INTERNATIONAL CONFERENCE ON RENEWABLE ENERGY TECHNOLOGIES AND BIO SUSTAINABILITY (ICRETBS 2025)

MARCH 22-24, 2025

VENUE: HOTEL LE ROI, DIGHA, INDIA

BOOK OF ABSTRACT

ORGANIZED BY

CENTRE FOR EDUCATION INNOVATION AND ENTREPRENEURSHIP, KOLKATA

EDITORS

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CONTENTS

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ISBN Number: 978-93-342-2510-5

ISBN Number: 978-93-342-2510-5

After the grand success of the first edition of the International Conference on Renewable Energy Technologies and Bio Sustainability (ICRETBS-2025)" during **February 21-23, 2024 at Mahishadal Raj College, Mahishadal,** we felt very encouraged to organise the event on a regular basis for disseminating the most recent scientific discoveries to the rural and sub-urban science enthusiasts of Midnapore district in West Bengal. It is with this aim and to promote business with leisure, we thought that the second edition of the conference should be organised at a touristic place. It is indeed a great pleasure for me that the second **International Conference on Renewable Energy Technologies and Bio Sustainability (ICRETBS-2025)**" is scheduled to be held **during March 22-24, 2025 at Digha,** Purba Medinipur, WB, on the beautiful beach of bay of Bengal. I am particularly excited that the conference is being held at a place like Digha where people normally come for leisure. This international conference will bring together the beginners and the experts from across the nations working towards sustainable energy technologies and bio-sustainable solutions for the betterment of our future.

Today, the planet earth where we all live is facing major challenges due to rapid industrial development often conducted in an unscientific manner leading to damages to the nature earth and its natural resources including biological creatures. It is this reason that United Nations have identified seventeen sustainable development goals that the nations across the globe must work for. In this context, development of technologies for renewable energy harvesting without causing environmental pollution could strongly contribute towards bio-sustainability. The latest developments in bio-sustainable technologies are also to be disseminated for public awareness. This conference aims to provide an opportunity for participants to discuss and exchange ideas and thoughts and their findings on these growing challenges of the modern society.

On behalf of the organising committee, I express my sincere gratitude to all the members of the organising team as well as to all the student volunteers, invited speakers, and the delegates without whom this event cannot be successful. I firmly believe that the delegates and especially, students of schools and colleges will be greatly benefitted through interaction with eminent scientists and take home some sweet memories of the programme. Wishing you all a memorable and enjoyable ICRETBS-2025 at Digha.

Date: March 20, 2025

Prof. Amit K. Chakraborty,
National Institute of Technology Durgapur
Organizing Chair,
ICRETBS-2025

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I am honored to express my heartfelt satisfaction with the publication of the abstract book for ICRETBS 2025. This book encapsulates a diverse array of ideas, research, reviews, and experiences, emphasizing both industrial and academic endeavors in renewable energy technologies and biosustainability.

In the face of rapid global technological advancements, we are dedicated to continually upgrading and refining our policies in academia, research, consultancy, and industry collaboration to meet national needs. I extend my gratitude to NewRoute for establishing itself as a pivotal player in promoting renewable energy and biosustainability through various initiatives, including funded research, product development, and international conferences in collaboration with institutes and industries.

Our goal for ICRETBS 2025 is to inspire the scientific community and industry to actively engage in research, develop innovative concepts, and bring them to fruition. The conference aims to showcase the latest scientific breakthroughs while fostering a global network of researchers and engineers committed to advancing energy systems. I sincerely hope that all participants will transform their ideas and visions into clean technologies that significantly contribute to the betterment of humanity, paving the way for a sustainable and energy-efficient future.

Date: March 20, 2025

Goutam Kumar Dalapati

Dr. Goutam Kumar Dalapati
National University of Singapore, Singapore
Co-Chair
ICRETBS 2025

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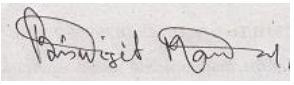
Candlelight represents an oath that must be upheld, which calls for a fuel source. I believe that if we have our own energy resources and technology, we will truly be free. We are all aware that the availability of energy sources drives and influences the global economy. The ongoing use of fossil fuels has resulted in resource depletion and serious environmental effects, which have sparked a growing interest in renewable energy sources and the pursuit of sustainable energy policies. Building a sustainable, dependable, and attainable energy system requires a global, interconnected endeavor. Both industry and the scientific community must do research, develop new ideas, and put them into practice. Presenting the latest scientific findings is the goal of the International Conference on Renewable Energy Technologies and Biosustainability (ICRETBS-2025). Its goals are to demonstrate the evolution of energy systems and to create a global network of engineers and researchers. I sincerely hope you will transform your thoughts and vision into a clean technology that will drive human progress. The following quote aptly captures the need for conference organization:

"If we both exchange one rupee,
We have one rupee.
But if we both exchange one good thought,
We have two good thoughts"



Dr. Biswajit Mandal
Haldia Institute of Technology
Organizing Secretary
ICRETBS 2025

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Dear Distinguished Delegates, Eminent Speakers, and Esteemed Guests,

It is my pleasure to welcome you to the **2nd International Conference on Renewable Energy Technologies and Bio Sustainability (ICRETBS-2025),** organized by the Center for Education Innovation and Entrepreneurship (CEIE), Kolkata.

As the Organizing Secretary, I am thrilled to see the overwhelming response to this conference, which brings together experts from academia, industry, and research institutions to share their knowledge and experiences in the fields of renewable energy and sustainable biotechnology.

Over the three days, we have an exciting lineup of keynote speakers, technical sessions, and poster presentations that will delve into the latest advancements and innovations in these fields. This conference provides a unique platform for networking, collaboration, and knowledge sharing, and I am confident that it will be a enriching experience for all of us.

I would like to extend my sincere gratitude to our keynote speakers, technical committee members, and sponsors for their support and contributions to this conference.

I look forward to seeing you all at ICRETBS-2025!

Date: 22nd March, 2025

Best regards,

Dr. Avijit Ghosh
Heritage Institute of Technology
Department of Chemical Engineering
Organizing Secretary
ICRETBS-2025

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Energy Saving strategies for water treatment processes: A survey of literature

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Abstract

The fundamental humanitarian objective is to provide everyone with access to affordable, clean water. But in the twenty-first century, this has become extremely difficult due to population growth, urbanisation, irrational exploitation of water resources for various anthropogenic activities and rapid industrialization. Gradual shift from conventional waste water treatment process like coagulation, sedimentation to the latest practices like membrane separation, electrodialysis was observed which aim to increase rate as well as energy efficiency of the processes. Urbanization will inevitably result in an increase in the volume of waste water and the energy needed to treat and manage it. Additionally, it is estimated that large quantity of India's wastewater is treated with energy-intensive, outdated pumping and electromechanical equipment. Reducing energy demand and consequent municipal spending requires a focus on energy efficiency and waste water management. In a time when environmentally friendly practices are becoming more and more vital, water utilities are crucial to preserve the supply of clean water for businesses, communities and agriculture. For precise use of water it is becoming a trending practice to use sensor based plumbing, energy efficient pumps and IoT enabled devices. Moreover new water treatment processes involving renewable energy sources can also be adopted on the basis of energy efficiencies. This paper narrates about the gradual development of water processing technologies on the fundamental aspect of energy usage and sustainability of the processes.

Keywords: Renewable energy, IoT, Waste water treatment, Sustainability, water utility.

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Magnetic CoffeeBots: Pioneering Sustainable Practices in Water Decontamination

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Abstract

Recent research has concentrated on tackling the substantial obstacles presented by water contaminants that are harmful to both public health and aquatic environments. Conventional approaches for eliminating these pollutants encounter numerous difficulties. In our response, we propose a new method that involves creating magnetic microrobots known as "CoffeeBots" from used coffee grounds. These CoffeeBots are intended to effectively remove oil, organic dyes, and microplastic pollution from seawater. The core of their operation involves the integration of iron oxide nanoparticles, which give the microrobots magnetic capabilities. This facilitates controlled movement, microswarm formation, and easy retrieval post-purification. The CoffeeBots production adheres to green chemistry principles, ensuring an environmentally friendly, high-yield, and cost-effective process. Their inherent hydrophobicity effectively captures and eliminates oil and microplastics. Furthermore, the CoffeeBots have been equipped with ascorbic acid to effectively eliminate methylene blue dye, for environmental pollution management. The reusability of these microrobots highlights the sustainable aspect of this technology, advocating for environmentally friendly solutions for clean-up. In summary, our research with CoffeeBots is enabling the nanotechnology revolution by demonstrating innovative, sustainable, and effective applications of nanomaterials in environmental remediation, aligning with the broader goals of advancing technology while ensuring environmental sustainability.

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Polyphenol induced green synthesis of mono, bi and tri-metallic nanoparticles: Its anti-microbial and anti-cancer activity

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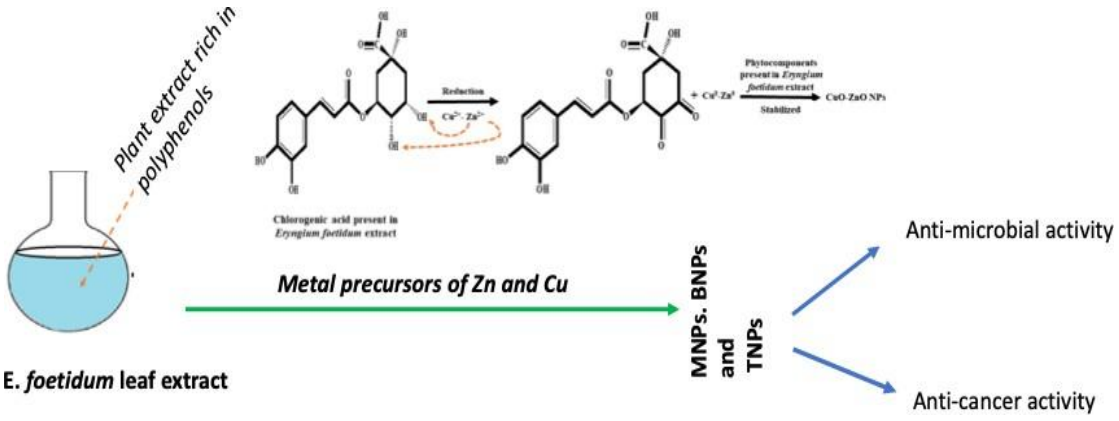
Abstract

Plants are rich in anti-oxidant activity and the leaf, stem, root, seed are generally identified by various polyphenolic compounds. Polyphenols contain -OH and -COOH groups; are responsible for the capping reaction of metal precursors to metallic nanoparticles. Herein, *E. foetidum* is a leafy vegetable widely available in north eastern region of India, was used for preparation nanoparticles. The plant is rich in polyphenols viz., chlorogenic acid, quercetin, luteolin hexoxide, luteolin glucuronide etc. The involvement of these polyphenols in the green synthesis of monometallic, bimetallic (CuO-ZnO) and trimetallic (Cu-Zn-Pt) nanoparticle (MNPs, BNPs, TNPs) were confirmed with reverse phase HPLC method. Spherical, elliptical and rod-shaped MNPs (CuO & ZnO), BNPs (CuO-ZnO) and TNPs (Cu-Zn-Pt) were synthesized respectively. Good anti-microbial activities were observed against both gram +ve and gram -ve bacteria with increasing order of anti-microbial activities of MNPs< BNPs< TNPs. Appealing anti-cancer activities against breast cancer cell lines were observed with inhibition rate of 89.20 % with 0.5 g/L BNPs (CuO-ZnO NPs). Good cytotoxic effect against HeLA cell line (for cervical cancer) and MCF-7 cell line (for breast cancer) were observed with Cu-Zn-Pt TNPs.



Keywords: Monometallic, bimetallic, trimetallic, cancer, polyphenol

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Carbon Capture using pH Swing Technology

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Abstract

The increasing carbon dioxide (CO_2) concentration in the atmosphere is a great threat to the greenhouse emission. Therefore, the reduction of CO_2 in the environment is very much essential to prevent further damage. The research on carbon capture and its utilization has taken much attention in the scientific community due to the sustainable development goal towards carbon neutrality in 21st century. Carbon dioxide concentration in the atmosphere can be reduced by increasing CO_2 fixation. The pH swing capture is very effective method for CO_2 capture. The principle of pH swing was implemented to observe how much carbon dioxide gas can be captured using various acids and bases, without the involvement of any external factors such as pressure and temperature. Both strong and weak acids were used to observe which kind of acids provide efficient carbon capture. The aim of this research is mainly based on finding suitable chemical reactions using a metal hydroxide sorbent for effective carbon capture, keeping in mind zero to negligible effects on the environment. The literature review stated that maximum of 35% efficiency can be reached using the pH swing principle. However, this research shows that for both strong and weak form of acids, more than 75% efficient carbon capture was being able to reach which makes it a suitable sustainable technology to capture carbon. The entire research was carried out under ambient conditions i.e., room temperature and ambient pressure, therefore making the entire process economically efficient.

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Efficient energy conservation methods for sustainable future: a case study on energy conservation at a public organization in Kerala

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Abstract

Energy conservation aims to minimize system losses, both direct and indirect, by adopting alternative sources and optimizing energy usage. Strengthening energy access, reducing energy costs, and transitioning to a low-carbon society are crucial for achieving energy security and sustainable economic growth. In this work, we have implemented renewable and sustainable energy solutions at Vaidya Ratnam P.S. Varier Ayurveda College, Kottakkal, Kerala, to reduce overall electricity consumption. Initially, the institution consumed a huge amount of conventional energy 264240 kWh annually. To address this, we have installed a biogas plant with a capacity of 40 m^3, two solar power plants, 10 kW and 2 kW capacities, rain water harvesting tanks having total capacity of 24 lakh liter, water effluent treatment plant capacity of 1.5 lakh liter, and well recharging along with energy-efficient LED lighting, BLDC fans, VFD in root blowers in water treatment plant, solar water heaters, replacement of mechanical filter pumps with automatic filter pumps, power factor adjustment, eco-friendly building construction, and optimized electrical load distribution. After implementing the conservation activities, the energy consumption of the institute has reduced to 230073 kWh and it leads to an annual savings of 34167 kWh units. These interventions significantly reduced grid electricity dependency by 12.93 %. Additionally, biogas plants contributed to sustainable waste management as it reduced carbon emission and the usage of 3240 Kg of liquified petroleum gas. The water effluent treatment plant improved water recycling and further reduced operational costs of the plant. The modifications were systematically implemented across key infrastructure, including the hospital, hostels, library, yoga center, academic block, administrative office, effluent treatment plant, canteen, postgraduate blocks, auditorium, and kitchens. Beyond cost savings, these initiatives contributed to a 763.82-ton reduction in the institution's carbon footprint per year, aligning with global sustainability goals. This study highlights the importance of integrating conventional and renewable energy systems for economic viability and environmental responsibility. The findings serve as a model for similar educational institutions aiming to transition toward sustainable energy solutions.

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Interfacial engineering of flexible perovskite solar cells using LiF for enhanced efficiency and stability

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Abstract

Flexible perovskite solar cells (PSCs) have attracted significant attention as a promising candidate for a transferable and wearable device. A low-temperature processed electron transport layer (ETL) is essential for the fabrication of flexible PSCs. Aluminum-doped zinc oxide (AZO) was recognized as an excellent electron transport layer (ETL) for the fabrication of planner PSCs due to their higher conductivity, mobility, stability, and good energy level alignment with the perovskite materials. In fact, the AZO layer can act as a protective layer for p-i-n-structured PSCs due to their high thermal and chemical stability. However, there could be some issues at the perovskite/AZO interface in this p-i-n structured PSC. This solution-processed AZO layer can cause damage to the perovskite layer in the device. To overcome these issues, we have used a thin LiF interfacial layer before the deposition of the AZO layer, which may act as a protective layer as well as an efficient hole blocker. In this study, we have fabricated flexible PSCs by introducing LiF at the perovskite/AZO interface with a device architecture of PET/ITO/PTAA/Perovskite/LiF/C_{60}/AZO/Ag. The incorporation of LIF at the interface improved the PCE of the device from 12.11% to 16.35% and from 7.68% to 9.29% over small and large areas, respectively. The devices with LiF also showed magnificent environmental stability without encapsulation and retained their 70% efficiency after 2000 h. This improvement can be attributed to efficient electron extraction and reduced charge recombination at the interfaces. Regarding flexibility, the devices retained their PCE even after 1000 bending cycles, demonstrating excellent mechanical stability. Our approach established that the thin interface layer of LiF could be an effective way for the fabrication of low-cost, high-performance, and stable flexible perovskite devices.

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Investigation on structural, electrical, magnetic, and optical properties of $Zn_{0.3}Ni_{0.7}O$@ZnO ($Zn_{1.3}Ni_{0.7}O_2$) composite Oxide

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Abstract

The current work emphasizes synthesizing and characterizing $Zn_{0.3}Ni_{0.7}O$@ZnO ($Zn_{1.3}Ni_{0.7}O_2$) composite oxide. A comprehensive set of investigations was conducted to investigate the synthesized nanoparticle's structural, optical, electrical, and magnetic properties. X-ray diffraction (XRD) studies confirmed the presence of ZnO and $Zn_{0.3}Ni_{0.7}O$. Scanning electron microscopy (SEM) revealed irregular microstructures, and the average crystallite size and lattice strain, calculated using the Williamson–Hall (W–H) equation, were found to be 148 nm and 0.0015, respectively. Magnetic measurements displayed a soft ferromagnetic behaviour with a narrow hysteresis loop at 10, 77, 120, and 320 K. AC conductivity measurements indicated frequency-dependent conductivity between 300–573 K, governed by thermally activated hopping of Ni^{2+} electrons. Activation energies of 0.038 eV (300–453 K) and 0.348 eV (483–573 K) were determined from DC conductivity. Dielectric studies showed a higher dielectric permittivity (ε') at 573 K compared to 300 K at low frequencies, attributed to dipole, electronic, ionic, and orientational polarization. Dielectric loss (ε'') was explained by Maxwell–Wagner's two-layer model based on Koop's theory, with activation energies of 0.357 eV and 0.038 eV and relaxation times of 2.85×10^{-6} s and 6.2×10^{-3} s at high and low-temperature regions, respectively. Diffuse reflectance spectroscopy (DRS) revealed absorption bands at ~418 and ~740 nm due to Ni^{2+} in octahedral coordination, ~674 nm for Ni^{2+} in tetrahedral coordination, and ~467 nm for Ni^{3+} in octahedral sites, elucidating the optical properties of the material.

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Enhanced photoelectrochemical water oxidation of Surface engineered SnWO4/ CoFeMOF photoanodes

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Abstract

Ternary metal oxides are being well studied for their suitability as photoelectrodes in photoelectrochemical (PEC) water splitting. Among various binary and ternary oxides, tin tungstate (SnWO4) based photoanodes have gained a lot of interest due to its favourable band edge positions, band gap (~1.9 eV), and high theoretical photocurrent density ~17 mA.cm-2. However, surface charge carrier recombination due to intrinsic defects and slow surface water oxidation kinetics limit PEC water oxidation performance of the photoanodes. In this work, we have fabricated nanoplate shaped SnWO4 photoanode by converting as prepared WO3 through hydrothermal method. The surface of the photoanode is modified by Cl-doping using spin coating technique. This led to passivate the intrinsic defect states in Cl-modified SnWO4. A uniform thin bimetallic CoFe metal organic framework (MOF) as a catalyst layer was fabricated on Cl-SnWO4 photoanode by dip coating technique. The incorporation of the CoFe MOF on Cl-SnWO4 photoanode significantly improved photocurrent density in the PEC water oxidation process. The photocurrent density of CoFe MOF/Cl- SnWO4 photoanode reached to a value of 2.2 mA.cm-2 at 1.23 V versus reversible hydrogen electrode (RHE) recorded under AM 1.5G radiation and that was ~1.4 times higher than SnWO4 photoanode (1.6 mA.cm-2 at 1.23 VRHE) and 1.1 times higher than Cl- SnWO4 photoanode (1.9 mA.cm-2 at 1.23 VRHE). Similarly, the applied bias photon to current efficiency (ABPE) value of CoFe MOF/Cl- SnWO4 photoanode reaches to 0.38%, which is ~1.7 times higher than SnWO4 photoanode (0.22%). The CoFe MOF incorporation in Cl-SnWO4 photoanode recorded one onset potential and that was cathodically shifted when compared to ClSnWO4. Similarly, the flat band potential also shifted negatively for CoFe MOF/Cl- SnWO4 photoanode which signified the band bending at the electrode/electrolyte interface for enhanced hole transfer. This was further validated by reduced charge transfer resistance from Nyquist plots. The photocurrent density vs time analysis also helped to confirm the enhanced lifetime of charged carriers after incorporation of CoFe MOF in Cl- SnWO4 photoanode. The open circuit potential (OCP) was also conducted to explore the surface photovoltage generation in the photoanodes. For CoFe MOF/ClSnWO4 photoanode showed significantly enhancement in ΔOCP which revealed increased in charge separation and reduction in recombination. This work provides an in-depth study on enhance charge separation and transfer through surface engineering for boosting PEC performance of CoFe MOF/ClSnWO4 photoanode for solar hydrogen production

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Production, Performance, Combustion and Emission Characteristics for Argemone Mexicana Oil Blends (B20, B40 AND B60) at Constant Compression Ratio of 17.5 in CI Diesel Engine

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Abstract

Biodiesel is a promising substitute as an alternative fuel, which has gained significant attention due to the predicted shortness of conventional fuels and environmental concern. The utilization of liquid fuels such as biodiesel produced from ARGEMONE MAXICANA by transesterification process represents one of the most promising options for using conventional fossil fuels. The Argemone Maxicana oil is converted into Argemone Maxicana oil methyl ester known as biodiesel, prepared in the presence of a homogeneous acid catalyst. The physical properties such as density, flash point, kinematic viscosity, Cloud point, and Pour point were found for Argemone Maxicana oil. The same performance, combustion, and emission study were carried out for bio-diesel and the diesel fuel for obtaining the baseline data for analysis in a compression ignition engine at a constant compression ratio of 17.5. Performance parameters like BSFC, BTHE and EGT are better than diesel. According to combustion parameters like maximum cylindrical pressure, rate of pressure rise, NHR, CHR and MBF, we got most promising values for bio-diesel. Bio-diesel emits fewer amounts of CO, CO_2, and HC in comparison to diesel. The values obtained from the Argemone Maxicana methyl ester are closely matched with the values of conventional diesel and can be used in the existing diesel engine with or without any modification.

Keywords: compression ignition engine, compression ratio, BSFC, BTHE, NHT, CHT.

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Porous media combustion for internal combustion engine: A brief review on recent advances

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Abstract

Human race became civilized when they started learning how to use fire. For ages combustion is used as major source of energy for small scale to large scale applications. Combustion systems are needed from cooking stove to rockets and missiles. Combustion systems has been subjected to all possible ways of modification since the human civilization realized that combustion leads to pollution and the resource of fuel is limited. Optimum utilization of fuel leads to energy security and economic prosperity for a nation.
Combustions systems are mainly of two types internal and external. Internal combustion systems are used in engines that finds various application such as automotive, locomotive ships etc. External combustion is used in stove, burners etc. Porous ceramic-based burner technology for external combustion systems is widely used engineering systems that are efficient, durable and cost effective. Porous media enhance combustion efficiency by enhanced heat transfer and uniform flame stabilization.
Porous media combustion eventually results in less NO_x and CO emission in IC engine. However, till date the brake thermal efficiency reported remains inferior to conventional system as there is a loss of combustion space due to introduction of porous media in a conventional IC engine. Porous media IC engine can be more efficient if some critical design challenges are overcome which facilitate controlled turbulent air fuel mixing or a better material becomes available at a cheaper rate than silicon carbide to fabricate the porous media.

Keywords: Combustion, Porous media, Ceramic based burner, Artificial Neural Network.

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Removal of heavy metal ions by char doped kaolin membrane

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Abstract

Heavy metal ions are non-biodegradable, possess toxic effects and can cause various disorders in human bodies such as lung problems, chronic kidney disease and even cancer making their removal from wastewater a crucial step in the treatment of the effluent released from factories. Membrane ultra-filtration is a leading-edge technology used in waste water management where a 'sieving mechanism' is used to separate dissolved contaminants from the feed under a pressure gradient, by retaining them on the membrane surface. In recent times, ceramic membrane technology has started gaining importance in the Effluent treatment sector owing to several advantages. Our work focuses on the fabrication of a cost-effective ceramic membrane to be utilized in the separation of heavy metal ions present in the wastewater discharged from various industries. By using kaolin, a naturally and easily available and highly porous alumino-silicate and char synthesized from waste polyethylene terephthalate (PET) bottles, we have come up with a relatively cost-effective way of sourcing raw materials used in the fabrication of ceramic membranes. Traditionally used polymeric membranes suffer from drawbacks such as low mechanical and thermal stability, shrinkage in water and are not abrasion resistant. Such drawbacks can be overcome by using ceramic membranes having higher chemical stability due to their compact crystalline structure, higher mechanical strength, longer shelf life and better performance. They also exhibit better thermal resistance owing to the presence of strong bonds between their atoms. Filtration of the aqueous solution of heavy metal ions through char doped kaolin membrane has yielded satisfactory results. The freshly synthesized disc shaped char-doped kaolin membrane has a porosity of 42% and when de-ionized water was passed through the membrane over a given period of time at an elevated pressure of 20 psi, it exhibited a flux equal to 5.6714×10^{-5}ml/m^{2}s. This displays the prospect of the use of low-cost clay membranes as a selective barrier that effectively treats wastewater by filtering out dissolved solids.

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Global Waste Management using AIML and IoT

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Abstract

Efficient waste management is pressing global challenge as urbanization accelerates and waste generation rises. This project proposes an AI-driven global waste management system that integrates IoT sensors, Machine Learning (ML), and robotic automation to revolutionize traditional waste handling processes. IoT sensors installed in waste bins monitor fill levels, enabling real-time data collection routes, reducing operational costs and carbon emissions. Robotic systems equipped with advanced image recognition use deep learning models like Convolutional Neural Network (CNN) to automate waste segregation, ensuring effective recycling and reducing landfill dependency by leveraging cutting edge technologies, this system promotes sustainability and environmental conservation. The project provides a userfriendly analytics dashboard to visualize data and monitor performance metrics ,while a notification module ensures timely alerts for waste collection items. This innovative solution not only optimizes waste management processes but also aligns with global efforts to minimize ecological impact and achieve longterm sustainability goals.

Keywords: convolutional neural networks, robotic automation, IoT sensors .

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Robust Nb-Ni_3S_2 catalysts for Alkaline Water electrolysis for green Hydrogen Production at industrial scale current densities

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Abstract

Currently, considerable attention has been captivated for development of robust and energy-efficient nano-catalytic network for industrial scale hydrogen production through water electrolysis. Herein, we developed electronically optimized Nb-Ni_3S_2 catalysts synthesized by one-step hydrothermal technique for water electrolysis. The grown self-supported catalysts were characterized by powder XRD, EDS, Raman spectroscopy and SEM. The grown catalysts were explored for hydrogen evolution and oxygen evolution reaction in alkaline electrolyte. The bi-functional electrolyzer using Nb-Ni_3S_2 catalysts are capable of generating the green H_2 and O_2 at industrial scale current densities (>300 mA/cm^2). Encouragingly, Nb-Ni_3S_2 catalyst exhibits the stabile catalytic performance at 300 mA/cm^2 over time interval of 100 hr. Over all, optimized electronic charge distribution on Nb-Ni_3S_2 catalysts and synergistic effect leads to enhanced catalytic performance for water electrolysis.

Keywords: Nb-Ni_3S_2 catalyst; Water splitting; Hydrothermal Technique.

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Smart Energy Meter Integrated with Residual Current Circuit Breaker with Overcurrent Protection (RCCBOC) to Improve Power Grid Stability

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Abstract

Power distribution networks are under a lot of stress due to the fast urbanization and increasing demand on electrical energy, which frequently results in grid instability, transformer failures, and power outages. Traditional energy meters lack real-time monitoring and adaptive control, making it difficult to prevent overload conditions and efficiently manage power distribution. To address these challenges, modern smart metering solutions are being developed to enhance grid reliability, improve power management, and ensure consumer safety. This paper presents a Smart Energy Meter integrated with Residual Current Circuit Breaker with Overcurrent Protection (RCCBOC) to enhance grid stability through automatic load shedding and real-time monitoring. The proposed system continuously monitors voltage, current, power factor, and load conditions to detect overloads, overcurrent events, and leakage currents, ensuring proactive fault prevention. The smart meter prevents transformer overloading and lowers the chance of major outages by immediately disconnecting selective non-essential loads when power usage is too high. The system makes use of AI-based demand prediction to maximize load balancing and IoT connectivity for real-time data transfer. By integrating residual current protection, overcurrent detection, and remote-control capabilities, the proposed system ensures safe, stable, and efficient energy distribution.

Keywords: Smart Energy Meter, RCCBOC, Grid Stability, Automatic Load Shedding, Overload Protection, IoT, Smart Grid.

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Alternative protein: modification and application in the food system

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Abstract

Alternative proteins for inclusion in new food products are one of the most widely discussed topics in food science. Unconventional proteins are gaining popularity worldwide because of their health benefits, environmental sustainability, and ethical merit. Thus, the study aimed to use whey protein isolate and pea seed protein in the food system. The whey protein isolate and pea seed protein were modified and used in the food system. Both the protein isolates were modified in the presence of natural deep eutectic solvents. The modification of the whey protein isolate and pea seed protein enhances the desired quality, namely thermal properties, emulsification behaviour, and rheological characteristics. The surface tension, thermal stability with high conductivity, and foam stability of the protein also improve in the presence of NADES. The sugar-based NADES significantly improved the protein properties and made them suitable for the food system. Modified whey protein is used as an egg protein replacer in bakery products, whereas modified pea seed protein is used to develop meat analogies. The study demonstrated various approaches to modify the alternative protein and its application.

Keywords: Protein; Whey protein isolate, pea seed protein, egg protein replacer; meat analoges

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Exploring the Potentials of Hybrid Renewable Energy Systems-A Review

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Abstract

The rapid industrial growth and increasing population leads to huge global energy consumption which in turn produces an energy crisis. In order to meet this huge energy demand, various fossil fuels are used which again leads to environmental pollution. Therefore, to meet the environmental sustainability various renewable energy sources such as solar, wind, geothermal, etc have been explored. These energy sources reduce greenhouse gas emissions. There are many applications of such technologies such as, electric cars, electric heating systems etc. In this study, the potential implications of various hybrid renewable energy (HRE) systems are explored in details where two or more renewable energy sources are used together to produce energy. One of the major advantages associated with using the HRE systems are when one energy system doesn't work well due to some factors then the other system may act. For example, we can say that the wind turbines generally can't produce energy when there not sufficient wind speed but the solar power system can work well if it's a sunny day. The generated energy through HRE systems can be stored in various ways. But the major disadvantage associated with this system is high energy installation costs especially in rural areas.

Keywords:
Hybrid Renewable Energy (HRE); Energy Consumption; Energy Crisis; Environmental Pollution; Environmental Sustainability.

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Functionalized Graphene Based Electrocatalyst from Graphite Sources Of Arunachal Pradesh For Sustainable Hydrogen Production

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Abstract

The global shift towards renewable energy has intensified interest in hydrogen production, with electrocatalysis emerging as a viable option. While platinum-based catalysts are extremely efficient, their high cost and scarcity have prompted the search for alternatives such as reduced graphene oxide (rGO), which has a high electrical conductivity, defect rich structure, tunable surface chemistry, strong catalytic support, large surface area, durable, and is cost effective. The addition of silica in rGO enhanced the mechanical stability, which prevents graphene agglomeration. In the present study, rGO was synthesized from the graphite sources of Tai region, Arunachal Pradesh, which naturally has <10% fixed carbon and more than 80% silica. The current work aims to optimize the reduced graphene oxide-silica (rGOS) composite for improved electrochemical characteristics in the hydrogen evolution reaction. Graphite sources have been extensively characterized using sophisticated techniques such as XRD (Fig.1), FTIR (Fig.2) Raman spectroscopy (RS) (Fig.3), XPS (Fig.4) to examine its structural and compositional properties.

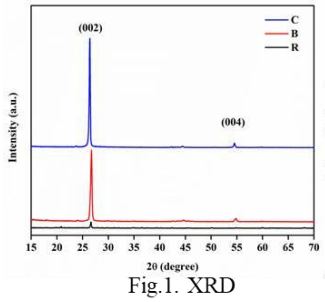

Fig.1. XRD

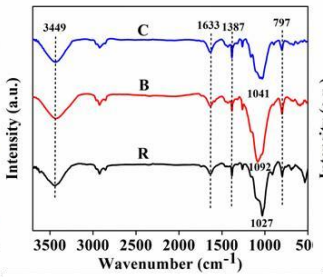

Fig.2. FTIR

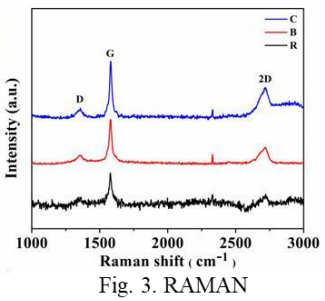

Fig. 3. RAMAN

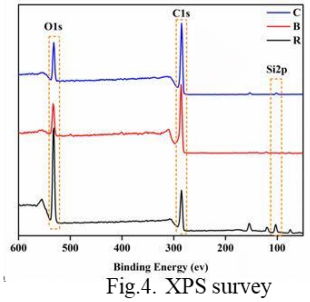

Fig.4. XPS survey

The synthesized rGOS was further characterized using XRD (Fig.5.), which revealed a highly crystalline structure and Raman spectroscopy (RS) (Fig.6.) complements XRD by identifying defects, disorder, and functional groups in the material. TGA (Fig.7.) was performed to analyse the stability of the material.

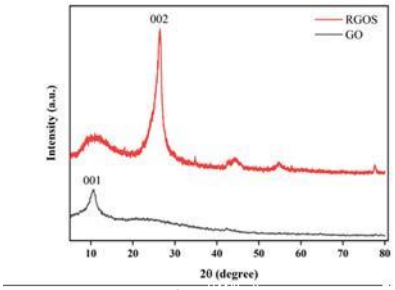

Fig. 5. XRD

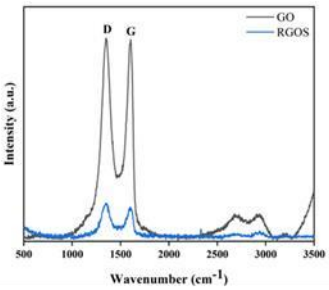

Fig. 6. RAMAN

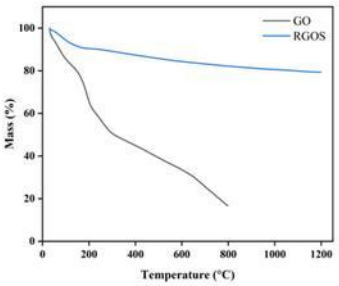

Fig. 7. TGA

The findings validate the successful synthesis of rGOS composites and provides a potential, effective and economical alternatives to platinum-based catalysts due to their abundance, attractive electrochemical properties, and the structural robustness provided by silica.

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Computational Identification of Heavy Metal(s) Resistance Genes in a Novel Lysinibacillus Variant: Bioremediation Potential

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Abstract

Heavy metal resistance in bacteria is crucial for bioremediation, requiring the identification of genetic determinants linked to metal resistance. This study aims to identify and characterize the genetic basis of heavy metal resistance in a novel variant strain of Lysinibacillus sp., utilizing bioinformatics tools for a systematic analysis of resistance genes and their functional annotations. This research provides the first comprehensive genomic investigation of heavy metal resistance in this newly identified Lysinibacillus sp. variant. A computational pipeline using Python 3.8, Biopython, and Entrez API systematically searched GenBank and the NCBI Protein Database, offering a rapid and cost-effective alternative to traditional experimental screening. Searches targeting arsenic, lead, mercury, cadmium, and chromium resistance genes revealed diverse resistance mechanisms, with strong responses to cadmium and chromium. Cadmium resistance genes (cadA, mt, and sod) and chromate resistance genes (chrR, chrA, yieF, and nemA) were identified. Arsenic resistance was conferred by arsC, though aox was absent. Lead resistance was mediated by mt and phoN, but pbrA/B were undetected. Mercury resistance was conferred by merA, while merB, merT, and merP were absent. These findings highlight this Lysinibacillus strain as a strong candidate for bioremediation. Future validation should integrate of computational approaches already validated in case of arsenate reductase activity.

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Synthesis of silver doped zinc oxide / magnesium oxide nanoparticles and its adsorptive studies on removal of congo red dye

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Abstract

The present study, aims to exploit the experimental determination of biosorptive characteristics of synthesized silver doped zinc oxide/ magnesium oxide nanoparticles (Ag doped ZnO/MgO-Np's) with leaf extract. Synthesized Ag doped ZnO-/MgONp's were characterized by SEM, XRD FTIR and EDX analysis. The resultant nanoparticle size obtained is 122nm. The process variables such as Agitation time, Initial concentration of CR dye, pH, Dosage of Ag doped ZnO/MgO-Np's and Temperature were performed and compared by using response surface methodology (RSM). At the optimized parameter conditions, the dye adsorption was studied from Isotherms, Kinetics and Thermodynamics, respectively. At the optimized conditions, maximum removal (94.3%) of CR dye obtained. It was found that the Freundlich-isotherm, pseudo second order kinetics fitted the data better as compared to other isotherm and kinetic models. The results of thermodynamic studies exhibit the exothermic nature, thermodynamically feasible nature of adsorption.

Keywords: Congo red, Ag doped ZnO/MgO-Np's, Isotherms, Kinetics, Thermodynamics.

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An extensive study on the hybrid system that integrates smart nanomaterials with renewable energy sources for sustainable wastewater treatment

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Abstract

Contaminated wastewater, particularly in developing nations, poses significant risks to ecosystems and human health. This review emphasizes the transformative role of smart nanomaterials in improving wastewater treatment (WWT) through advanced techniques such as adsorption, nanofiltration, photocatalysis, disinfection, sensing and monitoring. Notably, zero-valent metals and metal oxide nanoparticles, especially iron oxide, demonstrate superior efficiency in heavy metal removal compared to conventional carbon nanotubes[1]. Various smart nanomaterials like graphene-based nanomaterials (GBnMs) including polymeric metals, zeolite, Self-Assembled Monolayers on Mesoporous Supports (SAMMS), and biopolymer nanoparticles like chitosan, alginate, and polyhydroxyalkanoates (PHAs), are examined for their applications in WWT processes[2,3]. Photocatalytic nanomaterials, such as Bio-Char composites with TiO_2, ZnO, and spinel ferrites, effectively degrade organic pollutants into harmless byproducts[4,5]. The integration of semiconductor photocatalysis with membrane filtration, utilizing green-prepared TiO_2 and MnO_2 nanoparticles, leads to innovative water purification systems, which removes 98% humic acid from synthetic wastewater under sunlight[6]. Furthermore, renewable energy sources, like solar energy, can power pumps and aeration systems in WWT while facilitating photocatalytic reactions[7]. Despite commercialization challenges, this review highlights the potential of a sustainable hybrid system integrating smart nanomaterials with renewable energy sources that offers a cutting-edge solution for sustainable wastewater treatment and promotes global access to clean water.

Keywords: Smart nanomaterials, wastewater treatment, hybrid system, membrane purification, renewable energy

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Role of Surface Morphology on Electrochemical Performance of Ni-Co Alloy Films for Hydrogen Evolution Reaction

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# Equal Contribution

Abstract

Nanostructured Ni-Co alloy films are electrodeposited on copper substrates. Before electrodeposition, the surface of copper substrates is altered by etching, roughening, and polishing. The etched copper substrate results in the deposition of Ni-Co micro-spheres. While nanosized, spherical particles of irregular shape are obtained in the roughed and polished copper substrate. Structural analysis (XRD pattern) confirms that all three substrates show face-centered cubic (FCC) phase deposition of the Ni-Co alloy. Among the three samples, Ni-Co alloy film deposited on an etched copper substrate shows the lowest overpotential value of 221 mV vs. RHE for hydrogen evolution reaction. The porous surface morphology and nano-size particles of Ni-Co alloy film deposited on an etched copper substrate led to a higher active surface area, which rendered a better hydrogen evolution reaction. EIS measurement during the HER process revealed that Ni-Co alloy film deposited on etched copper substrate exhibited a significantly lower resistance than smooth and rough surfaces. High corrosion resistance is measured in Ni-Co alloy deposited on a polished copper substrate.

Keywords: Alloy based electrode, Ni-Co, Electrodeposition, electrocatalysis, Hydrogen Evolution reaction

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A Review on Recent Developments of Novel Plant Extracts and Compounds as Anticancer Agents.

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Abstract

Cancer is a severe metabolic syndrome that exhibits several typical traits, including angiogenesis, metastasis, apoptosis, growth signal generation, multiple replications, and insensitivity to anti-growth signals. Numerous approaches are available to treat cancer, including tumor surgery, radiation, immunotherapy, chemotherapy, cancer vaccines, photodynamic therapy, stem cell transformation, and more. But these treatments tend to come with serious adverse effects. Among these adverse effects are acquired resistance to these medications, low absorption, toxicity, non-specificity, rapid clearance, and restriction in metastasis. As a result, the hunt for substitute possible anticancer agents has focused on plants and natural products. Numerous plant products, including lignans, alkaloids, flavonoids, saponins, terpenes, taxanes, vitamins, minerals, glycosides, gums, oils, biomolecules, and other primary and secondary metabolites, are important because they either activate DNA repair mechanisms or inhibit cancer cell activating proteins, enzymes, and signaling pathways [Cdc2, CDK2 and CDK4 kinases, topoisomerase enzyme, cycloxigenase, and COX-2). These phytochemicals and their derived analogues are found in various plant parts, including the flower, flower stigmas, pericarp, sprouts, fruits, seeds, roots, rhizomes, stem, leaf, embryo, and bark, and they serve a variety of pharmacological purposes.
In the current study, we have attempted to address the natural compounds that are being used or are undergoing clinical trials these days for chemoprevention and chemotherapy purposes.

Keywords: Anticancer agents, Natural products, Phytomolecules, Clinical study, Drug discovery.

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Designed Assembly of Multimetallic Compounds as Promising Antibacterial and Antibiofilm Agents

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Abstract

The development of convenient and effective antibacterial drugs has become dominant in maintaining global health in the current era of growing bacterial threats and widespread antibiotic resistance. The conventional antibiotics have played a significant role in combating bacterial infections over the years. However, the emergence of multidrug resistant (MDR) bacterial strains demands constant innovation in antibacterial and antibiofilm research. In this context, multimetallic compounds of suitably designed organic scaffolds can be applied as potent antimicrobial agents. Copious bio-metals such as Cu, Zn and Co play crucial structural and functional roles in biological systems with diverse functions performed by their corresponding metal-binding proteins. Among different coordination systems, di- and multimetallic assemblies have exceptional structural features and huge potential in biology. The multiple metal centers in a multinuclear metal-organic framework act as specific sites for binding and activation of different biomolecules, displaying enhanced biological activity and selectivity as a result of synergistic effect and their robustness. There are several pharmacological factors that control the biological activities such as, (i) cellular uptake; (ii) frequency and structure of biomolecule adducts; (iii) the extent of metabolizing interactions. Thus, the occurrence of multi-metals in the coordination sphere, allow modulation of these pharmacological factors which in turn, may change the drug efficacy. This talk would try to explore our recent achievements on design, development, structural features and possible antibacterial and antibiofilm efficacies of some di- and multinuclear Cu, Zn and Co assemblies. Our study revealed that the management of biofilm-mediated maladies caused by a drug-resistant pathogen, methicillin-resistant *Staphylococcus aureus* (MRSA) can be achieved by a family of multimetallic compounds.

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An in-depth study on Graphene based nanocomposite for solar powered wastewater treatment system

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Abstract

Solar energy harvesting for water treatment is a promising solution to global water shortages, but challenges persist in developing efficient absorber materials. Graphene-plasmonic hybrid nanocomposites have been explored for solar water purification due to high surface area, and excellent working ability. These nanocomposites effectively remove contaminants making them a viable solution for sustainable water purification. Graphene, known for its unique thermal, chemical, optical, and mechanical properties, has gained significant attention in wastewater treatment. Various graphene-based materials, including graphene oxides, graphene quantum dots, and graphene nanoplatelets, are synthesized through chemical vapor deposition and exfoliation techniques. These materials act as adsorbents, electrodes, and photocatalysts to remove toxic pollutants from industrial, agricultural, and urban waste streams, reducing environmental and health risks. Graphene oxide-based nanocomposites are widely utilized for adsorption and photocatalytic degradation of pollutants, achieving removal efficiencies of over 90% in many cases which offers a cost-effective, scalable, and highly efficient solution. Some studies have even reported complete decontamination of wastewater. Graphene-based nanocomposites hold great potential in revolutionizing solar-powered wastewater treatment systems. This review illustrates about research and technological advancements in graphene-based nanocomposite for solar powered wastewater treatment system that are required to optimize their practical applications on an industrial scale.

Keywords: Graphene-plasmonic hybrid, contaminants, quantum dots, nanoplatelets, photocatalysts, exfoliation, decontamination .

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Modern innovative approaches for sustainable agriculture

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Abstract

Sustainable agriculture is very much essential for ensuring proper food security, which will ensure the availability, affordability, and accessibility of food to every corner. This chapter will explore the key advancements in vertical farming, aquaponics, hydroponics, and smart agriculture. Modern superior advanced technologies can integrate the traditional agriculture towards modern sustainable agriculture. The role of precision agriculture and regenerative agriculture, with the reference of remote sensing, artificial intelligence, and IoT in optimizing resources for the benefits in farming techniques, will highlight the successful implementations globally, focusing on the various impacts on productivity, economic livelihoods, and the conservation of the environment. The present chapter details the modern approaches related to structure, cost, economic feasibility, and its application in agricultural crop production. The impact of remote sensing and geographic information system (GIS) in prediction of crop yield, crop health monitoring, pest control, irrigation control, farming automation, and livestock monitoring will be also discussed in the chapter. The chapter will discuss the potentiality of these approaches to optimize yield, minimize environmental impact, resource efficiency and address challenges related to climate change resilient agriculture. Along with these, the feasibility of modern advanced smart agricultural techniques is also illustrated in this chapter.

Keywords: Sustainable Agriculture, Precision Farming, Modern Approaches, Climate Smart Agriculture, Food Security.

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A review on Biohydrogen Production from Industrial Wastewater: A Sustainable Energy Alternative

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Abstract

The depletion of fossil fuels and their environmental impacts have driven the search for clean energy alternatives. Hydrogen, with its renewable nature, zero emissions, and high energy yield, is a promising option. Biological methods such as dark fermentation, photo-fermentation, and microbial electrolysis cells (MECs) offer sustainable hydrogen production, with wastewater emerging as a valuable substrate due to its abundance and cost-effectiveness.

Industrial wastewaters from food processing, distilleries, and paper mills have shown potential for biohydrogen generation while reducing treatment costs. Key operational parameters such as pH, temperature, bioreactor configuration, and organic loading rate significantly impact hydrogen yields. Despite promising results, challenges like biomass washout and low production efficiency hinder large-scale implementation.

While dark fermentation has reached pilot-scale testing, electrochemical and photochemical technologies require further development. MECs stand out due to their modularity, high hydrogen yields and up to 80% chemical oxygen demand (COD) removal. A multidisciplinary approach integrating engineering, chemistry, and microbiology is essential for overcoming commercialization barriers. While challenges remain, ongoing research and technological advancements hold the potential to make biohydrogen a viable component of the future renewable energy landscape. This review highlights advancements in wastewater-based biohydrogen production, emphasizing its potential for sustainable energy generation and wastewater treatment.

Keywords: Biohydrogen production, Sustainable energy, Chemical oxygen demand (COD)

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Optimized DC-DC Converter Topologies: High Efficiency and Compact Design for Multipurpose Use

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Abstract

The demand for compact and high-efficiency DC-DC converters has grown significantly across various applications, including renewable energy systems, electric vehicles, industrial automation, and portable electronics. This paper explores advanced DC-DC converter topologies that achieve high power efficiency while maintaining a minimal footprint. Key topologies such as buck, boost, buck-boost, and resonant converters are analyzed for their design characteristics, efficiency optimization techniques, and suitability for multipurpose applications. Emphasis is placed on circuit design strategies, switching techniques, thermal management, and control methodologies that enhance performance. A thorough examination of low-size, high-efficiency DC-DC converter topologies intended for multipurpose applications is presented in this work. The creation of optimized topologies has drawn a lot of attention due to the growing need for small and energy-efficient power conversion devices. This study examines several converter architectures, such as buck, boost, buck-boost, and resonant converters, focusing on their performance traits, design trade-offs, and applicability for various application domains like portable electronics, electric vehicles, and renewable energy systems. In order to offer insights into the selection and optimization of DC-DC converters, important parameters like efficiency, power density, thermal management, and control methodologies are investigated. The suggested topologies are validated by simulation and experimental findings, which show how well they work to achieve excellent power efficiency with a small footprint. The results of this study address the increasing demand for small and dependable DC-DC converters in contemporary electronic applications, advancing next-generation power conversion systems.

Keywords: DC-DC converter, high efficiency, power density, multipurpose applications, compact design, energy conversion

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Thermal Performance Analysis of Magneto-Nanofluid Flow in a Mirrored Trapezoidal Enclosure with Distributed Heating

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Abstract

This study investigates the thermal performance of CuO-H_2O nanofluid within a mirrored trapezoidal enclosure under distributed heating and an external magnetic field. The enclosure features hot, cold, and adiabatic walls, creating a complex thermal environment. The research addresses the growing demand for enhanced thermal management solutions in energy systems through nanofluid applications. The analysis employs finite element methods to solve the governing equations, exploring the impact of varying Rayleigh numbers ($10^3 \leq Ra \leq 10^6$), Hartmann numbers ($0 \leq Ha \leq 70$), and magnetic field inclination angles ($0° \leq \gamma \leq 180°$) on convective heat transfer, flow patterns, and entropy generation. The novelty lies in the comprehensive analysis of thermal performance and entropy generation in such a complex geometry, a topic rarely addressed in existing literature. Numerical simulations reveal that increasing the Rayleigh number enhances convective heat transfer, with flow patterns transitioning from conduction-dominated to convectiondominated regimes. The magnetic field suppresses convective currents, reducing heat transfer rates, as indicated by lower Nusselt numbers at higher Hartmann numbers. The inclination angle of the magnetic field significantly alters flow structures, with anticlockwise rotation of the Lorentz force affecting streamline, isotherm, and heatline distributions. Entropy generation analysis highlights the contributions of viscous (NSv) and magnetic (NSm) irreversibilities, temperature gradients, and magnetic effects, providing insights into system irreversibility. Key findings demonstrate that optimal heat transfer performance can be achieved by balancing buoyancy-driven convection and magnetic field strength. This study contributes to the advancement of nanofluid-based thermal systems, offering valuable design guidelines for practical applications in energy systems.

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Computational Analysis of Electron Transfer Systems in Pseudomonas aeruginosa PPNB 101 for Microbial Fuel Cell Applications

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Abstract

Understanding electron transfer mechanisms in Pseudomonas aeruginosa is crucial for optimizing its potential in microbial fuel cells (MFCs). This study combines computational and experimental approaches to comprehensively analyze extracellular electron transfer (EET) pathways in P. aeruginosa PPNB 101, an exoelectrogenic strain. Advanced bioinformatics tools and real-time MFC experiments validate its bioelectric potential. A 16S rRNA sequence analysis via BLAST confirmed its classification, while bioinformatics tools in Python (v3.11), including Biopython, Pandas, and Matplotlib, facilitated sequence processing and visualization. Key EET-related genes, such as pilA, napA, nirS, nosZ, cytochrome c oxidase subunits, and quinone oxidoreductases, were identified. Categorization of electron transfer pathways revealed Respiratory (67%), Mediated ET (14.8%), Direct ET (10.2%), Metal Reduction (7%), and Pili-Related (1.1%) contributions represented in Fig.1. Gene distribution analysis emphasized the dominance of respiratory components and mediated transfer via phenazine- and quinone-based systems.

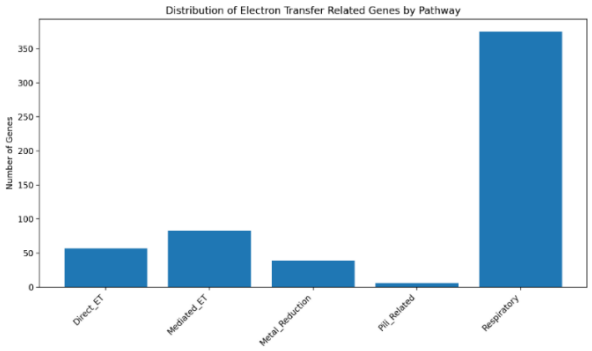

Fig.1

To validate bioelectric potential, an MFC experiment using this strain degrading cellulose recorded a peak voltage of 751 mV. Four chambers generated 2.04 V, powering a 2V LED, while nine circuits produced 6.50 V, illuminating a 6V LED with a power density of 2.30 mW/cm² at 4.10 mA/cm². These findings highlight P. aeruginosa's versatile electron transfer mechanisms, reinforcing its potential for sustainable bioelectricity generation.

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Characterization of bacteriocin producing lactic acid bacteria (LAB) and its application as a sustainable bio-preservative for enhancing the shelf life of fruits and vegetables

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Abstract

Bacteriocin-producing lactic acid bacteria (LAB) were isolated from local food samples collected in Midnapore town. The bacteriocin producer, *Lactiplantibacillus plantarum* HPM2, was identified based on phenotypic analysis and 16S rRNA sequencing. The bacteriocin produced by HPM2 exhibited a broad spectrum of inhibition against various food spoilage microorganisms, including *Listeria monocytogenes, Bacillus cereus, Staphylococcus aureus, Clostridium botulinum, Escherichia coli, Pseudomonas aeruginosa, Vibrio cholerae, and Klebsiella pneumoniae.* Notably, it showed strong inhibition against *L. monocytogenes.* The bacteriocin remained stable after heat treatment at 121°C for 10 minutes but was degraded by proteolytic enzymes. Maximum production occurred at 37°C, with an optimal pH range of 6.5–7.0 in MRS media containing 2.1% dextrose. Native-PAGE analysis indicated that the bacteriocin had a molecular weight between 5-20 kDa. The bacteriocin appears to belong to Class IIa, known for its heat stability and broad-spectrum antimicrobial properties. The bacteriocin has been applied as a bio-preservative to extend the shelf life of fruits and vegetables, including apples, bananas, grapes, and tomatoes. Fruits and vegetables treated with the bacteriocin showed an increased shelf life compared to untreated. These findings suggest that the bacteriocin is an effective and safe bio-preservative with no harmful effects on health. This research provides a foundation for the potential use of *L. plantarum* HPM2 producing bacteriocin as a food preservative in the future.

Keywords: Lactic Acid Bacteria (LAB), Bacteriocin, Bio-preservative, Shelf life.

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Solar power Generation and Smart Load Distribution Management System: A DL Based Approach

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Abstract

Abstract-Solar radiation is considered as a clean, sustainable, eco-friendly source of energy which can be converted into electricity. Thus, the growing demand of electricity can be fulfilled using photovoltaic cells that stores sufficient heat energy using solar thermal equipment's. The consistent supply of electricity to the consumers using solar photovoltaic cells always faces problem due to environmental conditions such as Solar radiations, Cloud coverage etc. throughout the year. Such changes complicate the integration of solar energy into power grids. To provide grid stability and best energy planning, strategic management of load is required to manage the load on priority basis. In this work, Deep Learning models (LSTM-Transformer: for modeling temporal dependencies and XGBoost: for capturing non-linear dependencies and feature importance,) learns to adapt different environmental conditions which improve prediction accuracy. This research presents a hybrid ensemble approach with real time data to address solar forecasting. The model detects a graphical pattern that shows power generation, by providing real time and past weather data. The model upgrades prediction accuracy through Neural Networks, enabling it to adapt across different locations, by consistence performance. The research achieved the Root Mean Square Error (RMSE) of ±4.75 kW and the actual solar power ranges from 0.00 kW to 270.98 kW. This model gives 93.30 % of accuracy. The model provides considerably better power predictions, making it useful for real world applications. The research contributes to the development of solar energy forecasting tools, increased flexibility for different areas. This work also aims at providing better decisions for eco-friendly energy worldwide thus providing a sustainable environment.

Keywords: Eco-friendly energy source, LSTM-Transformer, XGBoost, deep learning, prediction accuracy, neural networks, sustainable environment

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Polybenzimidazole: A Valuable High Temperature Proton Exchange Membrane (HT-PEM) alternative to Nafion

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Abstract

In context of the pollution free green energy generation, proton exchange membrane fuel cells (PEMFCs) are the promising way out for future energy requirement. In recent days, PEMFCs are the most commonly applied fuel cell. The low to moderately high operating temperature, high power density, flexibility and easy scale-up, makes PEMFCs a promising candidate as the next generation power sources for transportation, stationary, and portable applications. Although being extensively used in several important fields, the goal of world-wide commercialization of PEM fuel cells has not yet reached. The main barriers to commercialization are mainly cost and durability. The primary reason of a fuel cell cost is due to the membrane electrode assembly (MEA) that consists of a costly catalyst (usually Platinum (Pt)-based) layers and membrane electrolyte (generally Nafion). Polybenzimidazole (PBI), having unique properties like high thermal stability, excellent mechanical stability, high glass transition temperature etc., is extensively studied for the application in high temperature (>100^{o}C) polymer electrolyte membrane fuel cell (HT-PEMFC)**.** Despite all these excellent properties, PBI has not gained that much commercialization value due to its very poor solubility in various solvents like N,N-dimethylacetamide (DMAc), N-methyl-2-pyrrolidone (NMP) etc., and poor membrane fabrication process. In this work, we have focused on an easy, cost effective, affordable and convenient route of PBI membrane and its composite membrane fabrication for enhanced fuel cell performance. The drawbacks of dissolving PBI polymer, mentioned above have been overcome by using Methane Sulfonic Acid as solvent. For enhancement in acid doping level, proton conductivity and overall fuel cell performances and other properties, different types of inorganic fillers (reduced graphene oxide (rGO), phosphosilicate nano network (PPSN)) have been incorporated. For, rGO-PBI nanocomposite membranes, 0.743 Wcm^{-2} peak power density and 0.126 Scm^{-1} proton conductivity was achieved by rGO-PBI-1 at 170^{o}C. For PPSN-PBI nanocomposite membranes, 0.726 Wcm^{-2} peak power density and 0.116 Scm^{-1} proton conductivity is achieved with PPSN-PBI-10 at 170^{o}C.

Keywords: High Temperature Proton Exchange Membrane Fuel Cell (HT-PEMFC), Proton Conductivity, Polybenzimidazole (PBI), Fuel Cell performance

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Graphene-Induced Enhanced Room Temperature Ethanol Sensing of Nanostructured $Ni(OH)_2$

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Abstract

Volatile organic compounds (VOCs), including ethanol, play a critical role in health monitoring and law enforcement applications[1]. However, conventional metal oxide-based ethanol sensors suffer from high operating temperatures (>100°C), leading to excessive power consumption, poor stability, and compromised selectivity in humid conditions. Only a handful of studies have highlighted the efficacy of metal hydroxide-based ethanol sensors operating at room temperature. Recent advances in metal hydroxide-based sensors operating at room temperature have shown promise, with our group previously demonstrating a $Ni(OH)_2$ hexagonal nanoprisms film that yielded a response of 120 toward 100 ppm ethanol[2]. In this study, we report a novel ethanol sensor based on a β-$Ni(OH)_2$/reduced graphene oxide (rGO) composite, synthesized via a hydrothermal approach. Structural and morphological analyses confirmed the formation of well-dispersed β-$Ni(OH)_2$ hexagonal nanoprisms (35–40 nm) on rGO, with a high specific surface area of 207 m^2/g. The sensor exhibited exceptional ethanol-sensing performance at room temperature, achieving a response of ~250 to 75 ppm ethanol vapor with a rapid response time (2 s) and recovery time (27 s). These findings underscore the potential of β-$Ni(OH)_2$/rGO composites as efficient, low-cost alternatives for real-time ethanol monitoring in ambient environments.

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Treatment of various industrial waste water by using ceramic membrane technology

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Abstract

The treatment of industrial wastewater is an essential process for environmental protection and resource conservation. Various industries, including chemical, pharmaceutical, textile, and food processing, generate wastewater with complex contaminants that require effective treatment methods. Among the numerous treatment technologies available, ceramic membrane technology has emerged as a promising solution due to its high resistance to harsh chemicals, high temperature tolerance, and long operational life. Ceramic membranes, typically made from inorganic materials like alumina, zirconia, or titania, offer superior filtration performance for separating suspended solids, bacteria, heavy metals, and organic pollutants from wastewater. This technology operates on the principles of microfiltration, ultrafiltration, nanofiltration, and reverse osmosis, depending on the pore size and membrane material used. Ceramic membranes have demonstrated significant advantages over polymeric membranes, including higher fouling resistance, better chemical stability, and ease of regeneration. The use of ceramic membranes for industrial wastewater treatment can improve water reuse, reduce energy consumption, and lower operating costs compared to traditional methods like activated sludge or chemical precipitation. However, challenges such as high initial investment, membrane fouling, and the need for frequent maintenance remain key considerations. This review explores the potential applications, operational efficiencies, challenges, and advancements in ceramic membrane technology for industrial wastewater treatment. Moreover, it provides insights into recent developments, such as hybrid processes combining ceramic membranes with other treatment technologies to enhance performance and sustainability. This technology offers a viable and sustainable approach to treating industrial wastewater, ensuring compliance with stringent environmental regulations while promoting the reuse of water in industrial processes.

Keywords: Ceramic; Membrane technology; Waste water

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Enrichment of essential nutrients and bioactive functional groups in few selected marine organisms at Rangachang, South Andaman: A case study

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Abstract

Marine organisms are the lungs of our planet and a predominant source of sustenance and medicine playing an important role in regulating the natural balance of the biosphere. To investigate the bioprospecting applications of Dictyosphaeria cavernosa (Green Bubble Algae), Stylissa massa (Mango Sponge), Linckia laeviagata (Blue Sea Star), and Didemnum psammatodes (Brown encrusting tunicate) along with seawater and sediment, were collected aseptically from Rangachang, South Andaman (Fig. 1). Nutrients ammonia-nitrogen, nitrite nitrogen, inorganic phosphate, reactive silicate was estimated in seawater using colorimetric method and the total organic carbon in sediment was evaluated using Walkley-Black titration method. Scanning Electron Microscopy coupled with Energy Dispersive X-ray Spectroscopy (SEM-EDX) was utilized for the analysis of trace metals by assessing elemental composition through the detection of characteristic X-rays emitted from the sample upon interaction with an electron beam. Insights into the specific chemical bonds were identified using Fourier Transform-Infrared (FTIR) spectroscopy. Thermal properties were analysed using Thermogravimetric analysis (TGA) and Differential Scanning Calorimeter (DSC) techniques. Results indicated that the selected marine organisms accumulated essential trace metals and nutrients, which could be beneficial for biomedical applications such as wound healing and bone regeneration. The present sampling site is a hub of diverse marine organisms which is an essential platform for the functioning of ocean ecosystems, maintenance of food web of marine organisms thus providing benefits for mankind.

Keywords: Biosphere, Marine organisms, Nutrients, Trace metals, Bioactive moieties

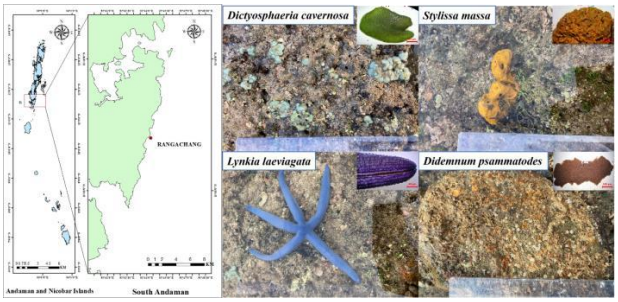

Fig. 1: Collection site and macroscopic images of marine organisms – Green Bubble Algae, Mango Sponge, Blue Sea Star and Brown Encrusting Tunicate (Inset: Microscopic images of respective organisms)

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A critical review on recent advances in thin-film semiconductor photocatalysis for green hydrogen evolution

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Abstract

Photocatalytic hydrogen evolution is emerging as one of the viable technique for green hydrogen production, offering an alternative to conventional technologies. Particulate method and thin-film approaches are the two mainly used techniques for green hydrogen production using photocatalysis. Recent reports reveals that thin film approach is much efficient over particulate method due to higher light absorption, increased charge separation efficiency, and scalable production processes. However, the quality and the performance of the film depends on the fabrication methods, material composition, and optimization techniques. Considering the above current work review, the recent advancements in thinfilm based semiconductor photocatalysts for hydrogen evolution. The review will emphasize various types of thin films, focusing on their surface modifications, plasmonic effects, heterojunctions, and nanostructures in photocatalysis, particularly in terms of charge carrier recombination, stability, and large-scale applications. In order to promote solar-driven hydrogen production for a sustainable energy future, this study provides an insight on the potential of thin-film photocatalysts.

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Critical load and Weak Bus detection Based on Stability Index of with the help of Synchrophasor Unit

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Abstract

With increasing demand and growing complexities, modern power systems are often pushed to their operational limits, making stability a critical concern. To prevent voltage collapse and ensure reliable performance, it is essential to assess the system's capacity and take necessary precautions in advance. One key aspect of this assessment is identifying weak buses, which can be effectively done using Phasor Measurement Units (PMUs). These devices provide real-time measurements of voltage, current, and phase angles, offering valuable insights into system stability. This paper explores a method for detecting weak buses and critical load using voltage stability indicators such as the First Voltage Stability Index (FVSI) and the Line Stability Index (LSI). By comparing these two approaches, we aim to determine which method provides more accurate and reliable results. The study applies these techniques to the IEEE 30-bus system, analyzing key factors like voltage stability, load variations, and the impact of load angles. Unlike conventional indices that often ignore the effect of load angles, this work utilizes PMU data to capture real-time variations in load angle, voltage, and current. The proposed approach is implemented and analyzed in MATLAB, demonstrating its potential to improve power system stability assessment and decision-making.

Keywords: PMU, Load Angle, Week Bus, IEEE 30 Bus System, Voltage Sensitivity index

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Renewable Energy for Sustainable Agriculture and Environment

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Abstract

Sustainable development, especially in the fields of agriculture and environmental preservation, depends heavily on renewable energy. Making the switch to renewable energy sources provides tremendous promise for meeting energy demands while reducing adverse environmental effects as the world's population rises and environmental problems worsen. Renewable energy has the potential to significantly improve energy efficiency, lower carbon footprints, and foster climate change resilience in the context of agriculture and the environment. The chapter will discuss thoroughly about the impact of renewable energy such as solar energy, wind energy, biogas, and hydropower, geothermal energy on both sustainable agriculture and the environment. Benefits and limitations of renewable energy application will be described in detail in this chapter. Along with these, the current chapter will also elaborate agricultural farmers' benefit and challenges with the application of renewable energy in agricultural irrigation and crop production system.

Keywords: Solar energy, Wind energy, Carbon footprints, Water footprints, Energy conservation, Sustainability.

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Modified Smith Predictor based optimal fractional PD-PD controllers for integrating first order plus time delay processes

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Abstract

A modified Smith Predictor structure is framed with a pair of fractional order PD controllers (FOPD) to ascertain enhanced closed loop responses for integrating first order plus time delay processes. The proposed design involves two fractional order PD (FOPD) controllers, one FOPD is in the forward path and the other is in the feedback path along with a low pass filter. Both the controllers are accountable for improved servo and regulatory responses and the filter works toward noise elimination. Rao-2 optimization algorithm is employed to find out the design parameters of fractional controllers and the associated low pass filter is designed based on the value of closed loop time constant of the concerned process. Performance of the proposed controller is evaluated in comparison with recently reported works on integrating first order plus time delay (IFOPTD) models.

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Application of Artificial Intelligence for Sustainable Agriculture

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Abstract

In today's society, Artificial Intelligence (AI) plays a vital role in the field of agriculture as it helps to monitor, understand, and predict many attributes of the chain production of different types of crops, vegetables, fruits, and many more. The main advantages of AI in agriculture are its flexibility, high performance, accuracy, and cost-effectiveness. By using traditional methods, farmers can't fulfil their requirements based on increasing demand of increasing popularity. So, they have to think in an innovative way to increase the production. This paper intends to discuss practices such as the Internet of Things (IoT), wireless communications, machine learning, and AI that mitigate issues related to crop diseases, weed management, and pesticides control, and water management. The chapter will detail different devices and sensors which are used to capture various sorts of field data that will be analyzed by the AI, and deliver the information through different software applications such as Agranimo, Plantix, Fasal, Cropin, etc. A special focus will be laid on the characteristics and limitations of the application of AI in agriculture field. Furthermore, the study will also illustrate the main challenges of popularizing the use of AI-based systems and sustainable smart agricultural techniques to reduce the difficulties.

Keywords: Artificial Intelligence, Sustainable Agriculture, Crop Monitoring, Smart Agriculture, IoT, Crop Production

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Shape-Selectivity in Gold Nanostructures as a Pre-requisite to Design Photothermal to Photovoltaic Devices

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Abstract

The brilliant colors of the dispersions of metallic colloids have been fascinated since antiquity, long before our understanding of light-matter interaction. The ability of noble metal colloids to manipulate light at the nanoscale has pioneered an emerging research area called plasmonics. The physical origin of the light absorption by metal nanoparticles is the coherent oscillation of the conduction band electrons, coined as, localized surface plasmon resonance (LSPR). The resonance frequency of this LSPR is strongly dependent upon the size, shape, interparticle interactions, dielectric properties, and local environment of the nanoparticles. As in many disciplines of fundamental physics, chemistry and biology, the past two centuries have made significant contribution in the investigation of optical phenomena at the nanometer scale pioneered by specific theoretical approaches to solve Maxwell's equations, together with powerful simulation techniques that are able to anticipate experimental observations. In this presentation, the localized surface plasmon resonance of various anisotropic gold nanostructures and their plausible applications from photothermal to photovoltaic devices will be elucidated.

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Study of synergistic effect of Si/SiC/C on Silicon surface formed using low energy carbon ion beam for HER reaction to enhance photocurrent and stability in highly acidic electrolyte for water splitting

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Abstract

Silicon (Si), being earth-abundant and inexpensive semiconductor is gaining attention as a potential photo electrode material for efficient solar-driven water splitting. As silicon has a bandgap of 1.12 eV, it is perfect for absorbing visible light of solar spectrum.[1] but for pristine Si, it needs to address its inherent corrosiveness in high acidic or basic pH solutions by surface treatment along with engineering of its optical band gap to straddle complete water redox potential.[2] Low energy ion beam implantation is therefore a special technique to modify the chemical composition with controlled defect formation in the surface and near surface region in order to change the band gap and increase the light trapping activity of silicon surface. We have used 12 keV carbon ion at normal (0°) and grazing (60°) ion incidence angles with different fluencies. C^+ ion implantation leads to form an amorphous layer containing combination of silicon and silicon carbide with graphitic carbon investigated using XPS exhibit a modified band gap which may use solar spectrum in more efficient way. We have found that the synergistic effect of Si/SiC heterojunction with carbon as cocatalyst enhanced the optical properties of pristine silicon as well as the photo current density for HER reaction with significant reduction in over potential in highly acidic solution. The kinetics of electrode/electrolyte interface in ion implanted samples has been improved studied by EIS technique. The open circuit potential (OCP) measurements shows the better charge separation in the modified surface.

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Smart Dual-Axis Solar Tracker with Predictive PID Control: Enhancing Efficiency in Solar Energy Harvesting

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Abstract

The efficiency of solar energy harvesting is significantly influenced by the orientation of photovoltaic (PV) panels. Traditional solar tracking systems utilize single-axis or dual-axis mechanical tracking mechanisms, which despite increasing power yield, suffers from inefficiencies due to energy loss during movement. In this research, a proposed model of a Smart Dual-Axis Solar Tracker with Super Efficiency using a Predictive PID Control Loop has been designed to optimize the tracking of solar radiation with minimal energy wastage. The proposed system integrates a Predictive Machine Learning (ML) Algorithm with a Proportional-Integral-Derivative (PID) controller, ensuring real-time and predictive sun tracking while reducing excessive movement of linear actuators and motors. The predictive model is developed based on historical solar trajectory data, geographical coordinates, and seasonal variations to forecast the sun's position throughout the year. The PID controller of this system refines the panel's alignment dynamically to achieve near-perpendicular solar incidence at all times, enhancing power output. Implementing this approach on a prototype system in a latitude of approximately 23.5°N (Tropic of Cancer) and 35°N (Europe region) demonstrated an improvement of 22-28% in energy yield compared to conventional dual-axis trackers. The system is designed to operate with an energy efficiency threshold of 72-75%, reducing unnecessary actuation and mechanical wear. The control logic considers weather conditions, cloud cover and atmospheric factors that influence solar irradiance. Additionally, real-time sensor fused with Global Positioning System (GPS) and Inertial Measurement Unit (IMU), both are enhancing tracking accuracy. A hardware-in-the-loop (HIL) simulation was performed using MATLAB/Simulink, validating the system's performance under varied environmental conditions. Experimental data collected from real-world deployment at latitude 28.61°N, longitude 77.23°E (Haldia 721657, India), and 51.51°N, longitude -0.13°E (Kolkata 700102, India) confirm that predictive tracking provides a 5-7% higher energy yield than conventional sensor-based tracking alone. The findings indicate that this intelligent solar tracking system can be a breakthrough for large-scale solar farms, residential rooftops, and industrial applications, optimizing energy harvesting and reducing operational costs.

Keywords: Solar tracking, Predictive PID control, Machine Learning, Renewable energy, Dual-axis tracker, Energy optimization, Photovoltaic efficiency, Real-time sun tracking, Sustainable energy.

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Production of Biofuel from Algal Biomass by Aqueous Phase Reforming

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Abstract

With the growth of the human population, the need for sustainable resources of energy has increased a lot. Large scale utilisation of fossil fuels would lead to absence of viable energy resources for our future progeny, so, for that we need renewable and clean sources of energy which are called Green Energy Resources. Biological hydrogen (H2) production (BHP) enhancement through the use of nanoparticle (NPs) supplements in the media is being recognized in recent times as an encouraging approach. The NPs, including those of metal and metal oxides, have shown a significant improvement in the BHP. A number of organisms as pure or mixed cultures can produce H2 in presence of NPs from pure sugars and biowaste as a feed. However, their H2 production efficiencies have been found to vary significantly with the type of NPs and their concentration. Therefore, Suitable bacteria like C. butyricum as inoculum and AuNPs provided a suitable approach for efficient H2 production from sucrose. Also, Kappaphycus alvarezii and sludge was processed for bio-hydrogen production. As a result, Reforming of aqueous phase with 7.5 wt% Au It is found that, with synthetic wastewater containing sucrose as a feed, anaerobic culture resulted in 62.3% higher yield than those to the control applying the minimum amount of AuNPs, remarkably, the H2 production, overall catalyst showed 61.25% of bio-hydrogen.Maximum bio-hydrogen yield was 36.1% for 2:1 (sludge: algae) at 360°C.The high ratio of acetate to butyrate and low production of ethanol in the presence of AuNPs is associated with a significant increase in H2 production. Aqueous phase reforming produces hydrogen from biomass-derived oxygenated compounds such as glycerol, sugars, and sugar alcohols. APR is unique in that reforming is done in the liquid phase. The process generates Biohydrogen without volatilizing water, which represents a major energy saving and therefore produces emission-free Hydrogen from biofuel with the ude of macroalgae Kappaphycus alvarezii to With the purpose of expanding applications in the field of production of Hydrogen with the help of Bio nanotechnology, the Biosynthesis of AuNps by aqueous reforming of a synthetic compound (brewery wastewater) is supported on activated Carbon. It is observed that AuNPs has the catalytic performance for the degradation of pollutants at the industrial level. Therefore, Gold nanoparticles exhibit excellent catalytic degradation and decomposition of pollutants making the environment cleaner and sustainable. Thus, Hydrothermal gasification(APR) resulted in syngas, biochar and higher H2 production by liquid phase formation and Anaerobic Digestion of cyanobacterium lead to the breakdown of complex Inorganic and organic compounds in the Industrial Wastewater that led to easy Reforming process. Recent Research with Certain Limitations and Recommendations are also to be taken care of for the Aqueous Phase Reforming Process. It can be used at domestic sectors and small scale Industrial operations for synthetic wastewater treatment and production of biofuels and Biohydrogen since the procedure is costly than the normal established SMR or CFR (Steam Methane Reforming & Catalytic Reforming). The process including the Bioreactor and Pyrolysis Incineration Plant should be more cost-effective for synthesising Au and H2 production. Keywords Hydrothermal gasification, Macroalgae, Microbial sludge, Bio-hydrogen production (BHP), Aqueous phase reforming (APR), Gold nanoparticles (AuNPs), Anaerobic Digestion

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$Zn_3Sb_4CO_6F_6$: A Zn (II)-based Oxyfluoride towards Sustainable Environment

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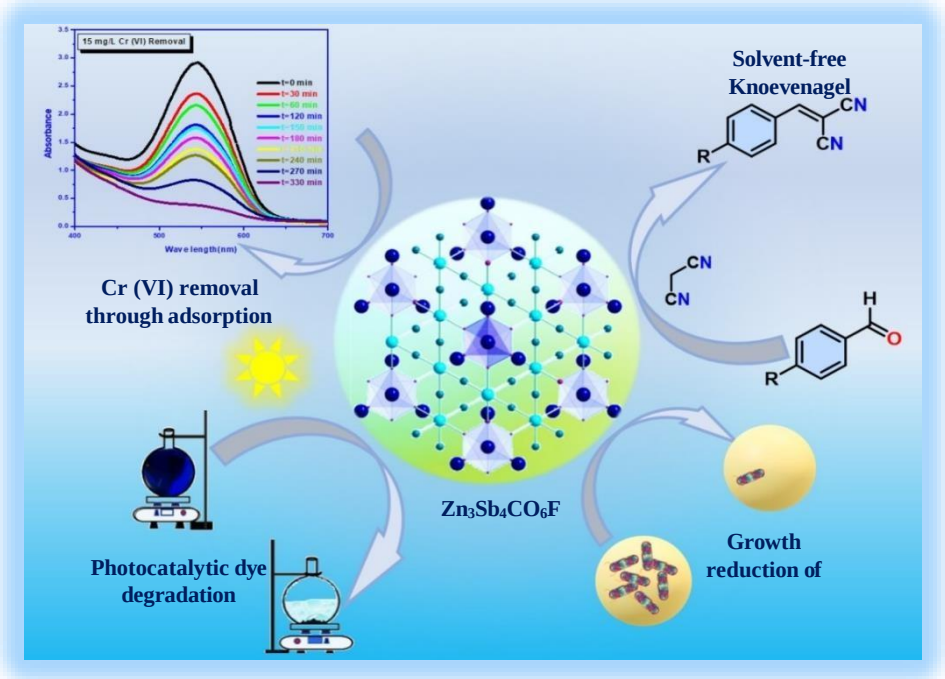
Abstract

Non-centrosymmetric $Zn_3Sb_4CO_6F_6$ has been identified as the first multifunctional [M-L-C-O-F] (M: transition metal cation, L: p block ion, O: oxide ion, and F: fluoride ion) with exceptional properties such as photocatalyst, adsorbent, catalyst for organic transformation, and antibacterial agent. It crystallizes into cubic symmetry (SG: $I\bar{4}3m$) with a = 8.1480 (5) Å and Z = 2.[1] The existence of ordered and disordered structures in higher symmetry could be explained by a single crystal X-ray diffraction (SCXRD) study. This compound successfully degraded methylene blue dye even at higher concentrations, e.g., 50 mg/L, by around 90% under solar illumination. Hydroxyl radicals were the responsible reactive oxygen species for these dye degradation activities, as evident from the radical scavenger experiments. $Zn_3Sb_4CO_6F_6$ was proved to be a proficient adsorbent towards Cr (VI) removal with q_{max} of 47.18 mg/g. An 'Agar cup assay' was employed to confirm the antibacterial activity of this compound against both Gram-positive and Gram-negative bacterial strains. This compound also functions as an excellent catalyst for the solvent-free Knoevenagel condensation reaction, with more than 90% yield. Structural optimisation by DFT and other theoretical investigations further proved that this compound exhibits direct band gap energy (E_g) of 1.76 eV, which is consistent with the experimental findings.



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Hydrogen Technology Developments for Industrial Decarbonization towards a Sustainable Future

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Abstract

Non-centrosymmetric $Zn_3Sb_4CO_6F_6$ has been identified as the first multifunctional [M-L-C-O-F] (M: transition metal cation, L: p block ion, O: oxide ion, and F: fluoride ion) with exceptional properties such as photocatalyst, adsorbent, catalyst for organic transformation, and antibacterial agent. It crystallizes into cubic symmetry (SG: $I\bar{4}3m$) with a = 8.1480 (5) Å and Z = 2.[1] The existence of ordered and disordered structures in higher symmetry could be explained by a single crystal X-ray diffraction (SCXRD) study. This compound successfully degraded methylene blue dye even at higher concentrations, e.g., 50 mg/L, by around 90% under solar illumination. Hydroxyl radicals were the responsible reactive oxygen species for these dye degradation activities, as evident from the radical scavenger experiments. $Zn_3Sb_4CO_6F_6$ was proved to be a proficient adsorbent towards Cr (VI) removal with q_{max} of 47.18 mg/g. An 'Agar cup assay' was employed to confirm the antibacterial activity of this compound against both Gram-positive and Gram-negative bacterial strains. This compound also functions as an excellent catalyst for the solvent-free Knoevenagel condensation reaction, with more than 90% yield. Structural optimisation by DFT and other theoretical investigations further proved that this compound exhibits direct band gap energy (E_g) of 1.76 eV, which is consistent with the experimental findings.

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Electrical Impedance Based Health Monitoring of Biological and Non-Biological Materials: A Journey from Macro to Micro

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Abstract

Biological tissues are developed with the three-dimensional array of the biological cells suspended in an extracellular matrix which is an ionic medium. The intracellular fluids like cytoplasm and nucleus-fluids (karyolymph, or nucleoplasm or nuclear sap) are also found to be conducting in nature. The cell membranes are developed with protein-lipid-protein bi-layer which produces a capacitive reactance towards the alternating electrical excitation. Collectively the biological tissue provides a complex electrical impedance towards the AC current flow through it which is called bioelectrical impedance or bioimpedance. Bioimpedance of the biological tissues depends on the tissue structure, tissue composition and the tissue health. The biological tissue health and composition can be assessed by measuring the electrical impedance of the tissue sample. In this direction, to study the tissue physiology and anatomy from the electrical impedance measurement, a number of methods have been proposed such as bioelectrical impedance analysis (BIA), electrical impedance plethysmography (IPG), electrical impedance cardiography (ICG), electrical impedance spectroscopy (EIS), electrical impedance tomography (EIT). Electrical impedance spectroscopy (EIS) has been found to be a promising technique not only in the biomedical applications, but also in other areas of applications for different material characterization. BIA, IPG and ICG are applied for medical applications. EIS is found as a non-destructive testing technique which measures the electrical impedance of the material under test and provides the information about the material composition, structure and health. Due to its several advantages the EIS technology has been applied to test, analyse and characterize the materials in a number of research areas such as electrical engineering, mechanical engineering, civil engineering, metallurgical engineering, material engineering, chemical engineering, biomedical engineering, food technology, biotechnology, microbiology and other applied sciences. In the EIS based material testing process, an array of surface electrodes is attached to the material under test and the electrical impedance and phase angle of the material is measured at several frequencies. To measure the electrical impedance of the materials is estimated by applying a constant amplitude of alternating current (or voltage) signal and measuring the voltage (or current) signal developed. A low frequency, constant amplitude electrical AC current (or voltage) signal is applied at a number of frequencies (f_1, f_2, f_3, …f_n) and the developed AC voltage (or current) signal is measured at all the frequencies. The electrical impedance (Z: Z_1, Z_2, Z_3, … Z_n) and the phase angles (ϕ: ϕ_1, ϕ_2, ϕ_3, … ϕ_n) are calculated at all the frequency points. The imaginary parts of the impedance (X: X_1, X_2, X_3, … X_n) are plotted over the real part of the impedance (R: R_1, R_2, R_3, … R_n) and the Nyquist plot is obtained to obtain the equivalent electrical circuit of the material. Electrical impedance tomography (EIT) is a CT imaging modality which uses electrical signals instead of X-Rays. Thus, EIT is found basically as a nonionizing CT scanning procedure which has been applied in a number of areas to solve several practical problems. Conventional CT imaging techniques such as X-Ray CT, PET, SPECT, MRI have been found with different advantages and disadvantages and hence they are found with their potential to be used in different applications. But due to some unique advantages, EIT is found to be a promising imaging modality in the field of medical and non-medical fields. EIT is found with a wide range of applications in several research domains. EIS is an electrical impedance-based material characterization technique which collects the lumped impedance parameters over a certain frequency range. On the other hand, EIT is an electrical signal-based CT technique that provides the spatial distribution of electrical conductivity or resistivity of the domain under test. EIS and EIT both are found very fast, safe, portable, low cost, and other advantages and therefore it has been applied in biomedical engg., mechanical engg., chemical engg., civil engg., material engg., biotechnology, and many other fields of engineering and applied sciences. In this talk the speaker will discuss the fundamentals of the electrical impedance methods, EIS and EIT technology and the associated instrumentation design and development. The effect of impedance sensors and contact impedance in impedance measurement systems will be summarized. The application of EIS and EIT will be discussed in detail highlighting the present scenarios, recent research trends and challenges. The research trends on EIS and EIT technologies in micro and nano technology will also be discussed. The advantages, limitations, future possibilities of EIS and EIT testing will be summarised.

Keywords: computed tomography (CT), bioelectrical impedance, electrical bioimpedance, electrical impedance spectroscopy (EIS), electrical impedance tomography (EIT), electrical impedance measurement, micro-systems, nanotechnology.

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Behavior Of Reinforced Concrete Shear Walls Under Lateral Loads

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Abstract

Reinforced concrete (RC) shear walls are common structural components. Their high in-plane stiffness significantly increases the lateral stiffness and decreases the lateral displacement of structures under wind and earthquake forces. In seismically active areas, RC shear walls are used alone or in conjunction with other lateral-resisting systems to handle lateral and gravity loads. Depending on the height-to-length aspect ratio, these walls could exhibit flexural, shear or shear-flexural behavior. When subjected to lateral loads, reinforced concrete shear walls exhibit a stiff and ductile behavior, effectively resisting lateral forces by primarily deforming in shear, with the reinforcement providing tensile strength to counteract the diagonal cracks that develop across the wall, allowing for significant energy dissipation and minimizing lateral displacement of the structure; this makes them a key component in buildings designed to withstand seismic forces and wind loads. Their behavior under lateral loading involves multiple stages, including elastic deformation, cracking, yielding, and ultimate failure. Depending on their aspect ratio, shear walls may exhibit flexural, shear, or combined failure modes. Flexural behavior dominates in slender walls, while shear-controlled failure is more common in squat walls. The response is influenced by factors such as reinforcement detailing, axial load level, and material properties. Under cyclic loading, shear walls experience stiffness degradation, strength deterioration, and energy dissipation through hysteretic behavior. Proper design and detailing, as per seismic codes, enhance ductility and ensure reliable performance. Understanding the nonlinear response of RC shear walls is critical for improving their resilience in earthquake-prone regions. Under lateral loads, reinforced concrete shear walls primarily behave as stiff, vertical cantilevers, resisting the forces by primarily bending deformation, with the reinforcement steel playing a crucial role in resisting the tensile stresses induced by this bending, effectively transferring lateral loads to the foundation and providing significant lateral stiffness to the structure, especially in seismic conditions; this behavior is generally considered elastic until reaching a critical load level where cracks may develop, leading to a more plastic response depending on the wall design and loading conditions.

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Metal Reinforced NBS Heterocyclic: A Potential Hydrogen Storage

Subhra Das

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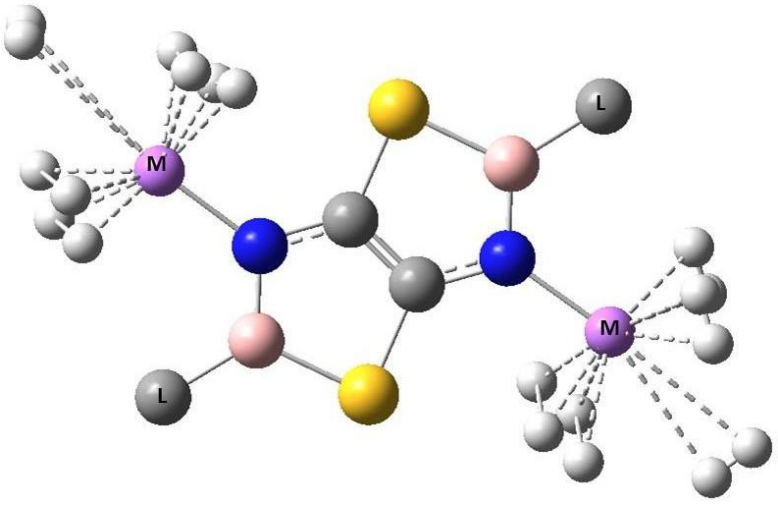
Abstract

To address the challenges related to hydrogen storage utilization of metal reinforced system would be an effective tool. Metal-Organic Frameworks (MOFs) have emerged as promising candidates for hydrogen storage due to their high surface area, tunable pore size, and chemical versatility. This study presents a comprehensive computational investigation of potential hydrogen storage in Metal (Li&Na)-based NBS heterocycles using density functional theory (DFT) methods. The primary objectives include identifying suitable MOF structures, evaluating their hydrogen adsorption capacities by calculating gravimetric weight percentage (wt.%), and comparing their performance against the Department of Energy's (DOE) 2025 targets. Additionally, bonding interactions between metal sites and hydrogen molecules were characterized using advanced techniques like Electron Localization Function (ELF), Non-Covalent Interaction (NCI) analysis, and Atoms in Molecules (AIM) theory. The study offers critical insights into the design and optimization of MOF-based hydrogen storage materials, contributing to developing efficient and stable systems for clean energy applications.



Metal Reinforced NBS Heterocycle

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IMPORTANT DATES

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