhibits the enhanced performance in electrochemical studies. In this study, MnO_2/RuO_2/N-rGO and AC/rGO nanocomposite materials are used as positive and negative electrodes of ASC. The MnO_2 and RuO_2 nanorods and nanoparticles were synthesized by hydrothermal method. The RuO_2 decorated on MnO_2 nanorods in various ratios (0.5, 1, 2.5, and 5 wt%) were synthesized by sonochemical method. Then N-doped graphene was combined with the most active MnO_2/RuO_2. The synthesized electrode materials were characterized by structural XRD and Raman Spectroscopy. The morphological analysis of SEM and HRTEM image shows nanorods morphology of MnO_2, spherical morphology of RuO_2 and sheet like morphology of rGO. Electrochemical techniques (Cyclic voltammetry (CV), Chronopotentiometry (CP), and Electrochemical Impedance Spectroscopy (EIS)]. The specific capacitance of MnO_2/RuO_2/N-rGO nanocomposite and AC/rGO nanocomposite were measured using three-electrode system Electrochemical studies were made by incorporating the above positive and negative electrode materials over nickel foam separated by a cellulose paper and using KOH as electrolyte. The results obtained were thoroughly discussed.

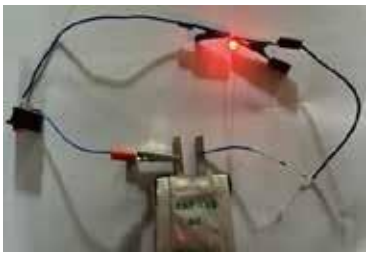

Figure 1. Fabricated Device

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EM015

Electrochemical Investigation of $Li_{1-x}Mn_xFe_2O_4$ nanospinels for high performance supercapacitor devices

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The slow reaction kinetics of batteries due to the shuttling effect of ions is reducing the overall output voltage and power density of the device. In this regard, hybrid supercapacitors which can exhibit both battery (Fast redox reactions) and EDLC (High energy density) type charge storage mechanisms are highly desirable. Ferrite materials, such as Mn Ferrite show novel electrochemical performance and thermal stability but it is limited by the low internal conductivity. In this research work, alkali metal namely Lithium is used as dopant to synthesize $Li_{1-x}Mn_xFe_2O_4$ nanospinels using citrate solgel and auto combustion method, which has significantly increased the conductivity of the material due to the high oxidising nature of Lithium. The inverse spinel structure is confirmed by the XRD whereas the composition and morphology are studied with EDAX and SEM analysis. The electrochemical performance is studied by taking the lithium doped Mn ferrite as anode and commercially available activated carbon as cathode. The specific capacitance is found using Cyclic Voltammetry, GCD and EIS which shows excellent cyclic stability and capacitance values.

EM016

Printed few layer 2D WS_2-based flexible triboelectric nanogenerator for self-powered UV sensing

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The efficient scavenging of mechanical energy from the environment has become an eco-friendly and sustainable method to meet the demands for greener and cleaner energy.[1] Herein, we have fabricated a printed, flexible 2D WS_2 based triboelectric nanogenerator (TENG) for the efficient harvesting of mechanical energy from surroundings. A few layer 2D WS_2 was obtained by efficient liquid phase exfoliation process. The TEM analysis demonstrates the formation of single crystalline, few-layered WS_2 sheets with an interplanar spacing of 0.62 nm. A flexible TENG was fabricated using screen-printed WS_2 film and polymethyl methacrylate as the counter layer with an active contact area of 4 cm^2. From the comparison of output performance, a voltage of 550V, short circuit current (I_{SC}) of 7µA is obtained for few layered WS_2, while an open circuit voltage (Voc) of 50V, I_{SC} of 1µA was obtained for the bulk WS_2 based TENG respectively. Under load testing, a peak power density of ~ 0.6 W/m^2 at 80 MΩ resistive load and a peak power density of ~ 0.093 W/m^2 at 60 MΩ resistive load was delivered by few-layered and bulk WS_2 based TENG respectively. The electrical output performance of few layer 2D WS_2 nanosheet based TENG was also measured under illumination of the UV light of wavelengths 254nm and 365nm, and a drastic change in the electrical output was observed enabling self-powered UV sensing. These results indicated a new way to effectively capture mechanical energy as well as a novel approach to self -powered UV sensors.

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EM017

SnO_x supported on Ti: A highly selective electrocatalyst for the electrochemical conversion of CO_2 to formate

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The conversion of CO_2 into useful chemicals or fuels is a desirable way to mitigate CO_2 from building up in the atmosphere and accelerating the global climate change. Among all the CO_2 conversion methods, the electrochemical reduction method is the most favored one, because it can be realized by means of renewable energy such as solar, wind, etc. Electrochemical CO_2 reduction is a promising method widely employed to convert carbon dioxide (CO_2) to formate where electrocatalyst, electrode and reactor configuration play an essential role. Formate, a two-electron reduction product from CO_2, is easily accessible and also valuable. In this study, SnO_x/Ti is used as an electrocatalyst for electrochemical CO_2 reduction. The electrocatalytic activity of SnO_x/Ti was evaluated for CO_2 reduction in both CO_2 and N_2-saturated 0.5 M $KHCO_3$ solution. The simultaneous occurrence of hydrogen and CO_2 reduction processes in CO_2 environment is identified by the positive shift (anodic shift) in onset potential with increase in current density compared to N_2 environment. The catalyst was characterized using XRD, SEM, and XPS techniques for is structural, elemental and morphological analysis.

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EM018

Lead-free high performance piezoelectric nanogenerators from aurivillius oxide compounds

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The development of piezoelectric materials which can hold its polarisation properties in higher temperature are essential for various applications like actuators, structural health monitoring etc[1]. This feature also assures the development of highly efficient mechanical energy harvesting. The Bismuth layered aurivillius type ceramic structures possess high curie temperatures (> 500 ˚C), resistance to thermal depoling and undoubtedly alternative for toxic lead-based piezoelectric materials[2]. In this work, aurivillius type bismuth tungstate and bismuth titanate nanoparticles were synthesized via solid state and hydrothermal route. XRD analysis revealed the formation of phase pure nanoparticles. Morphological analysis, dielectric properties and ferroelectric properties of the obtained particles were compared first. Then, piezoelectric nanogenerators (PENG) were fabricated with its pellets of small area and compared the performance via measuring open-circuit voltage and short- circuit current. Since, the demand of smart flexible devices is higher, we have also developed flexible PENG by incorporating these bismuth layered structures in PVDF via electrospinning and the piezoelectric performance were evaluated.

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EM019

Hierarchically Porous Green Carbon Aerogels from Lignin and Cellulose Nanofibers for Wearable Electronics Applications

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In recent times, lightweight flexible energy harvesting, and storage technologies are receiving significant attention and will be crucial assets for advanced wearable electronics applications.[1] Porous carbonaceous materials are emerging as potential candidates in these areas, but still pertaining certain limitations including multiple complex procedures, environmentally unfriendly precursors, non-heterogeneous pores, and low diffusion kinetics.[2] In the present study, hierarchically porous carbon aerogels (CAs) were synthesized by following a green, facile preparation route using bio-based lignin/cellulose nanofibers (CNF), involving deep-freezing and lyophilization followed by carbonization. The main aim of the study is to simultaneously control the hierarchical porous structure and surface area, by tuning the weight ratio of lignin to CNF in the precursors, and by achieving a directional freezing. The designed carbon aerogels are investigated for their morphology, thermal degradation, and surface studies before stepping to further electrochemical characterizations. Bio-derived lignin/CNF can serve as a green and sustainable precursor for porous carbon aerogels, which can open new insights into advanced wearable electronics applications in the field of defence and aerospace.

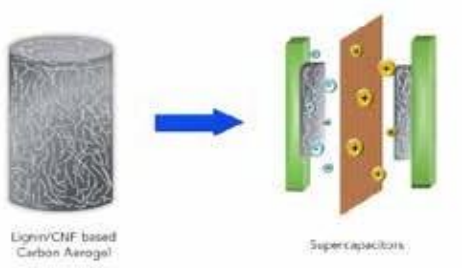

Figure 1. Schematic diagram for energy storage devices using Lignin/CNF based carbon aerogels

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EM020

High-Valent Manganese (IV) Complex: A Potent Electrocatalyst for Hydrogen Evolution Reaction

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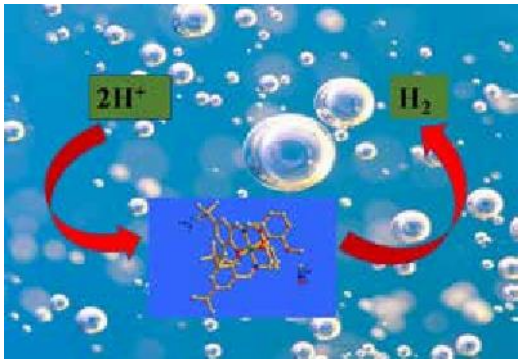
A novel mononuclear high valent manganese (IV) complex supported by 3-methoxysalicylamine moiety and 3,5-diteritiary butyl salicylaldehyde moiety was developed. The synthesized complex was characterized by Single-Crystal XRD analysis. By using BVS calculations, UV-Visible spectroscopy, Electron paramagnetic resonance spectroscopy (EPR), X-ray photon spectroscopy (XPS) confirms the oxidation state of manganese in L_2Mn complex is +4. The electrochemical experiments reveals that this Mn (IV) complex displays HER behaviour in acetonitrile solution using acetic acid as the proton source with an overpotential of 518 mV with a turn over frequency (TOF) is 3026 s^{-1}. The stability of this complex has been studied by conducting chronoamperometry. Also, we performed Cyclic voltammetry and UV-absorption studies after bulk electrolysis and observed no significant changes. These results confirm the complex remain intact and it act as an efficient electrocatalyst for HER.



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EM021

Development of a High-Performance Flexible Triboelectric Layer with Graphene Oxide for Wearable Energy Harvesting Applications

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The field of wearable electronics demands innovative solutions for sustainable energy harvesting. This study investigates a novel approach on flexible triboelectric layer designed to power these devices. The layer is comprised of a PVDF-HFP polymer membrane, a well-established material for energy conversion, reinforced with 2 weight percent (wt%) of graphene oxide (GO) nanoparticles. This reinforcement is achieved through a simple solution casting process. The addition of GO significantly enhances the crystallinity (64%) and electroactive β-phase content (~80%) of the PVDF-HFP, leading to a more efficient material for converting mechanical energy into electricity.Initial investigations suggested that PVDF-HFP/GO nanocomposite membrane holds promise as a triboelectric material for high-performance triboelectric nanogenerators (TENGs). TENGs utilize the triboelectric effect, which converts mechanical energy from everyday movements (like walking or tapping) into electricity.

This research paves the way for the development of self-powered wearable electronics. Imagine a future where our smartwatches fuel themselves from our workouts, or medical sensors function continuously without battery replacements. By harnessing the power of tiny movements and clever material science, we are creating a future where movement itself becomes our fuel.

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EM022

Aqueous binder based processing of $LiNi_{0.8}Co_{0.1}Mn_{0.1}O_2$ (NMC-811) cathode for lithium-ion cells

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Lithium ion cells find variety of applications ranging from portable electronics to space due to their unique features such as high voltage, high energy density and low self-discharge. Generally, lithiated transition metal oxides are coated over Aluminium foil to make cathode for lithium-ion cells. For this purpose, polymeric binders are added to the active materials to ensure proper adhesion with the foil as well as cohesion between constituents in electrode. The binder is a key component in determining the performance characteristics such as specific capacity, cycle life and rate capability. The processing of lithium nickel manganese cobalt oxide (NMC) cathode is usually performed using polyvinylidene fluoride (PVdF) binder and toxic organic solvents like N-methyl-pyrrolidone (NMP). On the other hand, aqueous binder based electrode fabrication offers a safer, environment friendly and cost effective route.[1] In the present work, a combination of carboxymethyl cellulose (CMC) and acrylic binder is used to process $LiNi_{0.8}Co_{0.1}Mn_{0.1}O_2$ (NMC-811) electrode. Electrochemical evaluation of this electrode in coin cell level demonstrated an initial reversible capacity of 188 mAh/g which is very much comparable to that of PVDF based electrode (192 mAh/g) and demonstrated 100 cycles with >80% capacity retention.

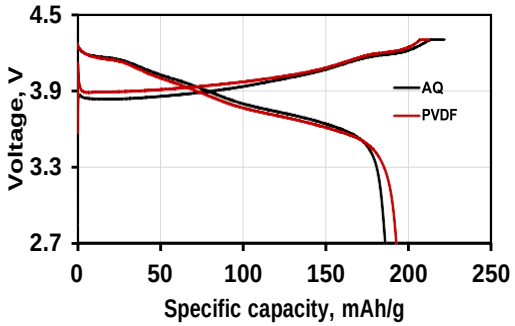

Figure 1. Comparison of the charge-discharge curves of aqueous binder (AQ) and PVDF based NMC-811

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EM023

Bio-Derived Silicon-Carbon Composite Electrode Material for High-Energy Lithium-Ion Batteries

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The development of high-performance electrode materials from sustainable sources will be an effective approach to the development of high-performance Lithium-ion batteries (LIBs). In the modern technology of advanced portable electronics and electric vehicles, LIBs are the most noticeable electrochemical energy storage systems. The development of energy dense LIBs needs high-capacity and sustainable electrode materials with better performance metrics. State-of-the-art LIBs use graphite and lithium cobalt oxide, which have limitations in terms of capacity and stability. Advancing energy density can only be achieved by introducing sustainable, cost-effective, high-capacity anode materials. Silicon-based electrode materials are emerging as promising anodes for next-generation LIBs due to their high theoretical capacity and abundance. In this report, we investigated the electrochemical performance of a silicon-carbon composite anode prepared from rice husk biomass. The developed silicon- carbon exhibits a high initial discharge capacity of 671 mAh g^{-1} at 0.1 C rate with excellent durability. Negligible self-discharge and good rate capabilities support the performance of theSi-Carbon anode-based LIBs.

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EM024

Advancements in Sustainable Photovoltaic Cells: Exploring the Potential of Single-Walled Carbon Nanotubes

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The growing environmental and resource challenges have intensified the search for clean, efficient energy sources. Recent advancements in nanomaterials have revolutionized electronic devices, yielding breakthroughs in fields like chemical sensing, healthcare, and renewable energy. While lead (Pb)-based materials have dominated high-efficiency solar cells, concerns over their stability, toxicity, and environmental impact have prompted a shift towards developing Pb-free alternatives. Concurrently, Single-walled carbon nano tubes (SWCNT) devices have emerged as promising eco-friendly solar cell options due to their non-toxicity, simplicity in fabrication, and enduring stability. This study investigates the feasibility of globally sustainable, lead-free photovoltaic cells utilizing SWCNT as the absorber layer, poly(3,4- ethylenedioxythiophene) polystyrene sulfonate (PEDOT:PSS) as the hole transport layer (HTL), and indium gallium zinc oxide (IGZO) as the electron transport layer (ETL). Through optimization of various parameters including absorber layer thickness, doping concentration, and defect density, as well as various HTL and ETL materials, the proposed configuration (FTO/IGZO/SWCNT/PEDOT:PSS/Au) achieves, an open circuit potential (VOC) of 1.06 V, a short-circuit current (JSC) of 43.19 mA/cm2 , a fill factor (FF) of 84.26 %, and a power conversion efficiency (PCE) of 38.89 %. This study marks a significant advancement in photovoltaic cell technology, demonstrating the lead-free materials in sustainable energy generation.

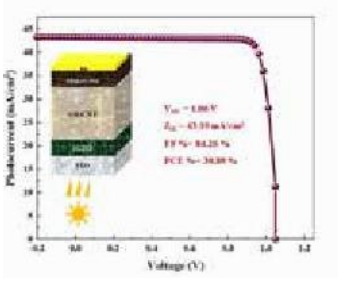

Figure 1. Device structure and performance of proposed FTO/IGZO/SWCNT/PEDOT:PSS/Au solar cell.

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SF001

Sustainable Thermochromic Polymeric Films for Smart Packaging

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The significance for fluorescence based luminescent materials has been a popular area of research because of its potential in an array of applications like sensing, smart packaging, biological imaging, anticounterfeiting, etc. The necessity to monitor temperature changes is essential for packaging applications.[2] In the present work, a reversible thermochromic system was developed based on curcumin molecule and modified boron nitride quantum dots (PQDs) incorporated biodegradable polymer, poly(3-hydroxybutyrate) (P3HB). The emission can be tuned by controlling the distance between the two fluorophores in polymer films.[1] Interestingly, the combination of two fluorophores in the polymer system displayed thermochromic behavior when temperature was increased beyond 50 °C (well above the glass transition temperature of P3HB ~ 5 °C) which was confirmed with the red shifted photoluminescence emission spectra from 556 to 592 nm. The effective interaction between curcumin molecule and PQDs in the amorphous region of the polymer tuned the emission of the film with temperature. The composite polymeric material exhibited highly efficient Förster Resonance Energy Transfer from donor (PQDs) to acceptor (curcumin molecule) with remarkable energy transfer efficiency of ~ 87%.

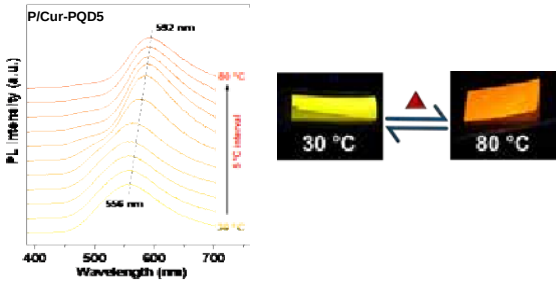

Figure 1. Temperature-dependent PL spectra showing the thermochromic behaviour of the film and the digital images under UV light showing the reversible colour changes with temperature.

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SF002

White Light Emission from Aggregation Induced Emission Active Organic Molecules

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Aggregation Induced Emission (AIE) is an interesting photophysical phenomenon in which molecules that are non-emissive in dilute solution are induced to emit upon aggregation with restriction of intramolecular motion as the principle mechanism. Carbazole Barbituric acid conjugates are organic dyes which exhibit AIE effect. We studied the photophysical properties of D-π-A based CBA conjugates by varying Water: THF binary solvent ratios. UV-Vis spectroscopy, fluorescence spectroscopy, time resolved fluorescence spectroscopy and DLS measurements confirmed AIE effect.[1]These organic molecules showed both halochromism and solvatochromism. Thus by the careful tuning of various parameters like solvent, pH, excitation wavelength and concentration we could tune the AIE emission to achieve White Light Emission (WLE). Dual component WLE was achieved from the mixture of two CBA conjugates Dodecyl Carbazole Barbituric Acid and Dodecyl Carbazole Thiobarbituric acid at 90% water fraction with CIE co-ordinates (0.39, 0.37). But single component pure WLE from organic molecule with good photostability remain as an important challenge. Herein we propose a single component WLE organic molecule by fine balancing of its Local Emission and Intramolecular Charge Transfer band emissions for OLED applications.[2,3]

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SF003

SOFT ROBOTIC ACTUATOR SYSTEM DEVELOPMENT THROUGH 4D PRINTING

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Recent advances in 3D and 4D printing of soft materials and multi-materials are revolutionizing the field of soft robotics by enabling intricate, responsive, and adaptable structures[1]. This study explores the development of a soft robotic actuator using poly lactic acid- thermoplastuc polyurethane (PLA-TPU) composite, leveraging the unique properties of shape memory polymers and elastomers. The CAD model of the actuator was created using CATIA and MatterControl software. From a library of polymers, PLA and TPU were selected owing to the excellent mechanical, bio, and printing properties of the former and the toughness and high ductility of the latter. Design of Experiments (DOE) approach was employed to determine optimal printing parameters for the extrusion-based 3D printing. The printed samples were characterized using Infrared (IR) spectroscopy, Thermogravimetric Analysis (TGA), and Dynamic Mechanical Analysis (DMA). For actuation, temperature was chosen as the external stimulus. To demonstrate the performance, a heating module was designed and attached to a gripper[2] which operates with an industrial robotic arm to pick objects. Employing 4D printing principles, the study combines the reversible deformation properties of shape memory polymer (PLA) with the flexibility of elastomer (TPU) to create complex, programmable, and reversible structures. The experimental results point towards a scalable strategy with broad applications in soft robotic actuators and smart end effectors.

Figure 1. Printed PLA-TPU bi layer composite

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SF004

Nanocellulose-based aerogels for diverse applications

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Naturally occurring, nanocellulose (NC) is a renewable, biocompatible, non-toxic, and biodegradable nanomaterial with a high specific surface area, low density, high aspect ratio, thermal stability, and high strength. According to recent research, NC-based aerogels received considerable interest because of their unique properties and wide range of applications. The well-known substance aerogel has noticeable features, including light weight, flexibility, and high porosity, which allow it to be used in a wide variety of applications. NC-aerogel is a third generation of aerogel that has a combination of excellent features, including high mechanical strength, easy modification, and green reproducibility. Presently, nanocellulose aerogels offer a very fascinating platform for a variety of functional applications across multiple fields, such as waste water purification, adsorption of heavy metal ions, organic dyes, and other pollutants, separation, energy storage, electromagnetic interference shielding, thermal insulation, and biomedical applications. In this work, we will be focusing on different applications of NC aerogel and their properties.

SF005

$InVO_4$ Ceramic- densification, phase evolution and microwave dielectric properties

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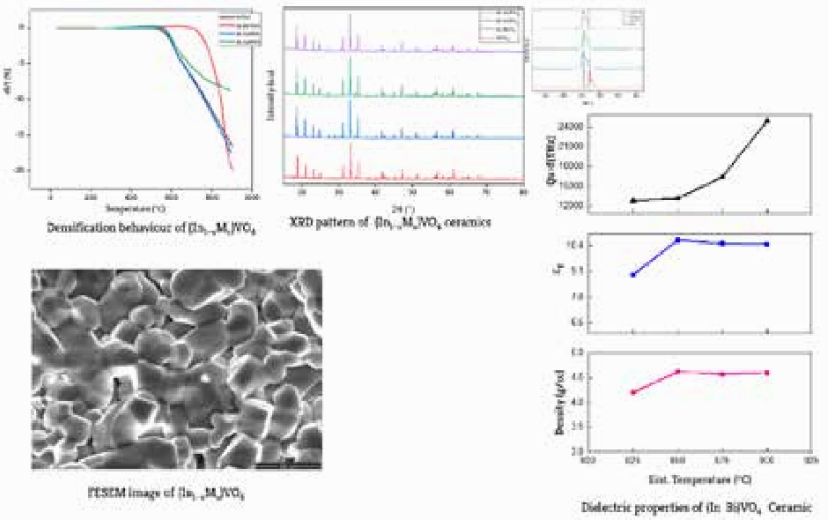
The $(In_{1-x}M_x)VO_4$ (with M= Bi, Sm, Ce & x 0- 0.5) ceramics have been prepared via a solid-state reaction method. X-ray diffraction analysis showed orthorhombic solid solution formed with trivalent cation substitution upto x =0.5. Densification behaviour of all the ceramics were analysed through push rod dilatometry and the ceramic samples could be densified below 900 °C. The structural and microstructural parameters of these ceramics were measured with the help of x-ray diffraction, scanning electron microscopy, and energy dispersive spectroscopy. Dielectric properties in 20 Hz to 10GHz have been measured with the help of an LCR meter, impedence analyser and a vector network analyzer (VNA). The effect of sintering temperature on microwave dielectric properties have also been systematically investigated. This work reports the microwave dielectric properties of InVO4 ceramics for the first time along with its modification through solid solution formulations. This system of microwave dielectric ceramic might be a potential candidate for microwave substrates, dielectric resonator and low-temperature cofired ceramic technology applications.



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SF006

JANUS STRUCTURE INSPIRED DOUBLE LAYERED PVA AEROGELS: STRUCTURAL, THERMAL, AND EMI SHIELDING PROPERTIES

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In the quest for effective solutions to combat the ever-growing issue of electromagnetic interference (EMI), researchers have turned to the development of lightweight materials with exceptional shielding property. This work introduces a novel approach to achieve superior EMI shielding through the development of multilayer aerogels using the concept of anisotropic nature on either side of aerogel matrix at a minimal thickness. These multilayer composites leverage the unique behaviour of PANI and MnO2@NRGO along with the matrices enabling the development of lightweight and highly effective EMI shield. Preliminary results show exceptional EMI shielding property, positioning this multilayer composite as a promising candidate for applications in aerospace, telecommunications, and electronics. The multilayer composites showed a shielding of 34 dB at 1:1 composition inferring that this potential composite has enhanced the shielding property with absorption dominant mechanism. This study contributes to the advancements of materials science for EMI shielding, offering a potential solution to the growing challenges of EMI in modern technology.

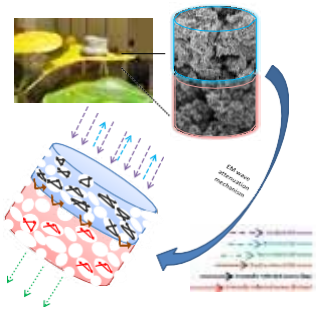

Figure 1. Scheme for EMI shielding attenuation of aerogel composites

NM001

Study on different sized CdSe –Q-dots filled PVA nanofibers with multicolor fluorescent emission

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Semiconducting nanocrystals have attracted great interests due to their wide applications arising from their unique optoelectronic properties.[1] Nanocomposites comprised of polymer- Quantumdots (QD's) improves their effectiveness and have implications in sensors, photonics, transistors, pharmaceutical transport, and other domains.

In this work, PVA (Poly Vinyl Alcohol) nanofibers were prepared by electrospinning process. QD's of different size (CS8, CS4 and CS2) with loadings (0.5 to 5wt%) were used, and the effects of quantum dots on the properties of the fibers were studied. The color emission in three different regions (orange, yellow and green) with different size of Q-dots were obtained. The uniform distribution of Q-dots in nanofibers was confirmed by SEM and TEM. The color mapping was seen using EDAX spectra, which reveals the uniform distribution of Cd and Se in the polymer matrix. The chemical composition of surface of PVA-CdSe was demonstrated by XPS analysis.From the study we fabricated PVA-CdSe nanofibers with improved luminescence efficiency with multicolor fluorescent emission which can be used for detection and sensing applications.

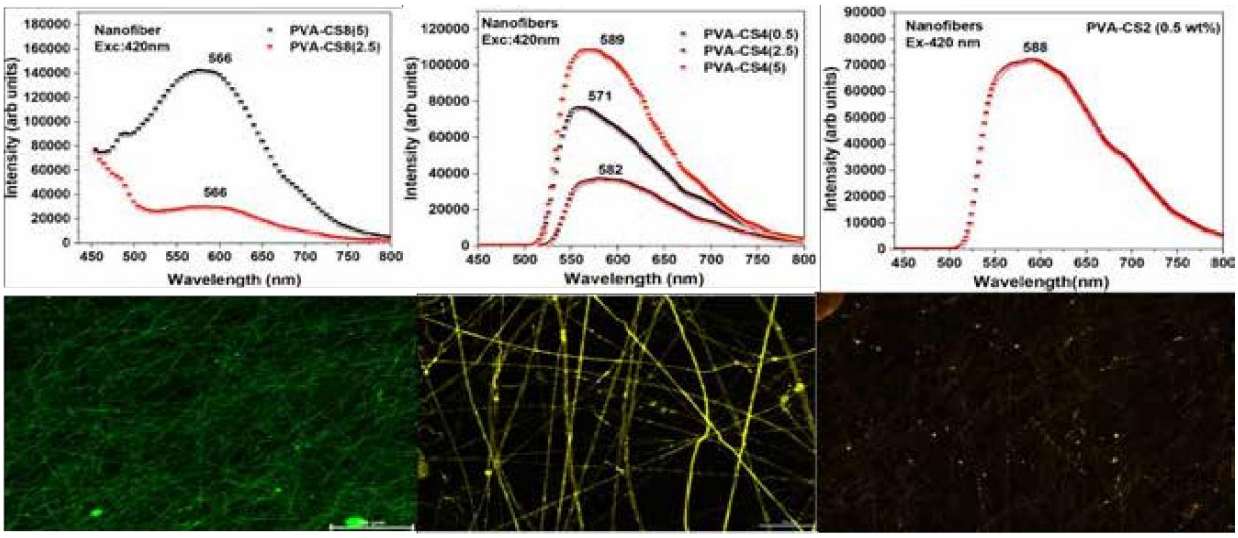

Figure 1. Photoluminescence spectra (above) and respective Confocal microscopy image (below) for PVA-CdSe with CS8, CS4 and CS2.

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NM002

Tuning of Room Temperature Ferromagnetism through pH-Selective Growth of Hierarchical ZnO Nanostructures

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This study presents a novel approach for synthesizing hierarchical ZnO nanostructures using a pH-dependent solution process technique at low temperature, employing minimal reagents to promote eco-friendly practices. Various crystalline ZnO nanostructures, including hexagonally shaped 3D nanoflowers, 2D nanorods and a combination of flowers and rods, were synthesized and confirmed via transmission electron microscopy. Remarkably, all samples exhibited room temperature ferromagnetism (RTFM) without additional modifications such as doping or nanocomposites. Magnetization-hysteresis (M-H) measurements confirmed the presence of RTFM, with the sample displaying both rods and flowers showing the highest saturation of 0.01 emu/g at a coercive field of 216 Oe. Oxygen related defects such as oxygen vacancies (O_v) and surface adsorbed groups were found to play a crucial role in the observed RTFM in undoped samples. These vacancies introduce localized electronic states within the band gap, leading to spin polarization and magnetic behavior even at ambient conditions. The presence of O_v and surface adsorbed oxygen in the sample is confirmed by X-ray Photoelectron Spectroscopy (XPS), Photoluminecence, Fourier Transform Infrared Spectroscopy (FTIR) and Raman Spectroscopy.

NM003

Structural and Electrochemical Characterization of Electrodeposited Bi_2O_3 on Metal Foam Electrocatalysts

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Electrodeposition is an established method for the synthesis of nanostructured electrocatalyst which finds its application in various fields such as electrochemical energy conversion and storage technologies[1] A good control over the shape, size and distribution of nano particles helps to exploit the deposited catalyst in its respective area of application. Thus it is important to characterize the synthesized catalyst for its surface morphology, elemental composition and electrochemical behavior to confirm its feasibility in area of implementation. The high surface area and structural rigidity made metal foam material a trending substrate for catalyst deposition[2]. As part of CO_2 reduction studies Bi catalysts were found to be effective in conversion of CO_2 into formic acid/formate. In this work the Bi_2O_3 catalyst electrodeposited on Copper foam and Nickel foam from $Bi(NO_3)_3$ precursor solution and tested its applicabilityin CO_2 reduction. The as prepared electrodes were characterized using SEM/EDS for morphology and elemental composition. The electrochemical properties of the deposited foammaterials were characterized for their functional properties as an electrocatalyst using voltametric techniques such as cyclic voltammetry, linear sweep voltammetry etc. in 0.5M $KHCO_3$. The Electrochemically active Surface Area (ECSA) of the as prepared electrodes weredetermined from double layer capacitance (C_{dl})[3] and interfacial properties such as charge transfer and transfer processes involved in the reaction were investigated using ElectrochemicalImpedance Spectroscopy (EIS).[4]

Keywords: Electrodeposition, Bismuth, Metal foams

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NM004

Antibacterial Studies of ZnO Nanomaterials Synthesized by Solution Combustion Method

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Zinc oxide (ZnO) is a versatile material known for its exceptional properties, making it a subject of extensive research in various fields. This project focuses on the synthesis of ZnO powder using the solution combustion method and its comprehensive characterization through X-ray diffraction (XRD), TGA-DTA , FTIR , UV - visible spectroscopy,EDS-SEM and Antibacterial studies. The synthesized ZnO powder exhibits multifunctional properties, making it a promising candidate for diverse applications. The solution combustion method, chosen for its simplicity and cost-effectiveness, involved the exothermic reaction between zinc acetate dihydrate and isopropyl alcohol as fuel. The obtained ZnO powder was thoroughly characterized using XRD, revealing the formation of highly crystalline hexagonal wurtzite ZnO structure. In conclusion, this project successfully synthesized ZnO powder through the solution combustion method and extensively characterized it using XRD, TGA-DTA and antibacterial studies. The multifunctional properties exhibited by ZnO, such as its crystallinity and antibacterial activity, make it a promising material for a wide range of applications. Optical characterizations employing UV-Visible spectroscopy demonstrated the absorption peak centered near 375 nm as the characteristic peak for hexagonal wurtzite ZnO. The synthesized ZnO nanoparticles demonstrated promising antimicrobial activity against both Gram-negative and Gram-positive bacteria Further research and development in this area could lead to innovations in the fields of electronics, photonics, and healthcare etc

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NM005

A Study on Catalytic Reduction of Nitroarenes and Dye Degradation Using Porous Cuprous Oxide Microspheres: A Sustainable Approach for Environmental Remediations

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Hazardous pollutants that endanger human health and the environment include nitroarenes and dyes such as MB, BCG, and Rhodamine. They're involved in carcinogenesis, mutagenesis, and toxicity, and are absorbed by plants, potentially harming humans and animals Reducing nitroarenes is crucial, as it lowers their environmental impact and enables the synthesis of key organic compounds where catalysts play a vital role in this reduction process by accelerating reaction rates and enhancing selectivity. However, conventional bulk catalysts have limitations such as high cost and limited selectivity. To address this, porous cuprous oxide microspheres (p-COMs), have been developed via simple reduction methods employing hydrazine monohydrate. The structure and morphology of the material were analyzed using UV-VIS, FT-IR, pXRD, DLS, TGA, SEM, TEM, and EDX. Notably, the reduction of nitroarenes and dye degradation proved challenging with only NaBH4. However, employing p-COMs facilitated these conversions within an exceptionally short time frame. This work highlights the catalytic potential of p-COMs to accelerate the rate of nitroarene reduction and dye degradation, offering significant insights into practical methods for mitigating the environmental impact of hazardous organic pollutants.

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NM006

Manganese Modified Prussian Blue Nanoparticles for Photothermal Stimulation of Neurons

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Neuromodulation involves the stimulating or blocking the flow of action potentials through the nervous system, and it is used in prosthetics and neural regulation. Electrical Neural Stimulation has historically been the main technique for neuromodulation. However, alternative techniques that have been developed offer significant advantages over this electrical stimulation.[1] One such method is Infrared neural stimulation. Infrared neural stimulation (INS) is the method of using infrared light to stimulate neurons. The use of infrared light is advantageous over electrical stimulation such as finer spatial resolution, no direct contact between the stimulation source and target neurons, no electrochemical junction between the source and target tissue, no stimulation artefact on the recording electrodes. While the disadvantages of INS include thermal tissue damage and a restriction on the maximum depth of stimulation due to absorption of light in the intervening tissue.[2] This process can be enhanced by the addition of exogeneous materials that exhibit strong absorption at wavelengthswhere water is transparent. As a consequence, excellent spatial selectivity, minimal potential risks and inefficiencies can be attained. Particularly, nonspecific heating of intervening tissuein the path of the illuminating light and allowing deeper penetration into tissue is possible.[3] Inthis study, Manganese modified Prussian Blue nanoparticles(Mn-PBNPs) have been developed for the application in infrared neural stimulation.The as synthesized nanoparticles have been characterized and its ability to stimulate neurons has been demonstrated in vitro, thus indicating that these nanoparticles can serve as efficient nanotransducers for INS.

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NM007

A comparative approach on variant ratio metric synthesis of amino acid-based graphene quantum dots and their electrochemical sensing applications

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Graphene quantum dots (GQDs) are carbon nanomaterials with sizes less than 10 nm, known for their unique properties, including low toxicity, high solubility, tunable photoluminescence, and biocompatibility.[1] These features have made GQDs highly attractive in the realm of carbon nanomaterials, as evidenced by the burgeoning literature on this subject. Various methods for synthesizing GQDs from organic, inorganic, and biomaterials have been reported. This study focuses on the synthesis of GQDs using amino acids, methionine and tryptophan as precursors. Amino acid-based GQDs are expected to be less toxic and more biocompatible compared to those synthesized from other organic or inorganic materials.[2] We investigate the effects of varying amino acid proportions on the structural, heteroatom doping, and functional characteristics of the resulting GQDs. Additionally, the electrochemical sensing properties of these GQDs are explored for sensing various analytes with biological and environmental significance.

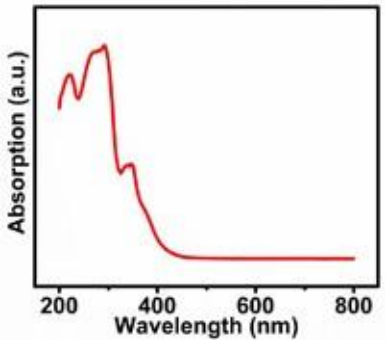

Figure 1. Absorption spectrum of the developed amino acid-based GQDs

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SB001

Dissolvable microneedles for the rapid delivery of drugs: Development and evaluations

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Novel drug delivery systems, exemplified by microneedles, offer a non-invasive route for critical drug administration.[1] Here, we explore the delivery of Misoprostol, a commonly used drug for labor induction, through microneedles.[2] Microneedles composed of blends of PVP10 & PVP 360 and Hyaluronic acid were fabricated using micro-molding, with Misoprostol loaded via tip loading. [3] The developed microneedles demonstrated rapid drug release into the media, with instantaneous release within 2 minutes, irrespective of the dissolving polymer used. In vitro and in vivo animal experiments were conducted to assess the skin insertion and dissolution characteristics of the dissolving microneedles, aiming to advance maternal health applications. Our findings suggest the potential of microneedle-based delivery of Misoprostol as a promising approach for maternal health, offering rapid and efficient drug administration in critical situations. Further research is warranted to optimize the formulation and explore clinical efficacy in human subjects.

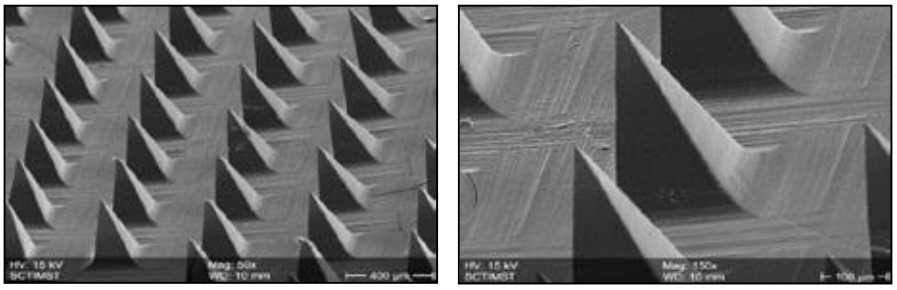

Figure 1. SEM images of microneedles

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SB002

Fabrication of mucin-functionalized polycarbonate urethane membranes for enhanced soft-tissue adhesion

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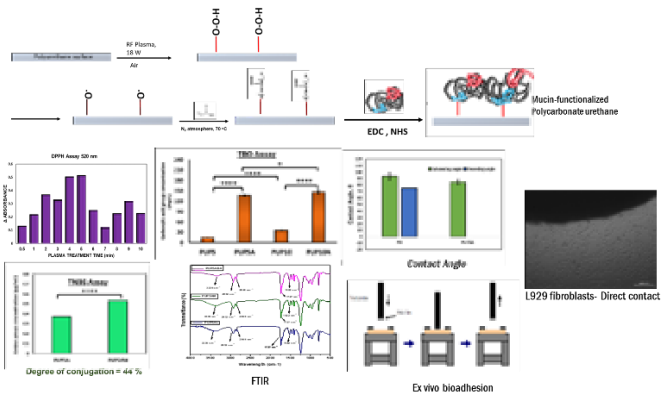
Polycarbonate urethanes (PCU) are segmented block copolymers with incorporated carbonate linkages. With their exceptional resistance to hydrolysis, environmental stress cracking, and metal ion oxidation, polycarbonate urethanes have demonstrated significant promise as long-term medical implants. However, the bioinert surfaces of PCU limit its applicability in broader areas. This work demonstrates the development of a mucin-functionalized PCU electrospun membrane by surface activation. The electrospun membranes were plasma-treated and subjected to graft polymerization by polyacrylic acid. It was observed that these membranes had ample surface functional groups to facilitate the immobilization of bioactive molecules onto the surface without affecting their bulk characteristics. Mucin was then immobilized using 1-Ethyl-3-(3-dimethyl aminopropyl) carbodiimide (EDC) coupling. Studies using atomic force microscopy and contact angle analysis revealed a notable increase in surface characteristics such as roughness and wettability, respectively. The tensile strength of the membranes was not significantly affected with plasma treatment. Over 90% cell viability was observed when L929 mouse fibroblast cells were treated with the membrane extracts. The modified membranes showed enhanced cell adhesion compared to the untreated membranes. Furthermore, they also exhibited an increased force of bioadhesion when tested on swine small intestinal mucosal tissue.



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SB003

Silk fibroin modified acellular porcine liver scaffold as a potent biological graft promoting constructive remodeling in rat abdominal wall defect model

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The rat abdominal wall defect model is a valuable tool for studying the regenerative potential of biological and synthetic scaffolds. In the present work, acellular biological scaffold fabricated from the porcine liver and mechanically augmented with citric acid crosslinked silk fibroin (SF100DPL) has been evaluated by implanting in a full-thickness abdominal wall defect in Wistar rat in comparison to unmodified acellular porcine liver matrix (DPL).[1] The study revealed that DPL and SF100DPL integrated into the host abdominal wall without any signs of infection or immunological rejection. The extent of inflammation evaluated using histomorphometry revealed more pronounced inflammatory cell infiltration which reduced significantly on 90days. The antibody response (IgG+IgM+IgA) showed an initial antibody-mediated immune activation, followed by tolerance on 90days. Masson's trichrome staining and immunohistochemistry demonstrated skeletal muscle island formation initially at the host-graft interface at 21days that transformed into an organized skeletal muscle structure while extending towards the mid-graft region as time progressed to 90days. Herovici's staining further confirmed neocollagen deposition and maturation within the explant. Thus, the SF100DPL scaffold has effectively modulated the inflammatory and immune response to promote better tissue integration and regeneration leading to constructive remodeling revealing its applicability in surgical regeneration of skin or cirrhotic liver

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SB004

De Sol-gel Synthesised Phosphate-Based Bioactive Glasses: Characterization and Bioactivity for Biomedical Applications

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Phosphate-based glasses, known for their porous structures, show promise in biomedical applications, particularly in tissue engineering. This study explores the use of Sol-gel derived phosphate-based glass in such applications. We synthesized glasses by mixing precursors of P2O5, CaO, Li2O, TiO2, and Bi2O3, which were diluted or dissolved in ethanol and added dropwise to a magnetic stirrer. After gel formation, the samples were dried and calcined. Their in-vitro bioactivity and biodegradability were evaluated in simulated body fluid (SBF) over a period of up to 7 days. The samples were analyzed before and after immersion in SBF using X-ray powder diffraction (XRD), Scanning Electron Microscopy (SEM), and Fourier Transform Infrared Spectroscopy (FT-IR).[1] XRD confirmed the amorphous and glassy nature of the samples, while FT-IR showed the local structure of the glasses.[2] In vitro mineralization experiments demonstrated that calcined synthesised powders undergo a transformation into the hydroxyapatite phase upon immersion in SBF solution. The findings indicate that glass composition significantly affects apatite-forming ability, suggesting that these materials can be tailored for specific biomedical applications.

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SB005

Development of Borate Based Bioactive Glasses for tissue engineering applications through the Sol-gel Method

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Borate bioactive glasses (BBGs) have been extensively studied for their promising applications in biomedicine due to their capacity to enhance tissue-implant interactions, promote bone regeneration, and support wound healing. The specific borate-based bioactive glass powders discussed, composed of B2O3, CaO, Li2O, and P2O5, were synthesized using the sol-gel method. These glasses typically exhibit lower chemical durability, leading to rapid degradation; however, the addition of lithium oxide has been shown to enhance their chemical stability and control their degradation rate.[1] To analyze the BBGs, several characterization techniques were employed. Fourier Transform Infrared Spectroscopy (FTIR) was used to identify various chemical groups present in the glass. X-ray Diffraction (XRD) provided information on the structural crystallinity of the materials. Scanning Electron Microscopy (SEM) revealed surface morphology and microstructure details, while Energy Dispersive X-ray Spectroscopy (EDX) assessed the elemental composition. In vitro mineralization tests demonstrated that the BBG powders, once calcined at 600 °C, transformed into the hydroxyapatite phase upon immersion in simulated body fluid (SBF).[2] This transformation is crucial as hydroxyapatite closely resembles the mineral component of bone, making BBGs highly beneficial for biomedical applications. These unique properties of BBGs present exciting opportunities for advancing healthcare, particularly in bone regeneration and wound healing.

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SB006

A process-property relationship study of alginate-based hydrogel beads and its biomolecular diffusion for potential applications in cell encapsulation

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Hydrogels have exciting potential encapsulation applications, such as cell delivery in regenerative medicine. Alginate has been one of the extensively used biopolymer for the preparation of hydrogel beads in this regard. However, understanding the relationship between processing, structure, properties and performance of biomaterials, in line with the material science tetrahedron, is the key aspect of any biomaterial development. To this end, here we focus on how different process parameters influence the properties of alginate based hydrogels, including its ability to diffuse biomolecules. Briefly, the hydrogel beads were prepared by varying process parameters such as nozzle diameters, alginate concentrations, and calcium chloride concentrations. The biomolecular diffusion studies were conducted using Brilliant blue dye as a model compound. Our results indicated that there was a significant effect of nozzle diameter and alginate concentration on bead characteristics. The bimolecular diffusion studies revealed that, absorption of BB dye decrease with increasing nozzle diameter, alginate concentration, and calcium chloride concentration. Absorption kinetic study showed a gradual increase in the absorption as a function of time. While the release kinetics exhibited an initial burst release followed by a slow and sustained release. The study provided interesting insights into how different processes influence the properties of alginate hydrogel beads, which in turn influence the diffusion of nutrients and other therapeutic molecules. Further studies are ongoing to investigate the effect of bead characteristics on cellular viability and function in vitro.

SB007

A Comparative study on Hydroxyapatite and β-Tricalcium Phosphate for Efficient Drug Delivery of Curcumin, Berberine

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A novel challenge for scientific community is to develop calcium-phosphate based ceramics that can serve as a combination of both bone substitute and drug carrier, during bone repair process.[1] Bioactive materials such as hydroxyapatite (HAp) and β-tricalcium phosphate (β-TCP) can be utilized for drug delivery as well as localized/on-site drug release as they improve the surface properties *i.e* increase surface ions for bonding with drugs.[2] In the present work, HAp and β-TCP powders were synthesized by facile chemical precipitation method. It was confirmed by Raman spectra through the presence of intense characteristic peaks of HAp at 962 cm^{-1} and that of β-TCP at 967 and 948 cm^{-1}. SEM images show that both HAp and β-TCP were formed in spherical shape with an average particle size of ~50 nm and ~200 nm respectively (inset of Fig.1a &1b). From EDS analysis, Ca/P ratio was calculated as 1.57 and 1.42 for HAp and β-TCP respectively; it also confirmed purity of samples through the absence of any trace residues. The potential of HAp and β-TCP powders as carriers of anti-inflammatory drugs such as curcumin and berberine through physical adsorption has been studied using time dependent absorption measurements up to a period of 48 h. For both the drugs, HAp shows a higher loading efficacy than β-TCP. The loading efficacy of HAp and β-TCP against berberine was calculated as 90% and ~85% respectively (Fig. 1). For curcumin the loading efficacy of HAp and β-TCP was calculated as ~75% and ~64%, respectively. Hence, this approach of loading HAp with drugs may be an effective method of its efficient transport and release in the intended region.

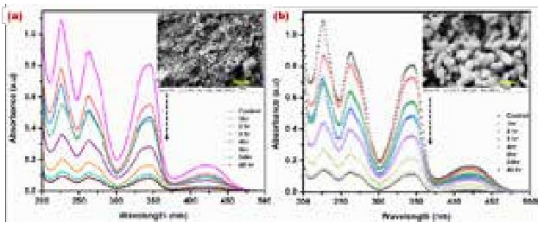

Figure 1. UV-Vis spectrum of Berberine loaded in (a) HAp (b) β-TCP [Inset: SEM images of (a) HAp (b) β-TCP]

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OM001

1,5-diazocines: Structure-to-Property Investigations to Electroluminescence

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Owing to their interesting photophysical properties, diazocines (Dzs), an eight-membered heterocyclic scaffold with two nitrogen have been explored as building blocks for developing novel functional materials for diverse applications. Our interest to investigate how judicious tuning of the connectivity of two nitrogen atoms present in the Dz core with N-CH_2-N bridge to N-N linkage to the absence of connectivity between them could influence the optical, electrochemical, thermal properties and intermolecular interactions led to a detailed structure-to-property investigations.[1] The study revealed a greater thermal stability, improved photophysical attributes, and an amorphous nature for the methylene bridged N-CH_2-N-Dz. Based on these observations that indicate higher suitability of N-CH_2-N-Dzs for electroluminescent applications, novel diarylketone functionalized Dzs with N-CH_2-N linkage were designed and explored as the host materials for PhOLED devices with $Ir(ppy)_3$ being the dopant that offered an impressive external quantum efficiency from these devices.[2]

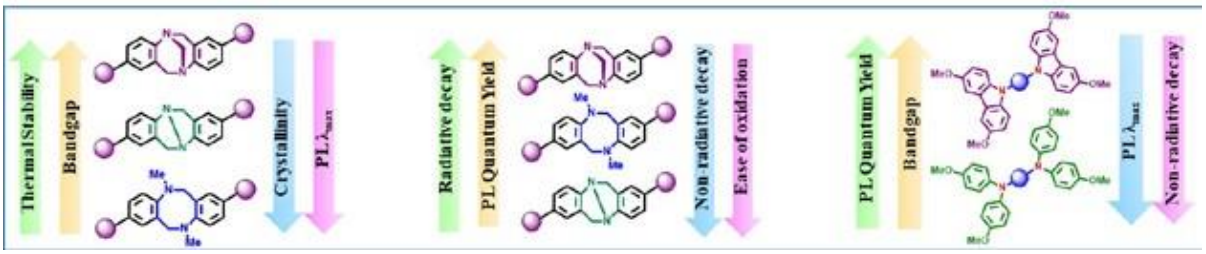

Figure 1. N-CH_2-N, N-N, N-0-N diazocines explored in this work

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OM002

Carbon quantum dots incorporated Li-doped ZnO hybrid films for improved UV photodetection

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Organic/inorganic hybrid thin films have recently emerged as promising materials for the optoelectronic community. The long-term stabilities and high mobilitiesof the carriers within inorganic materials coupled with the levels of cost-effectiveness and flexibilities of organic materials render them the optimal choices for use in hybrid materials. ZnO materials have gained interest due to immense potential in optoelectronic field owing to its long-term stability, transmittance, light detection, and solution processability.[1] Lithium doped ZnO (LZO) is effective for its application in transparent conductive oxides and photodetectors.[2] Without appreciably changing the work function and valence band edge, greater electron conductivity is produced by lithium ions intercalated within the ZnO lattice as dopants in place of interstitial zinc defects, which behave as trap states. Carbon quantum dots (CQDs) have shown promising optoelectronic applications due to their controllable fluorescence emission, low cytotoxicity, excellent thermal stability, and distinctive broad emission.[3] Deep-UV photoluminescence and photodetection are possible using CQDs because of its absorption peak transition at about 250 nm, which is obtained from the π–π in the sp_2 framework. This work focusses on improving the photodetection capabilities of LZO thin films with the incorporation of carbon dots.

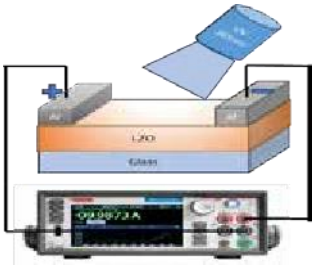

Figure 1. UV Photodetector measurement

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OM003

STIMULI-RESPONSIVE PHENOTHIAZINE DERIVATIVES FOR OPTOELECTRONIC APPLICATIONS

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Metal-free small organic molecules with ordered π-conjugated twisted skeletons are capable of engendering brilliant multifunctional materials.[1] Achieving multi-photofunction in a single organic molecule is challenging due to interfering radiation pathways during emission. However, these materials are essential for understanding new luminescent mechanisms and for enabling promising applications.[2] The current work mainly focus on multi-functional materials involving donor–π–acceptor architecture with synchronised photophysical behaviour such as aggregation induced emission (AIE), mechanofluorochromism (MFC) and thermally activated delayed fluorescence (TADF). We report two classic, organic donor–π–acceptor type molecules, *NTPOM* and *NTPCF*, which are composed of phenothiazine as electron donor and nicotinonitrile as electron acceptor, equipped with methoxy- and trifluoromethyl- groups, respectively. The photophysical investigations including the UV-visible absorption, fluorescence, and phosphorescence were carried out. The thermal properties of these emitters were investigated by thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC) under nitrogen atmosphere. The solution state electrochemical properties of the molecule were investigated by cyclic voltammetry (CV). The results of Wide Angle XRD (WAXD) and Scanning Electron Microscope (SEM) revealed that the MFC mechanism was the transformation between ordered crystalline and amorphous states upon external stimuli. Steady state and time-resolved PL studies at variable temperatures together with computational and crystal structure analysis were used to rationalize the TADF properties of these compounds. The presented results demonstrate that these nicotinonitrile-phenothiazine derivatives, with promising chemical, photophysical, and electrochromic properties have the potential for multifunctional applications.

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OM004

Defect and Doping Induced Emission in $MgGa_2O_4$ for Tunable Luminescence and Optoelectronics

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In this work, a solvent free solid state reaction has been employed to synthesize spinel $MgGa_2O_4$ (MGO) in different annealing environment. Notably, the spinel $MgGa_2O_4$ crystal exhibits blue luminescence (Figure 1a) originating from the self-activation of octahedral GaO_6, in which the strong binding energy between photogenerated electron (Ga^{3+}) and hole (O^{2-}), defined as Frenkel excitons is expected to prevent the interface charge–transfer,.[1] This MGO depicted photoluminescence quantum yield of ~ 41%. In MGO, Mg is tetrahedrally coordinated by oxygen atoms and has a full T_d symmetry, and Ga has a six-fold distorted oxygen octahedral coordination belonging to the D_{3d} point group. We have doped 2% of Mn ion in MGO (MGO-Mn) but the emission properties and quantum efficiency was poor. To further improve the emission property MGO-Mn is heated under reducing atmosphere which boosted the green emission (Figure 1b) leading to enhancement in PLQY ~ 64%. Moreover, the material also exhibits a persistence emission (inset of Figure1) of more than 900s. which making the material as an afterglow phosphor. The thermoluminescence studies also support the persistence results in which the traps are getting shallower in the reducing atmosphere. The materials show potential for color tuning and optoelectronic applications.

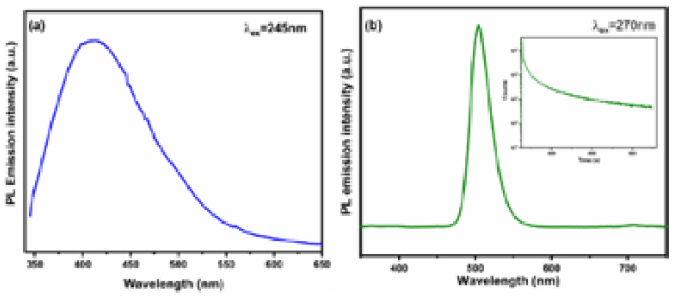

Figure 1. (a) Emission spectra of MGO (b) Emission spectra of MGO-Mn, inset represent the persistence decay plot MGO-Mn

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OM005

Tailoring Emission Properties of Metal Halide Hybrids for Optoelectronic and Security Applications through Crystal Engineering

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The increasing significance of MHs within the research community underscores their vast potential in advanced optoelectronic properties, paving the way for future technological breakthroughs.[1,2] This study delves into the realm of crystal engineering to finely tune emission properties in metal halide hybrids (MHs) for a spectrum of applications, spanning LED lighting,[3] scintillation,[4] and security measures.[5] Two distinct polymorphic forms of MHs were synthesized: $(BT)_2SbCl_5$ and $(BT)_2(TMA)SbCl_6$, with BT denoting $C_{10}H_{16}N$ and TMA representing $C_3H_{10}N$. While the former displayed an emission peak at 610 nm, the latter emitted at 590 nm under room temperature conditions. Exploiting these highly emissive materials, down-converted white light LEDs were engineered, yielding natural white LED parameters: CCT of 3371 K, CRI of 84 Ra, and LED efficacy of 78% for the first polymorph, and cool white LED parameters: CCT of 5171 K and CRI of 82 Ra for the secondpolymorph. Additionally, both materials exhibited radioluminescent properties, mirroring to their photoluminescent emissions, suggesting potential applications in scintillation detection. Moreover, their emissive traits render them apt for advanced anti-counterfeiting measures, encompassing document protection, fingerprint detection, and brand/product authentication. This investigation underscores the adaptability and pragmatic utility of crystal-engineered MH hybrids in tackling an arrayof technological challenges across diverse domains.

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OM006

Amplifying Plasmonic and Chiroptical Effects via Peptide-Derived Chiral Conjugated Polymers

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Chiral polymers consistently maintain a competitive edge over their achiral counterparts due to their effective utilization of asymmetry, allowing them to mimic natural systems across various domains. The uniform and ordered macroscopic structures of chiral π-conjugated polymers, capable of adapting their morphologies, offer a wide array of opportunities in chiral photonics.[1] These opportunities extend to applications in electronics, spintronics, and sensing, with the potential for seamless integration into device fabrication. The recent surge in the development of chiral conjugated polymers and organic-inorganic hybrid systems across diverse research fields such as plasmonics, chiroptics, and magneto-optics has attracted significant attention, positioning it as an emerging and crucial area with the potential to drive advancements in metamaterial applications.[2]

In this study, we employ well-known diacetylene and thiophene-based systems to develop novel chiral conjugated polymers, utilizing peptides as readily functionalizable chiral precursors. Additionally, we incorporate photo-tunable azobenzene moieties to introduce a photocontrol element that enables further manipulation of the system through photoisomerization. These structural modifications in the polymer backbone instigate mesoscopic alterations within the system, which subsequently manifest in the resulting macromolecular properties. We extend our exploration of diacetylene and thiophene-based polymers towards the realms of chiral plasmonics, and chiroptics. The peptide tethered diacteylenes were effectively used for tunable thermo-, halo, solvato-chromism.[3] Further, modification of the system lead to enhancement of SPR properties of chiral gold nanoparticles.[4]

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OM007

Characterizing Dislocations on Silicon Carbide using Etch Pits

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Silicon Carbide (SiC) has revolutionized the world of material science because of its excellent properties, such as wide bandgap (3.26 eV), low power losses, high thermal conductivity, and resistance to chemical reactions, thus making it an important component in power electronics, automotive technology, telecommunications, and industrial processes. However, defects and dislocations often arise during the material growth, which can impact device performance and reliability by affecting its electrical and optical properties. Therefore, classifying and understanding the characteristics of dislocations in silicon carbide is very important. In this study, etch pits were developed on n-type 4H-SiC single crystal by defect etching using molten KOH. Etch pits provide a sign of crystal defects, usually formed at high surface energy regions like dislocations, where their stress fields create local mechanical stress.[1,2] Morphological study and mechanism of formation of dislocations identified by etch pits, are discussed[3]. The interaction and interconversion phenomenon between Basal Plane Dislocation (BPD) and Threading Dislocation (TD) are also discussed.[4,5]

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OM008

Harnessing the Dual-Mode Luminescence of Er/Yb Co-Doped $SrLaLiTeO_6$ Double Perovskite Phosphors for Remarkably Wide Range Temperature Sensing and NIR pc-LEDs

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The ever-increasing demand for efficient and economic photonic materials has hastened the quest for robust, multifunctional phosphors. Herein, a dual-mode luminescent $SrLaLiTeO_6:Er^{3+}$, Yb^{3+} double perovskite phosphor whose concentration-dependent up and down-conversion luminescence are investigated, and underlying mechanisms are discussed. Temperature-dependent up-conversion luminescence of $^2H_{11/2}\rightarrow{}^4I_{15/2}$ transition exhibits negative thermal quenching, owing to the thermalization process from the $^4S_{3/2}$ level.[1] Temperature-dependent Raman analysis confirms a decrease in the phonon lifetime from 0.43 to 0.28 ps indicating an increased number of phonon decay channels, which explains the rapid thermal quenching of up-conversion emission at elevated temperatures.[2] The diverse thermal quenching of the thermally coupled levels contributes to the exceptionally high relative sensitivity of 4.49 $\%K^{-1}$ at 140 K. A maximum sensitivity, Sr of 0.84 $\%K^{-1}$ (698 K) is obtained from the Raman-PL intensity ratio (RPIR) of the v_1 band (719 cm^{-1}) and the 986 nm emission band ($^4I_{11/2}\rightarrow{}^4I_{15/2}$) of Er^{3+}. Hence, by employing multi-mode temperature sensing techniques a single phosphor can be used for optical thermometry for a broad temperature range from 90 to 698 K. In addition, the Near Infra-Red (NIR)-II emission of Er^{3+} corresponding to $^4I_{13/2}\rightarrow{}^4I_{15/2}$ transition shows excellent thermal stability, maintaining 72% of the room temperature intensity at 500 K.

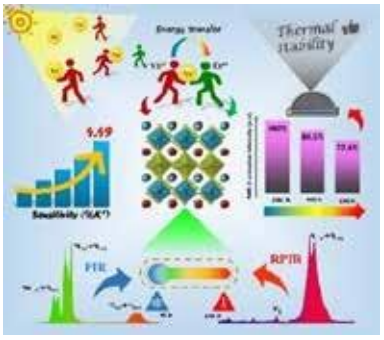

Figure 1: Graphical abstract illustrating the multifunctionality of the phosphor.

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OM009

Investivations on the impact of Sb incorporation on GeSeTe glass matrix

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Chalcogenide glasses are amorphous solids containing either S, Se and/or Te which provide applications in electronic industries, imaging and photonics. In the present work, the $Ge_{20}Se_{60}Te_{20}$ glass matrix is kept as a host matrix, and its optical and physical properties with the substitution of Te with Sb are studied. Amorphous chalcogenide glass is prepared using a rocking and rotating tubular furnace and X-ray diffraction is employed to examine the amorphous or crystalline nature of bulk sample. The compositional element ratio is confirmed by the energy-dispersion X-ray spectroscopy technique. Diffuse reflectance spectroscopy is used to determine the optical band gap of prepared samples. The band gap is due to the indirect electronic transitions, and the band gap values are found to vary with the addition of the fourth element Sb. The differential scanning calorimetric studies indicate the increase in transition temperature with the addition of Sb which increases the cross-linking and thereby rigidity of the glass. FT-IR spectroscopy confirms that these glasses are IR transparent except for some absorption mainly due to –OH and impurity bonds. Studies prove these materials to be promising candidates for the development of tunable optical devices for optoelectronic applications.

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CM001

Experimental Testing of Flexible Composite Materials made for Neutron Shielding Purpose Using Am-Be Neutron Source

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Flexible neutron shielding materials are prominent requirement for electronics and semiconductor-based components used in nuclear fusion and fission reactor as well in space application. The development of flexible rubber-based composites has been attempted for radiation shielding. The composites have been made by infusing the specific elements which are good for neutron shielding. The testing of such material in neutron enviorment arenecessary to prove their functional characteristics. An experiment has been conducted at institute for plasma research for testing of composite materials and their shielding capability has been demonstrated. An Am-Be source available at Institute has been utilized to conduct the experiment. The attenuation of the neutron flux has been demonstrated by measuring the outgoing neutrons after the shield material. The experiment has successfully demonstrated the shielding efficacy of the materials and establish them for utilization of neutron enviourment where flexible shielding is required.

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CM002

Development of MoS_2 functionalized MWCNTs based epoxy nancomposites subjected to severe erosion wear conditions for wind turbine application

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Epoxy-based thermosetting polymer composites are commonly used in structural applications for space exploration. Epoxies' intrinsic brittleness restricts its use in scenarios where composite structures are subjected to severe solid particle erosion (SPE) conditions. Conventional reinforcement materials, such as MWCNTs, exhibit adverse effects on the SPE resistance of epoxy composites. The synthesis of erosion-resistant reinforcing particles which show synergistic effects of better mechanical characteristics and SPE resistance in epoxy matrix has become crucial in this regard. MoS_2/MWCNTs hybrid nanoparticles were successfully synthesized using an in-situ hydrothermal reaction. The 2D MoS_2 nanosheets were deposited over the available active sites of 1D COOH-functionalized MWCNTs, with individual MoS_2 nanoclusters also getting formed. The resultant hybrid epoxy/MoS_2/MWCNTs showed enhanced SPE resistance and mechanical properties when compared with conventional epoxy/MWCNTs nanocomposites. Epoxy/MoS_2/MWCNTs nanocomposites showed low erosion rate of 480 mg/Kg and 138 mg/Kg at 15° and 90° impact angles whereas epoxy/MWCNTs nanocomposites showed high erosion rate of 548 mg/Kg and 300 mg/Kg at 15° and 90° impact angles. Epoxy/MoS_2/MWCNTs showed predominant micro-ploughing behavior, while epoxy/MWCNTs showed predominant micro-cutting erosion behavior. Epoxy/MoS2/MWCNTs hybrid nanocomposites showed improved tensile strength by 29% and better percentage elongation at the break by 5.38% when compared with pure epoxy.

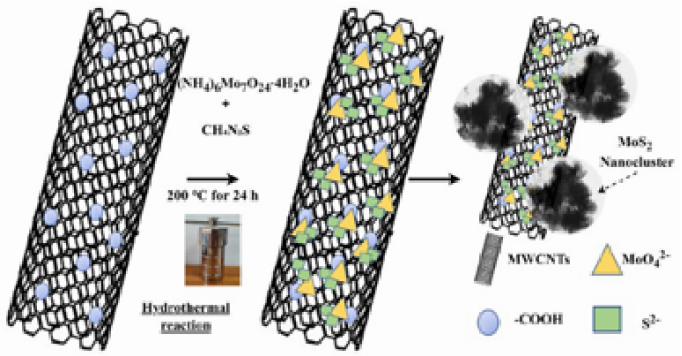

Figure 1.Graphical representation of the hydrothermal synthesis of MoS2/MWCNTs

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CM003

Influence of hygrothermal cycle aging on the mechanical and thermal properties of glass epoxy composites reinforced with carbon nanotubes

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The long-term durability of fiber-reinforced polymer composites under environmental stresses is a critical concern. This study investigates the influence of hygrothermal cycle aging on the mechanicaland thermal properties of glass epoxy composites reinforced with and without carbon nanotubes (CNTs).The composites were then subjected to hygrothermal cycle aging in a water bath at 80°C and 90% relative humidity. Tensile properties, ILSS and viscoelastic properties through Dynamic Mechanical Analysis (DMA) were determined before and after aging.The results showed that the inclusion of CNTs improved the tensile strength and ILSS. Furthermore, upon hygrothermal aging, the CNT-reinforced composites exhibited better retention of their mechanical properties compared to the composites without CNTs. DMA analysis revealed that the glass transition temperature and thermal stability of the CNT-reinforced composites were also better preserved after aging.The findings of this studyhighlight the potential of carbon nanotubes in enhancing the long-term durability of glass epoxy composites under hygrothermal conditions. The insights gained can contribute to the development of more resilient fiber-reinforced polymer materials for various engineering applications.

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CM004

Fabrication of Flexible, Hydrophobic and UV-Resistant Hybrid Nanocomposite of Polypropylene via Latex Technology for Green EMI Shielding

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The demand for effective electromagnetic interference (EMI) shielding materials has driven the development of novel and facile approach to the fabrication of conductive polymer nanocomposites. In this study, a polypropylene (PP)-based hybrid nanocomposite was prepared by incorporating Super P conductive carbon black (SPCB) and graphene nanoplatelets (GNP) via latex technology. Hybridizing the nanocomposite by the usage of two different fillers has resulted in a substantial improvement in EMI shielding performance of the material along with its mechanical and thermal properties. The samples were fabricated and tested in different thicknesses to ensure that EMI shielding effectiveness (EMI SE) is a thickness dependent property and also the studies were carried out over a broad range of microwave frequency. A high electrical conductivity of 7.6 S m^{-1} was obtained and exceptional EMI SE of 65 dB (X band), 69.76 dB (Ku band) and 72.38 dB (K band) was showcased by 2mm thickness composites. The optical microscopy images of PP latex incorporated with the fillers gave a clear understanding about the formation of conducting networks within the polymer matrix at percolation threshold. The thermal stability of the composite in both oxidative and inert atmosphere showed a marginal improvement compared to that of pure PP. An increment was observed on analyzing the crystallization temperature (T_C) and onset crystallization temperature ($^{O}T_C$) due to the nucleating behavior of the fillers used and also the melting temperature (T_M) of the composite showed a shift from double melting behavior to single as the fillers explicitly nucleated a particular polymorph of PP. The current work has shown that the addition of SPCB and GNP showed a significant increase in both the hardness and tensile strength of the composite and it also helped in protecting the polymer matrix against ultraviolet (UV) radiation. The work aims at fabricating a flexible, hydrophobic and low-density polymer nanocomposite showing excellent absorption dominant EMI SE.

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CM005

Recent Progress Of Composite Materials In Architecture – A Review

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Present architectural materials have certain drawback such as limited durability, high cost, environmental impact during production, difficulty in recycling and disposal. Sometimes they may or may not meet certain structural requirement. Taking in account of composite material they offer architects a versatile and sustainable solution for designing and constructing modern structures that meet the demand of today's architectural challenges. Composites such as fibre-reinforced polymers (FRPs) offer high strength to weight ratios, making them ideal for structural application. Compared to traditional materials, composites are lighter, which can reduce the overall weight of structures. They do have environmental benefits such as recyclable and contribute to sustainable building practices. Additionally, their lightweight nature can reduce transportation cost and energy consumption during construction. Throughout the lifespan of a building composite material may offer energy efficiency benefits, such as insulation property which can reduce energy consumption for heating and cooling. At the end of their useful life, they may be disposed of, recycled, or reused.

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CM006

Enhanced Thermoelectric Performance in Benzodithiophene-based Copolymer/Single-Walled Carbon Nanotube Composite Film for Efficient Industrial Waste Heat Recovery

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Industrial effluent pipelines are a notable source of waste heat that can be harnessed into electrical energy utilizing organic thermoelectric (TE) materials. The efficacy of TE materials is quantified by a dimensionless figure of merit (*ZT*), expressed as $ZT = S^2\sigma T/\kappa$, where *S* represents the Seebeck coefficient, σ stands for electrical conductivity, *T* denotes temperature, and κ signifies thermal conductivity. For efficient TE conversion, it is desirable to have high values of *S* and σ, along with a low value of κ.[1,2] In this work, a benzodithiophene-based conjugated polymer was utilized to create a TE composite with single-walled carbon nanotubes (SWCNTs). The TE behavior of the composite was evaluated as a function of SWCNT weight percentage, revealing a peak p-type TE response at 50 wt.% SWCNT content. The composite film was then doped with BCF, resulting in a 1.5-fold increase in power factor (PF). The change in film morphology was analysed through SEM, which indicated improved dispersion of the polymer in the SWCNT network, improving the electrical transport. The charge transfer behavior and intermolecular interactions between SWCNT and the polymer were investigated through UV-vis-NIR absorption and Raman spectroscopy. The doped composite film achieved a maximum PF of 125 $\mu W/mK^2$ at 435 K. The fabricated 7-legged TE device, delivered a peak power output of 0.2 μW at a temperature difference of approximately 100 K, marking the highest value reported for conjugated polymer/SWCNT composites, thereby indicating its promising potential for sustainable power generation from thermal sources.

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CM007

Rejuvenating the Electrochemical Performance of Gel Polymer Electrolyte Using Humate as Ionic Liquid for Solid-State Lithium Batteries

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Solid-State Lithium batteries (SSLB) represent a promising avenue for advancing the field of energy storage, offering a compelling combination of high energy density, enhanced safety, and improved performance. Despite their immense potential, SSLB are still in the early stages of development. Herein a novel approach of solid electrolyte fabrication has been carried out by the usage of Humate substance as a replacement for the conventional ionic liquid. Lithium Humate liquid is extracted from low quality coal sample via alkali treatment using hydrothermal method. Gel polymer electrolyte film was synthesized with an optimized ratio of 75 wt% of host polymer poly(vinylidene fluoride-co-hexafluoropropene) (PVDF-HFP) and 25 wt% of ionic salt (Lithium perchlorate) $LiClO_4$casted with newly synthesized Lithium Humate ionic liquid by simple solution casting technique at 25 °C. For comparative study different samples were fabricated one with Lithium Humate (PS-LH) and with BMITFSI (PS-IL).[1] The prepared films were physicochemically characterized by XRD,SEM and FTIR.Electrochemical Impedance Spectroscopy revealed that the film prepared using LithiumHumate (PS-LH) has ionic conductivity of about 3.4 x 10^{-3}S cm^{-1}which is higher than the othersample (PS-IL).

Figure 1. Graphical Abstract

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CM008

REE Influence on In Vitro Bioactivity Response of Mesoporous Bioactive Glasses as the Application of Bone Tissue Engineering

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In this study, we developed europium and terbium ions incorporated into SiO_2- Li_2O- P_2O_5-CaO-Ga_2O_3 glass system prepared by modified sol-gel method for bone tissue regeneration by the fast response of bioactivity and anti-microbial effect with fluorescent properties. Transmission electron microscopy analysis revealed that Eu-MBGs and Tb-MBGs hold mesoporous-natured nanoparticles with a size (of ≤ 200 nm). The MBG powders exhibit pore volume (~ 0.3 to 0.9 cm^3/g) and large specific surface area (~ 400 to 500 m^2/g) with 0.4-0.9 relative pressure (p/p0) indicates type-IV isotherms, and also H3 type hysteresis loops contain uniformly distributed slit-shaped pore channels within the mesoporous range (10 nm), from Brunauer-Emmett-Teller surface area analysis. The prepared MBGs were physicochemically characterized by XRD, FESEM with EDX, FTIR, DLS particle size analysis, and Zetapotential. Additionally, the photoluminescent properties of before and after SBF immersion were examined by fluorescent spectroscopy. Eu^{3+} and Tb^{3+} ions stimulate the fast response ofin vitro bioactivity proven by SBF studies. Furthermore, antibacterial studies were conductedby gram-positive (S. aureus) and gram-negative (E. coli) pathogenic bacteria using the agar well diffusion method. Therefore, the synthesized REE-doped MBG powdered particles are hypothetically well capable of bone tissue applications.

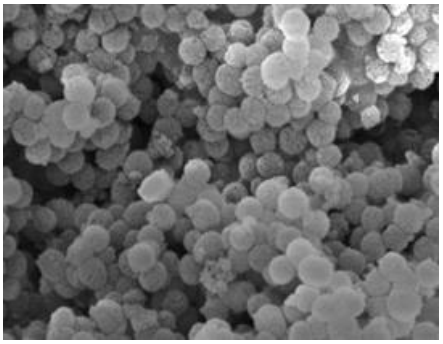

Figure 1. FESEM image of MBG

CM009

Comprehensive role of tannic acid in the preparation of antibacterial, hydrophobic, oleophilic, boron nitride/chlorobutyl rubber nanocomposite for reusable protective clothing and oil-water separation

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Boron Nitride (h-BN) possesses unique qualities like increased thermal conductivity, non-toxic nature, and environmental friendliness[1]; hence, it is a good reinforcing agent for chlorobutyl rubber (CIIR). Tannic acid (TA) holds excellent bio-functional properties and is considered as an exceptional bio-exfoliating agent[2]. Hence, in this study, we have utilized the bio-exfoliating ability of TA to exfoliate h-BN and evaluate its efficiency in reinforcing the CIIR matrix. Results demonstrate the exceptional role of tannic acid in imparting multifunctionality to chlorobutyl rubber. CIIR matrix introduced with h-BN:TA (h-BN:TA/CIIR) display excellent mechanical performance due to the reinforcing effect shown by excess TA in addition to the exfoliating effect. In addition, h-BN:TA/CIIR composite exhibited superior antimicrobial activity against S. aureus. The retention of thermal decontamination efficiency of the composites with increase in the number of cycles ensure their promising application in the field of reusable gloves and chemical protective clothing. The exfoliated filler created a tortuous path inside the matrix which prevents the permeation of solvent. Hence the work intends to synergize the hydrophobic nature of h-BN, exfoliating capacity of TA and the barrier abilities of CIIR for the adsorption of oil from oil-water mixture and portrays the future of the trio in water purification.

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CM010

Morphological, Mechanical, and Barrier Properties of Polymer Composites and Nanocomposites for Diverse Applications

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The synergistic combination of materials with distinct properties paves the way for the creation of novel materials with exceptional characteristics. These materials exhibit heightened strength and unique attributes while maintaining reduced density, illustrating the extensive potential of employing cutting-edge technologies in composite synthesis. The art of crafting intelligent and profitable materials through the manipulation of diverse parameters and material blends underscores the immense scope for advancement in this field. The advent of nanotechnology has further catalyzed a tenfold increase in research and development. This presentation focuses on the properties and applications of diverse polymer-based composites. Specifically, it encompasses natural rubber/nitrile rubber blend nanocomposites, date palm fiber-reinforced foam composites, and bio-composites derived from natural fibers, including nanocellulose-based composites. Various characterization techniques, such as transmission electron microscopy (TEM), scanning electron microscopy (SEM), X-ray diffraction analysis, and the assessment of mechanical properties, stress relaxation, thermo-mechanical characteristics through dynamic mechanical analysis, thermal conductivity, and barrier properties, are employed to elucidate the distinctive attributes of these composites and nanocomposites. Our findings highlight the significant role of various fillers in acting as compatibilizers and reinforcing agents, contributing to the enhancement of long-term mechanical performance and barrier capabilities in these composite materials.

CM011

Influence of Graphene Oxide/Nano Silica Hybrid Nanofiller in the Rheological and Gas Barrier Properties of Natural Rubber Nanocomposites

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This study explores the influence of a hybrid nanofiller composed of graphene oxide and nanosilica (GO/NS) on both the rheological and gas barrier characteristics of NR nanocomposites. A particular focus lies in analyzing the Payne effect induced by the hybrid filler. Additionally, the research investigates how the uniform dispersion of this hybrid filler within the nanocomposite creates a convoluted pathway, thereby enhancing gas impermeability. NR GO/NS 3 exhibits low gas permeation for oxygen and nitrogen, with a reduction of 44.35% in oxygen permeation and 44.7% in nitrogen permeation compared to neat natural rubber. Through this examination, the study underscores the pivotal role played by the GO/NS hybrid nanofiller in shaping the mechanical and barrier attributes of natural rubber nanocomposites. These insights hold significant promise for the advancement of materials aimed at achieving superior gas barrier properties across a range of applications.

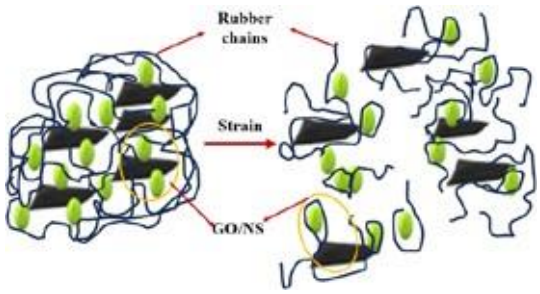

Figure 1. Schematic illustration depicting the breakdown of NR GO/NS rubber clusters and the formation of chain segments at the GO/NS hybrid filler surface under applied strain

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CM012

A Study on Polymer Composite Materials and its applications

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Nowadays, Polymer composite materials represent a versatile class of engineered materials with a wide range of applications. This study explores the important synthesis and characterization and applications in different industrial applications, due to their unique blend of properties. A composite material comprises reinforcement, fillers with fibers and matrix. These composites exhibit enhanced mechanical, thermal and electrical properties compared to traditional materials. The synthesis methods, such as Injection molding or layer-by-layer deposition, play a crucial role in tailoring the composite's Structure and performance. This study also highlights the eco-friendly aspects of certain bio-based polymer composites, contributing to Sustainability in material science. This study will definitely helpful for the researchers, scholars who are new to this field overall, the ongoing research and development in polymer composite materials hold promise for advancements in industries ranging from aerospace to automotive, offering lightweight, durable and multifunctional solutions.

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CM013

Carbonized Electrospun Polyacrylonitrile Fiber Mats Reinforced Polydimethylsiloxane Composite for Electromagnetic Interference Shielding

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As we are living in technological era, the usages of the electronic devices are significantly raised and these electronic devices and wireless communication are working in high electromagnetic (EM) frequency range. So, there are high chances of Electromagnetic interference (EMI). EMI affects the functioning of electronic devices and they are harmful to human beings thus the use of EMI shielding materials are of great use. The demand for light weight and flexible EMI shielding materials with high mechanical properties are increasing day by day. In this work we fabricated carbonized electrospun polyacrylonitrile (PAN) fiber mats reinforced polydimethylsiloxane (PDMS) composite with different number of layers of CNF mats [CNF PDMS composites] and investigated their dynamic mechanical properties and the EMI shielding efficiency. Properties of the CNF PDMS composites such as storage modulus, loss modulus, damping parameters, degree of entanglement, Adhesion factor, reinforcement efficiency factor, C-factor and EMI shielding efficiency were determined. The The composite with four layers of CNF exhibited higher storage modulus, loss modulus, tan D, and EMI shielding effectiveness (50 dB) with thickness of 2.2 mm in the frequency range of 8-26.5 GHz. The reinforcement properties of CNF PDMS composites are important for structural applications and in flexible electronic devices.

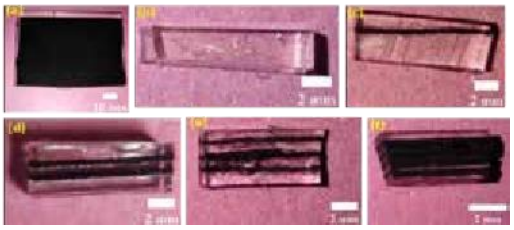

Figure 1. Digital photograph of carbonized electrospun polyacrylonitrile (PAN) fiber mats reinforced polydimethylsiloxane (PDMS) composite. (a) CNF PDMS composite (surface) (b) Pure PDMS, (c-f) cross-sectional view of CNF PDMS composite layer-1 (c), CNF PDMS composite layer-2 (d), CNF PDMS composite layer-3 (e), and CNF PDMS composite layer-4 (f), respectively.

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CM014

Tellurium nanoparticles incorporated Carbon nanofiber and their Polydimethylsiloxane composite for Electromagnetic Interference Shielding

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The rapid development of the electronic sector has paved to the emergence of wireless network and miniaturized wearable electronic devices, which has become a serious threat to global world as these electronic devices emit high frequency Electromagnetic (EM) radiations which leads to Electromagnetic interference (EMI). EMI has huge impact in different fields such as telecommunication, military, medical fields. To resolve this problem, high performance light weight hydrophobic green EMI shielding materials with good flexibility, and desired properties are required. Polymer composites are effective for EMI shielding. In the present work, Tellurium nanoparticles (Te NPs) incorporated into nitrogen doped carbon nanofiber (Te-CNF) was prepared through electrospinning, followed by carbonization, for EMI shielding applications. The incorporation of Te NP into CNF can improve the 3D conductive network by improving the electrical properties. Te is a metalloid with low band gap and can introduce polarization sites and hetero-interfaces in CNF. Te-CNF exhibited an average EMI shielding effectiveness of 37 dB in the X-band region with a thickness of 0.08 mm and a density of 0.499 g cm^{-1} and possessed a high electrical conductivity of 0.68 Scm^{-1}.Te-CNF exhibited higher SE_A values compared to SE_R due to the synergistic effect of the incorporated Te NPs and nitrogen-doped CNF, such as interfacial polarization, conduction loss, polarization loss, and multiple scattering and multiple internal reflection of EM waves. To improve flexibility and for ease of handling, polydimethylsiloxane has been used in this work.

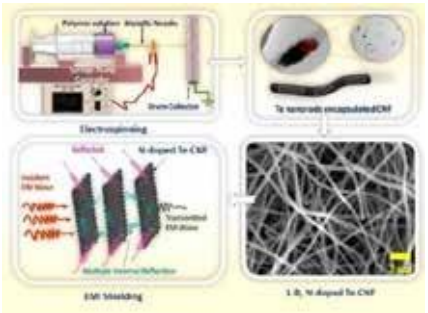

Figure 1. Schematic illustration of preparation of Tellurium nanoparticle incorporated electrospun PAN fiber and their EMI shielding performance

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CM015

Electromagnetic Shielding Properties of Polyaniline Decorated Hexagonal Ferrite

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The prompt development of high energy electronic and telecommunication devices begot the issue of electromagnetic pollution.[1,2,3] The unwanted interference of electromagnetic radiation could cause vital harm to the precision and functionality of sophisticated devices and also cause health consequences to humans and other living-organisms.[1] With the shrinkage of electronic components and the complex nature of modern devices, there's a pressing demand for electromagnetic interference (EMI) shielding materials that can seamlessly integrate into modern designs. Recent research has focused on developing materials with high electrical conductivity, permittivity, permeability, and tailored configurations.[3] W-type hexaferrites and conductive polymers like polyaniline emerge as promising candidates due to their excellent magnetic properties and conductivity.[2,4] The synergic effect of a composite comprising of W-type hexagonal ferrite and PANI could offer excellent EMI shielding performance.

The present study is an investigation on the effect of filler concentration of W-type hexagonal ferrite on the electromagnetic interference (EMI) shielding properties of polyaniline. Ferrite filler particles have been synthesized by solution combustion method. The polyaniline/ hexagonal ferrite composites were fabricated through an in-situ chemical oxidative polymerization method. The X-Ray Diffraction and Fourier Transform Infrared Spectroscopic analysis confirms the formation of hexagonal ferrite and its composite with polyaniline. The composite shows an average shielding effectiveness of 47.2 dB for 30% filler loading with thickness 2 mm, which is about 99.998% of shielding efficiency, in K band.

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CM016

Designed and Tailor-made Double Hydrophilic Block Copolymer-Graphene Nanoplatelet Hybrids for Reinforcing Epoxy Thermosets

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Because of their propensity to build micellar nanostructures, amphiphilic block copolymers (ABCs) are an appropriate and unique toughening agent for epoxy systems individually on their own and in grafted form. The presence of epoxiphilic and phobic ends in ABCs is responsible for the self-assembly and the micellar structure [1]. The nanofiller-grafted ABCs are capable of enhancing the toughness to a great extent via the synergistic characteristics of nanofillers and the ABCs. Even though there is sound literature supporting the effect of ABCsin epoxy[2], the action of double hydrophilic block copolymers (DHBC) in the epoxy matrix is less handled. Hence, the grafting of nanofillers in DHBCs and their subsequent role in tuningthe properties of epoxy is a new concept. Hence this paper tries to bridge the gap by studying the effect of grafted fillers based on DHBCs in epoxy matrix. As a result, the current study focuses on the synthesis of double hydrophilic graphene nanoplatelets (rGO-g-DHBC) via nitrogen oxide-mediated polymerization (NMP) for epoxy toughening application. The prepared rGO-g-DHBC was effectively utilized for epoxy toughening applications, resulting in a 457% improvement in toughness without compromising its inherent tensile strength. The mechanism behind the improved toughness was elucidated with the help of a Scanning ElectronMicroscope (SEM), and the thermal, and rheological characteristics were studied.

CM017

Magnesium Alloy Composite as Bone Implant Material

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Bone fractures caused by accidents and diseases are increasing day-by-day in the world. Fractured bone repair and fixing using non-biodegradable bioimplants require secondary implant removal surgeries and it causes undesirable effects such as stress shielding and release of metal ions. This has a very negative impact on the emotional and physical condition of the patients and also causes a financial burden to the patients. Therefore, intense research is underway all over the world to develop efficient, biocompatible and biodegradable temporary bioimplant materials. Magnesium (Mg) alloys are suitable candidates for temporary bone implants because of their bio-degradable characteristics and high biocompatibility. Mg has high similarity to natural bone in terms of elastic. The strength-to-weight ratio Mg is very high,and its density is very similar to that of bone. Pure Mg corrodes quickly in the physiological and high chloride environment. Thus, pure Mg is replaced by Mg alloys and Mg metal composites (MgMC) for bioimplant application developments. But Mg alloys show uncertaintyin corrosion rate in physiological condition due to rapid formation of hydrogen and ion releasethat lead to severe pH change which has negative effect on bone-implant integration. MgMCs with appropriate reinforcements have great potential as temporary biomaterial due to their tailored mechanical and corrosion properties.

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CM018

Hydrophobic Modifications of Carrageenan-Based Sustainable Nanocomposites

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The versatility of the anionic algal polysaccharide carrageenan has long been a subject of discussion and exploration, particularly for its affinity towards water molecules. While this property is advantageous in certain applications such as water remediation, wound healing, etc., the usefulness of this biopolymer is significantly limited when it comes to applications such as food packaging. In a collaborative effort, scientists from around the world areconducting research to explore diverse methods to introduce a hydrophobic nature into these polysaccharides without compromising their other functionalities.[1] Considering these ongoing studies, this work is crafted to provide a comprehensive understanding of the various sustainable methods and techniques used to tune the hydrophobic nature of carrageenan-based bionanocomposites, both through surface modifications and changes to their chemical structure and attached functional groups.[2] This work primarily focuses on how the hydrophobicity of carrageenan bionanocomposites varies based on the type and refinement of carrageenan and with the incorporation of additives, including plasticisers, reinforcing agents, bioactive materials, etc. The integration of nanofillers such as polysaccharide-based nanoparticles, nanoclays, bioceramic and mineral-based nanoparticles and their synergistic effects in hybrid bionanocomposites are also discussed,[3] highlighting the practical applications of these research findings in various industries.

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CM019

H_2 Enrichment from Syngas Separation via bio-based Polymer Membranes using MD Simulations

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Syngas is a major component that is exuded from gasification and pyrolysis reactors which have been using heavily in recent times for biomass conversion. This work aims at separating the gases from syngas and completely obtain pure Hydrogen gas which can further be used for various other purposes, mainly meeting the fuel demands. Before experimenting with different polymers reinforced with nanofillers to study the separation process, MD simulations have been employed to study the permeability and selectivity of gases through the selected polymer membranes, that have been reinforced with nano-biochar, which itself is a byproduct of gasification and pyrolysis, thereby reusing the end-product of these processes. Diffusivity and solubility of the gas components have been studied and thereafter, permeability have been examined providing comparative analysis among the polymers used in the membranes.

CM020

Viscoelastic and rheokinetic behaviour of cellulose nanofiber/ cloisite 30B hybrid nanofiller reinforced epoxy nanocomposites

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Cellulose nanofiber (CNF) was employed as a green dispersant to enhance the dispersion of nanoclay in the epoxy matrix by preparing a hybrid nanofiller consist of CNF and nanoclay (Cloisite 30B) hereafter referred as hybrid nanofiller. The cure kinetics of the epoxy resin and diamino diphenyl methane as curing agent in presence of hybrid nanofiller was studied by isothermal rheokinetic analysis at different temperatures. Intercalated and trapped nanoclay inside the CNF network morphology of the hybrid nanofiller resembles a trapped prey in spider web. The accelerating effect of the hybrid nanofiller toward epoxy curing was determined by the Arrhenius equation. The synergistic effect of hybrid nanofiller on the cure reaction causes a reduction in the activation energy. The hydrogen bonds between the hydroxyl groups of CNF and epoxies, along with the epoxide ring-opening catalyzed by the quaternary onium ion in nanoclay due to the unique morphology of the hybrid nanofiller, significantly lowered the activation energy required for curing. It was also found that the complex viscosity during the epoxy chain growth strictly follows an exponential growth and the characteristic relaxation time for the viscosity growth was well described by William–Landel–Ferry (WLF) equation. The high-resolution TEM images of the fabricated nanocomposite reveal the intercalated morphology of the nanoclay in the epoxy matrix. The viscoelastic properties of the hybrid nanocomposites were studied and compared with that of respective binary nanocomposites of epoxy/nanoclay and epoxy/CNF. Quantification on the crosslink density, filler effectiveness ‘c’, degree of entanglement and peak factor was determined from DMA analysis.

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CM021

Enhanced Mechanical, Thermal, and Barrier Properties of HNT-NC incorporated PVA/PEO Films for food packaging

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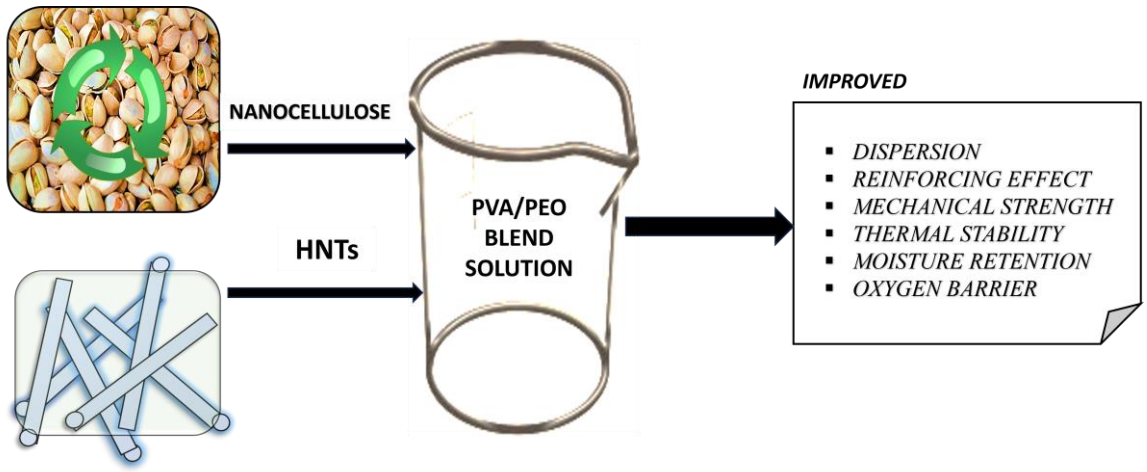
Abstract

When reinforced with safe and non-toxic additives, PVA can achieve high barrier, biodegradability, and biocompatibility features, making it a suitable replacement in the packaging business.[1] The present work is a novel nanocomposite of polyvinyl alcohol/polyethylene oxide (PVA/PEO) with halloysite nanotube-nanocellulose hybrid filler (HNT-NC) enhancing mechanical, thermal, and barrier properties. Compared with morphologically similar nanofillers like carbon nanotubes (CNTs), HNTs are widely available, non-toxic, and easily dispersed, mainly used for drug delivery and food packaging applications.[2] Nanocellulose (NC) with high surface area, aspect ratio, and crystallinity can enhance the barrier property against oxygen and other gases and provide reinforcement and biodegradability.[3] The effect of HNT-NC loading on the properties of the nanocomposites was evaluated using IR, XRD, TGA, DSC, water vapour transmission rate (WVTR), moisture retention capacity (MRC), peroxide value (POV), and mechanical studies. The tensile strength, Young's modulus, and thermal stability improved significantly, due to the barrier effect offered by the hydrogen bonding network. Nanocomposite maintains low WVTR and good MRC and can protect the food from moisture and maintain its freshness. The oxygen barrier property was enhanced by 67% in PPH3C5 (27 ± 1.54 mEq/Kg) compared to PP.



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PB001

Endorsement of Deep Eutectic Solvents from Non-Conventional Precursor Materials Applied as High-Performance Catalytic Curing Agents for Epoxy Resins

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Epoxies have traditionally been a favorite in the coating industry due to their faster and more convenient curing process, prolonged shelf life, and high performance of the end products, which remain the basic requirements of the epoxy industry[1]. Deep eutectic solvents (DESs), characterized by their structure containing a hydrogen bond acceptor and donor, have garnered considerable attention in various fields[2]. Here, we propose a new type of curing agent based on deep eutectic solvents (DESs) using salicylic acid and N, N'-Bis(2-aminoethyl)ethane-1,2-diamine (commonly known as triethylenetetramine, TETA) and compared it to conventional TETA, and DESs derived from choline chloride in curing DGEBA epoxy resins. The physical stability of the formulated DESs was confirmed through polarizing optical microscopic analysis, demonstrating the absence of crystals or residues. Purity was validated via 13C NMR spectroscopy, while FTIR, 1H NMR, and mass spectrometry corroborated the formation of hydrogen bonds among constituents. Furthermore, the curing efficiency of the newly formulated DESs was investigated, and characterization via FTIR and DSC revealed distinct curing mechanisms, with DMA showing a 70% increase in storage modulus and an 85% increase in loss modulus compared to pure TETA. This advanced epoxy-hardener system paves a new way for high-performance epoxy resins.

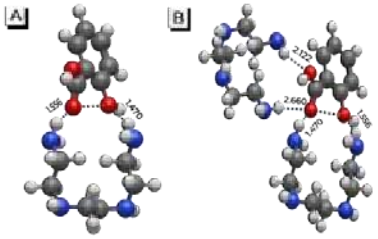

Figure 1. Geometrically Optimised structures of a) Salicylicacid/Triethylenetetramine(1:1) b) Salicylicacid/Triethylenetetramine(1:2) DES systems using B3LYP/6-31+G(D)* auxiliary basis sets using orca program. (All the bond distances are in Angstrom units).

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PB002

Enhancing Barrier Properties: Practical Analysis of Transport of Solvents and Gases in Natural Rubber/Graphene Oxide-Silica Core shell (GSC) Hybrid Nanocomposites.

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This work comprehensively explores the transport properties of natural rubber/graphene oxide-silica hybrid core-shell (NR/GSC) nanocomposites, with a focus on diffusion, sorption behavior, swelling parameters, and gas permeability. The study evaluates the performance of these composite membranes, revealing significant reductions in oxygen and nitrogen gas permeability by 71.3% and 68.48%, respectively. The influence of filler geometry and concentration on transport properties is meticulously analyzed. Experimental results elucidate the sorption behavior, swelling parameters, and transport coefficients of NR/GSC composites, providing valuable insights into their performance across different environments. Among various compositions, GSC10 emerges as the optimal formulation, demonstrating superior diffusion and gas permeability characteristics compared to other compositions. The study carefully dissects the impact of filler geometry and concentration on transport properties, enhancing the understanding of the relationship between filler characteristics and composite performance. Theoretical models predict that the Peppas-Sahlin model and the Affine model for mole percentage solvent uptake and molecular mass between successive crosslinks, respectively, best fit the experimental values. This work significantly contributes to thegrowing body of knowledge in nanocomposites, offering a detailed perspective on the transportproperties of NR/GSC membranes and underscoring the superior performance of the GSC10 composition.

PB003

Neurocompatible substrates using the blend of polycaprolactone (PCL) and polyvinylpyrrolidone (PVP) for peripheral nerve repair.

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Repair of peripheral nerve injury aims at reinstating the impaired motor and sensory functions, which is very challenging. Currently, regeneration strategies are applied to tackle this problem. Substrates with neurocompatible materials which can host the neuronal cells and channelize their growth, play the key part in nerve regeneration approach.

This study explores the potential of polycaprolactone (PCL) and polyvinylpyrrolidone (PVP) blends to create an optimal substrate for nerve regeneration. Polycaprolactone (PCL), chosen for its biocompatibility, serves as the substrate matrix with mechanical integrity. Blending it with a biocompatible, water-soluble polymer like poly(N-vinyl-2-pyrrolidone) (PVP) helps in tuning surface properties and degradation rates. PVP also serves as a sacrificial component in aqueous environment to produce porosities.

Characterization of the polymer blend compositions was done to explore the wettability (contact angle measurements), composition (FTIR), and microstructure (SEM). The sheets of optimized blends were subjected to the assessment of cytocompatibility and neurogenic potential using neuronal cell lines. Results indicate that the PCL-PVP blend scaffold significantly enhances the neuronal cell attachment and the proliferation compared to unmodified PCL scaffolds and tissue culture polystyrene (TCPS). Evidently, the new PCL-PVP substrate could be used as a scaffold in neuronal tissue regeneration.

PB004

Effect of Green Synthesised TiO_2 Nanoparticles on the Optical Properties of Chitosan/Aminated Starch Sustainable Blends

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Biobased polymer blends for advanced optoelectronic applications represents an innovative and sustainable approach in research.[1] Chitosan a natural polymer, and another biopolymer derivative, aminated starch, form a novel biopolymer blend system hitherto unexplored fully.[2-3] The combination of the polymers has been found to enhanced the biodegradability, thermal stability, and optical properties. Initially, titanium dioxide nanoparticles were green synthesised using lemon peel extract followed by its characterisation. FTIR, XRD, UV-visible, FE-SEM have been employed for the structural characterisation of the synthesised nanoparticles. Aminated starch blended with chitosan was later developed through solvent casting with better physiochemical properties and chemical compatibility, subsequently titanium dioxide nanoparticles were added to the optimised system. The effect of the addition of nanoparticles on the optical properties of the blend was duly analysed by UV-visible spectroscopy. The absorbance, optical band gap, extinction coefficient and optical conductivity were studied to analyse the effect of nanoparticles. The composites have been observed to exhibit favourable optical properties rendering them suitable for different optoelectronic applications. The biodegradation studies point out the sustainability of utilising the composites for advanced optical applications. The research contributes to the development of innovative biobased materials for fabricating optoelectronic appliances including flexible displays, sensors, and solar cells.

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PB005

Elastomer-based Vitrimers - Preparation, Characterization, and Applications

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Elastomers and rubber products hold prime importance in all aspects of modern society. However, the permanent cross-links of those polymers enormously block their frontier developments and restrain them from being reproducible and reshaped. In consequence, the majority of the waste materials become landfill and their incineration leads to serious environmental crises. An intense search to handle the hurdles of the permanent cross-linking system has begun long before and a new group of polymers known as vitrimers came out that works on the backbone of dynamic covalent networks (DCN). These exchangeable bonds give the polymer reproducibility, self-healing, and recycling abilities along with enhanced mechanical properties. Vitrimers can be developed from bioresources or petrochemical origins and various chemistries have been developed to formulate these polymers. Tremendous innovations have been employed in the area of elastomer-based vitrimers in recent years. The natural rubber-based vitrimers incredibly exceed the others in implementation and application segments as they developed from a bio-origin. Here our study enfolds the various types of elastomer-based vitrimers and focuses on their synthesis routes, characterization, property evaluation, and potential applications. The goal of this is to provide a comprehensive overview that combines the majority of elastomer-based vitrimers, their blends, and their potential future developments in a concise format.

MA001

Post-Processing Effects on Microstructure and Mechanical Properties of Wire Arc Additive Manufactured Mild Steel Plates.

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This study aims to examine the fabrication of a 150mm × 150mm mild steel plate through the Wire Arc Additive Manufacturing process. The plate was fabricated through layer-by-layer deposition utilizing a 12 mm diameter mild steel wire. The main objective of the work is to analyze the properties of the WAAM processed plate and to study the effect of post-processing on the variation in the microstructure and mechanical properties. The WAAM plates were cold rolled with different percentages of reductions. Initial macro and microstructural observations revealed the presence of porosities in the fabricated plate, which are diminished significantly through cold rolling. Increasing the rolling reduction to 10%, 15%, and 25% leads to enhancement in the interlayer properties and decrease in the porosity levels. Moreover, substantial improvements in strength are noted due to the cold working effects on the WAAM processed plate. Furthermore, the tension test samples were subjected to fractography analysis. The fracture behavior and identification of potential defects or failure mechanisms were conducted. Correlations between processing parameters, microstructural features, and mechanical properties were established.

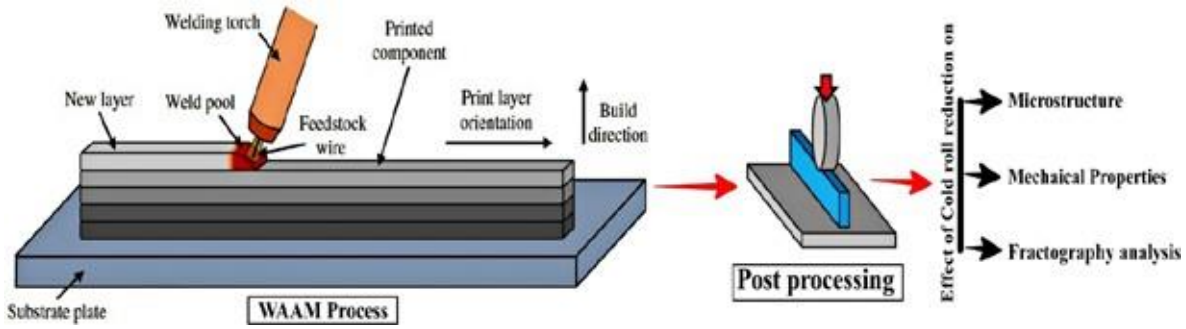

Figure 1. Methodology employed in the current study.

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MA002

NF3 Plasma Etching Process for Substrate Surface Treatment in Diverse Applications

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Plasma technology have various applications in the material processing. The utilization of NF3 plasma etching systems for metallic surface treatment has gained significant traction across a myriad of industrial applications [1]. This abstract provides a concise overview of the key aspects and applications of NF3 plasma etching systems in treating metallic/dielectric/semiconductor/conductor surfaces. RF glow discharge initiates electron generation, leading to ionization and dissociation, facilitating plasma deposition and etching. NF3 plasma enhances fluorination processes, crucial for etching silicon, molybdenum, tungsten and uranium substrates. The developed NF3 plasma system increases fluorine atomic concentration, benefiting semiconductor and nuclear industries. Experimental setup development, parameter characterization, and NF3 gas breakdown are discussed. Simulation of plasma fluorination and its impact on the etching process is also included [2]. NF3 plasma etching systems offer precise, sustainable solutions for substrate surface treatment, driving advancements in various fields. NF3 plasma etching systems represent a cutting-edge solution for metallic surface treatment across a wide range of applications. Their versatility, precision, and environmental sustainability make them indispensable tools in modern industry, facilitating advancements in technology, and sustainability.

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MA003

Study of correlation between prior β-grain size and tensile properties of β-quenched Zr-2.5%Nb alloy

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Tubes made of Zr-2.5Nb alloy in cold worked in stress relieved (CWSR) condition are used as Pressure Tubes (PTs) in Pressurised Heavy Water Reactor (PHWR) with design life of 30 years[1-3]. Alternate fabrication route for pressure tubes through heat treatment is being explored for Indian PHWR to imrpove in reactor peroperties of the PTs. For the development of heat-treated pressure tube, process parameters need to be tuned to achieve optimum microstructure and texture. In microstructural aspect, prior β-grain size is a very important factor in influencing the mechanical property of the material. In this study, the specimens of Zr-2.5%Nb alloy are exposed to different temperatures in β-phase region for varying soaking time. Very fast heating and quenching were performed to attain random texture. The prior β-grain size was measured by using optical microscopy. Tensile properties of heat-treated Zr-2.5%Nb specimens were studied at room temperature.

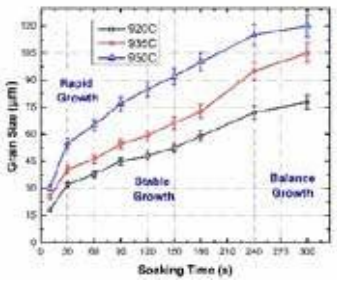

Figure 1: *Relationship between prior β-grain size and soaking time for β-phase region*[4]

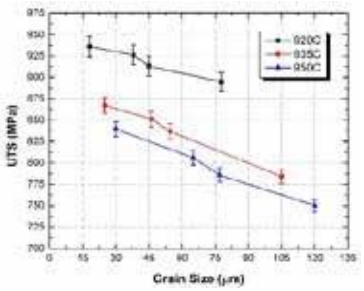

Figure 2: *Relationship between prior β-grain size and UTS*

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MA004

Influence of anodic oxidation on the surface morphology and electrochemical behaviour of oxide film on AZ31 Mg alloy

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In the present investigation, a facile electrochemical anodization process was performed to form a protective oxide layer on AZ31 Magnesium alloy using silicate based electrolyte. The influence of anodizing parameters such as applied potential and time on the final properties of the formed film was studied. The surface morphology and phase composition of the anodic film were analyzed using SEM and XRD studies respectively. The SEM micrographs evidenced the formation of anodized surface with different morphologies via different applied potentials. The adhesion strength of formed anodized layer on substrate was studied using pull Off adhesion test and the results indicated that the anodized specimens showed improved adhesion compared to substrate. The corrosion behaviour of anodized AZ31 Mg alloy was investigated by means of potentiodynamic polarization and electrochemical impedance spectroscopy analysis. The decrease in i_{corr} value observed for anodized specimens was attributed to the formation of protective magnesium oxide layer on the Magnesium surface. The results of electrochemical impedance spectroscopy studies in NaCl solution also have endorsed the structural changes occurred in the formed anodic film by the variation of applied voltage during anodization. The corrosion resistance of anodized magnesium alloy is remarkably improved by the anodization process.

MA005

Development of Sustainable Functional graded Metals with Solid State Ultrasonic Additive Manufacturing

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Solid State Ultrasonic Additive Manufacturing (SSUAM) is a groundbreaking technique that integrates additive manufacturing and ultrasonic welding to produce Dissimilar & Functional graded Metals. This method holds significant promise for advancing material sustainability due to its unique benefits. Unlike traditional additive manufacturing, SSUAM operates at relatively low temperatures, which minimizes thermal distortions and residual stresses, preserving the material properties. This low-energy process not only reduces the carbon footprint but also enables the use of a wider range of materials, including dissimilar and recycled ones, enhancing resource efficiency. Additionally, SSUAM's precise material deposition and minimal waste generation contribute to sustainable manufacturing practices. The ability to create lightweight, high-strength functional graded metals with intricate geometries supports the development of efficient structures in aerospace, automotive, and other industries, leading to reduced material consumption and improved fuel efficiency. Furthermore, SSUAM facilitates the repair and refurbishment of existing components, extending their lifecycle and reducing the demand for raw materials. As industries increasingly prioritize sustainability, SSUAM stands out as a transformative technology that aligns with global efforts to reduce environmental impact and promote sustainable development in manufacturing.

With this aim to achieve sustainable functional graded metals we are Developing Machine and Technology with solid state ultrasonic additive manufacturing in our research.

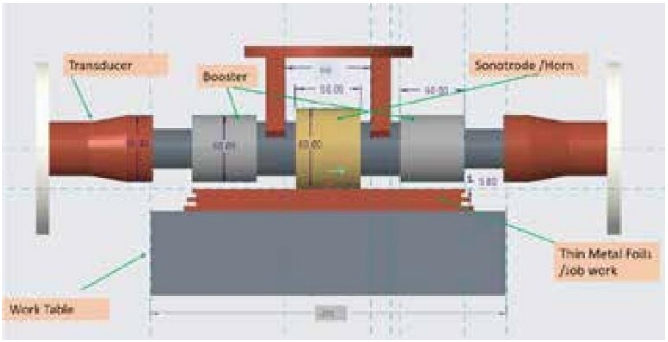

Figure 1. Design of Ultrasonic Sonotrode & Transducer

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