ABSTRACT BOOK

THE FIRST INTERNATIONAL CONFERENCE ON SUSTAINABLE TECHNOLOGIES (ICST-2024)

12-15TH DECEMBER 2024

ORGANIZED BY
MICROSYSTEM DESIGN-INTEGRATION LAB
BIDHAN CHANDRA COLLEGE, ASANSOL, WB, INDIA
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Volume Edited by
Dr. Goutam Mukherjee, Dr. Saumen Chakraborty, Dr. Sudipta Roy, Dr. Amit Banerjee, Dr. Ajay Kumar Sharma, Mr. Apurba Paramanik

Patron in Chief
Dr. Falguni Mukhopadhyay

Bidhan Chandra College
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Recognized by U.G.C (Govt. of India) and affiliated to Kazi Nazrul University
Asansol – 713304, Dist – Paschim Bardhaman , West Bengal , Ph : 0341-2283020
Visit us: www.bccollegeasansol.ac.in; E. Mail: office@bccollegeasansol.ac.in

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From the Desk of the Principal, Bidhan Chandra College, Asansol

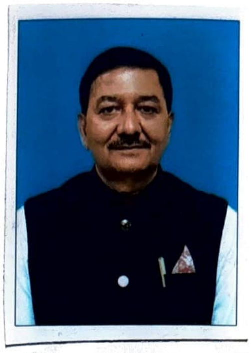
This is a matter of extreme pleasure and deep satisfaction that the First International Conference on Sustainable Technologies (ICST2024) is being organized in hybrid mode by the Microsystem Design Integration Laboratory of the Department of Physics, Bidhan Chandra College, Asansol, in association with TCG Crest, Kazi Nazrul University, Asansol, West Bengal, India on 12-15 December 2024, the venue being the National Institute of Technology, Durgapur, West Bengal, India. As an Anusandhan National Research Foundation project, the ICST-2024 is supported by the Science and Engineering Research Board (SERB), Ministry of Science and Technology, Government of India. The stature and magnitude of such an academic endeavor on part of the Department of Physics of our institution mark a historical moment of both celebrating an unprecedented academic achievement reached through continuous and sincere collective pursuit and looking forward to a new journey. As the principal of Bidhan Chandra College, I truly feel proud of our institution, and on behalf of the administration I wholeheartedly congratulate the ICST-2024 Organizing Committee. The conference is meant to offer a global platform to the aspirant scholars of science and technology and senior and junior academicians, by introducing them to not only the highly sophisticated scientific discourse engaging some of the most renowned persons in the field, but also some schemes related to the empowerment of young and women scientists. On behalf of Bidhan Chandra College, we extend our heartfelt gratitude to every resource person of this Conference for their enlightening contribution as a 'star speaker' – a term aptly used in the Conference brochure. My best wishes for all the participants from different institutions and places. We also take the opportunity to express our gratefulness to the Ministry of Science and Technology, Government of India, New Delhi, India, and Kazi Nazrul University, Asansol, India. I would like to acknowledge the cooperation of the National Institute of Technology, Durgapur, India, and especially its Director, for providing us with a venue that is appropriate in every sense. We look forward to a great academic experience and my sincere greetings to all who are directly or indirectly associated with it.

Principal
Bidhan Chandra College
Asansol

राष्ट्रीय प्रौद्योगिकी संस्थान दुर्गापुर
(शिक्षा मंत्रालय, भारत सरकार के अधीन राष्ट्रीय महत्व का संस्थान)
NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR
(An Institute of National Importance under Ministry of Education, Govt. of India)

प्रो. अरविन्द चौबे / Prof. Arvind Choubey, निदेशक / Director

Ref. No. : NITD/DS/2024/ ५५ **Date :**December 06, 2024



DIRECTOR'S MESSAGE

I am delighted to know that the **First International Conference on Sustainable Technologies (ICST2024)** is being organised at **National Institute of Technology Durgapur during December 12-14, 2024**. The theme of the conference as evident from its title is highly commendable at a time when the world is facing serious sustainability challenges due to various technological, socio-economic and geo-political crises. I am extremely grateful to the organising committee of the ICST 2024 to come up with the initiative to arrange such an event. What makes me very impressed is that the conference themes have been chosen keeping in mind the multidisciplinary nature of today's research which will allow the delegates to closely interact for possible future collaboration in cross-disciplinary fields. I am told that within a span of three months since first circulation of the conference, the organisers **have received more than 250 papers** to be presented at the conference which in itself is an achievement. I am confident that **40-plus invited/keynote/plenary** lectures to be delivered by renowned researchers and scientists from across the country and abroad will enormously enrich the young researchers. Wishing all the delegates, students and invited guests a happy and enjoyable time at ICST 2024.

(Prof. Arvind Choubey)

E-mail : director@nitdgp.ac.in, Website : www.nitdgp.ac.in
महात्मा गांधी एभेन्यु, दुर्गापुर- 713209, भारत / Mahatma Gandhi Avenue, Durgapur - 713209, India
टेल/Tel. No.- +91-343 254 6397, फैक्स/Fax No.- +91-343 254 7375

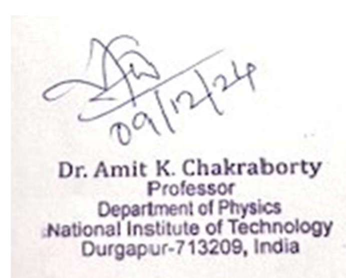
Message from the Conference Chair

Rapid industrialization across the world over the past century has not only improved our standard of living but also has caused several existential concerns for us such environmental pollution, ecological imbalance and climatic crisis. Industrial growth also resulted in industrial wastes bulk of which go directly into air or water bodies thereby making our air unbreathable and water undrinkable. In view of these, in 2015 the United Nations have come up with the seventeen sustainable development goals (SDGs) which all the signatory countries must adhere to while planning any developmental activities.

The **First International Conference on Sustainable Technologies** being organized at **National Institute of Technology Durgapur** during **December 12-14, 2024** is aimed to provide a common platform to researchers across the globe for interaction on various technological challenges that the world is facing in tackling some of these SDGs. As today's scientific advancement is not restricted to any single branch of science or engineering, emphasis has been given on attracting delegates from a diverse background. Physicist, Chemist, Chemical engineer, Materials, Mechanical, Electrical and Electronic Engineers, Computer and data scientists - all will come together in this conference to deliberate on how new discoveries and technologies can shape a sustainable future for our planet earth.

I am extremely happy to note that we have received almost **250 papers from** the delegates and more than **40 invited/keynote/plenary speakers** from across the world have confirmed their participation. I hope that this international conference will provide an opportunity to all the participants, particularly to the students and young researchers to exchange their ideas with the experts in various inter-disciplinary areas of **Energy Conversion & Storage, Solid State Materials & Devices, Water & Environment, Quantum Science & Technology, Data Science, AI & ML, Biotechbnology & Healthcare** etc.

On behalf of the organizing committee, I express my sincere gratitude to our main sponsor, the **Anusandhan National Research Foundation,** DST, Govt.of India and other industry co-sponsors. My heartfelt thanks also to various publishers (**Wiley, Springer and Taylor & Francis**) who have partnered with us to publish the papers presented in this conference. I am also **grateful to all the distinguished Resource Persons** (Invited/Keynote/Plenary speakers, Session Chairs) and above all our young delegates without whom the conference would be meaningless. Wishing you all a very interactive and enjoyable time at ICST 2024, Durgapur.



Keynote Talk Abstracts

Nanometer-MOSFET-Based Charge Transfer Device: Applications from Single-Electron Manipulation to Qubit Readout

Hiroshi Inokawa* and Hiroaki Satoh

Research Institute of Electronics, Shizuoka University
3-5-1 Johoku, Naka-ku, Hamamatsu 432-8011, Japan
** inokawa.hiroshi@shizuoka.ac.jp*

Abstract (Max 100 words)

Nanometer-scale miniaturization of silicon device, i.e. metal-oxide semiconductor field-effect transistor (MOSFET), has brought new opportunities in charge transfer. In this report, such attainments are introduced as arithmetic operation by single electrons, accurate current generation for metrological standard, capacitance extraction in atto-farad range for device characterization, qubit readout by capacitive gate-based sensing, etc.

I. Introduction

A circuit block consisting of two serially connected MOSFETs with a capacitor at the central node (Fig. 1) has a function of charge transfer from the positive-voltage side to the other when the MOSFETs are alternatingly switched on and off. Miniaturization of MOSFET into nanometer dimension has reduced the parasitic capacitances in and around it to atto-farad level (~10^{-18} F), which enables single-electron manipulation at room temperature and ultrasensitive capacitance measurement. New opportunities brought about by such capabilities are presented in this report.

II. Results

Coulomb blockade emerges at the central node due to the reduced capacitance around it. This leads to the accurate transfer of single electrons, realizing multilevel memory [1], arithmetic operation by single electrons at room temperature [2], and current standard with a precision of 0.2 ppm [3,4].

Since the transfer current is proportional to the relevant capacitance and switching frequency, spectroscopic measurement in atto-farad order becomes possible, resulting in applications such as parameter extraction for nanometer-scale MOSFETs [5] and capacitive biosensing in arrayed format [6].

Fast and sensitive electrometer is highly demanded for readout of charge and spin qubits [7]. Capacitive gate-based sensing [8] with integrated charge transfer device is proposed for scalable qubit arrangement [9], and its operation is verified by simulation with advanced capacitance modeling [9].

III. Conclusion

Nanometer-scale charge transfer device has brought and continues to bring new opportunities in single-electron manipulation and atto-farad sensing.

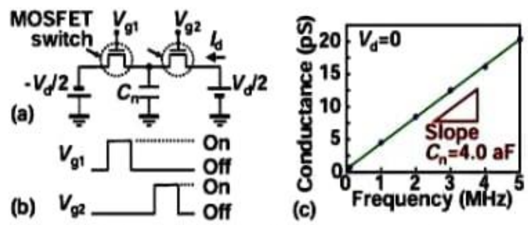


Fig 1: (a) Charge transfer device consisting of two serially connected MOSFETs, (b) gate voltage waveforms, and (c) an example of conductance dI_d/dV_d vs. gate pulse frequency.

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Battery Performance Enhancement via Electrode and Electrolyte Engineering

Satishchandra Ogale

Research Institute for Sustainable Energy, TCG-CREST, Sector V, Salt Lake, Kolkata-700091, India

Indian Institute of Science Education and Research, Dr. Homi Bhabha Road, Pune-411008, India

Abstract

During the past decade, research and technology developments in the field of energy storage, in general, and Batteries, in particular, have acquired significant international attention. While Li-ion batteries are still on the forefront, several new and emergent chemistries and battery designs are being actively pursued because of Li scarcity (need for recycling) and safety. Amongst these, the noteworthy are Na-ion batteries, Li/Na Metal Batteries, aqueous Zn Batteries, and anode-free Li/Na batteries. In this talk, I will briefly outline this scenario and then discuss some of our recent research on Anode-Free batteries and Na-ion batteries, including industrial collaboration in the latter case, with the focus on the electrode and electrolyte engineering aspects.

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The Untold Story of Fuel Cells

K. K. Nanda
Institute of Physics, Sachivalaya Marg, Bhubaneswar – 751005, India

Abstract

Due to the increase in population and urbanization, analysts and policymakers have identified a number of drivers of future needs. The World is going to face challenges with construction materials, energy security, food and water security, environmental issues, health care, etc. Among these challenges, energy security is a key contributor to economic development and growth. Renewable energy technologies are in increasing demand as they can produce clean power without causing harmful emissions into the environment. Scientists believe in the possibility of switching to a fully sustainable global energy landscape by 2050. My talk will focus on future sources of energy, especially, focusing on fuel cells and catalysts used for the same. It may be noted that fuel cells is ignored while considering the World electricity generation by source.

Emergent Materials for Nanophotonic and Energy Harvesting Devices

Samit K Ray

Department of Physics, IIT Kharagpur
Email : physkr@phy.iitkgp.ac.in

Abstract

We shall discuss the progress of emerging two-dimensional (2D) transition metal dichalcogenides (TMDs), inorganic perovskites and their heterostructures for photonic and energy harvesting devices. Utilizing the superior luminescence properties and high colour purity of inorganic perovskite nanocrystals, we reported the fabrication of colour-saturated $CsPbBr_{3-x}I_x$ (x=0-3)/ZnO heterojunctions based white light emitting diodes on a flexible platform. Hybrid heterostructures comprising of zero-dimensional perovskite nanocrystals having excellent photosensitive characteristics offer the possibility to achieve next generation optoelectronic devices with superior functionalities. This has been demonstrated through giant photo-amplification in highly stable α-$CsPbI_3$ NCs on layered WS_2 mixed-dimensional heterostructures photo-FET with asymmetric contacts. Finally recent trends in piezo-phototronic and triboelectric energy harvesting devices would be reviewed.

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Effect of Structural Distortion on the Electronic Structure of Bulk ReS2 and ReSe2 - Potential Bifunctional Photocatalysts

Professor V. R. Dhanak

Physics Department,
Room 308 Oliver Lodge Building,
University of Liverpool,
Liverpool L69 7ZE
UK
vin@liverpool.ac.uk

Abstract

Transition metal dichalcogenides display high degrees of structural and electronic complexity, providing fertile grounds to study the interplay between these properties. The unique, low symmetry rhenium dichalcogenides (ReX2, X = S,Se) are investigated using soft and hard X-ray photoelectron spectroscopy (XPS) coupled with density functional theory calculations, giving deeper understanding of the relationship between the atomic and electronic structure. Core level spectra reveal the presence of inequivalent anion sites resulting from high levels of structural distortion. Multiple photon energies allow for the first accurate experimental determination of the binding energy of the Re 5p core level which was found ~ 0.1 eV below that of the Re 4f 7/2 core level. The positions of the valence band maximum and conduction band minimum with respect to the vacuum level are determined, and the resulting band alignments demonstrate the potential of both dichalcogenides as bifunctional photocatalysts for water splitting. Collectively, these measurements offer new insights into the relationship between the atomic and electronic structure, forming the basis for future developments of ReX_2-based devices.

Quantum Computing and Quantum Technology

A.K. Pati

Professor, CQuERE, TCG-Crest, Kolkata

Abstract

Classical information science has a great impact on various technological developments such as computers, internet and a host of other information processing devices. However, the present generation has witnessed a revolution in the emerging technology-- called quantum computing and quantum technology. I will give a brief introduction to Quantum Computers which are promising new devices that can perform certain computational tasks much faster and efficiently compared to classical computers. During my talk, I will bring out some fundamental differences between classical and quantum information. Also, I will highlight several quantum communication and quantum technological feats which are otherwise impossible in the classical world. Quantum technology will have a deep impact on all aspects of human life by solving complex problems that are currently intractable and provide secure communication links presently unthinkable.

Quantum computing with trapped ions

Prof. Manas Mukherjee
Director, The National Quantum Federated Foundry (NQFF), Singapore
Associate Professor & PI, Centre for Quantum Technologies, NUS

Abstract

Quantum technologies in general and quantum computing (QC) in particular is predicted to be one of the most disruptive among the emerging technologies. Therefore, translation of this technology is happening at a neck break speed. As an example, small scale quantum computers are now available over the cloud as a software as a service (SaaS) offered by leading corporates as well as startups. Even though the current backend quantum hardware are too noisy to yield any useful quantum advantage, they are the best playground to explore the potentials of a quantum computer. Among the various physical realizations of a quantum computer, ion trap-based quantum processor is one of the front runners. This platform has shown high fidelity gates and our interest is to exploit it for quantum machine learning, quantum simulation and sensing. We will discuss the challenges that lay ahead in scaling up of this system and how we intend overcome them in the context of the "hype" in the field.

Functionalized Metal-Organic Frameworks (FMOFs): Advancing Clean Energy Applications and Ultra-Sensitive Detection of Organic Environmental Contaminants

Dr Priyabrata Banerjee[1,2]*

[1]*Electric Mobility and Tribology Research Group, CSIR – Central Mechanical Engineering Research Institute (CMERI), Mahatma Gandhi Avenue, Durgapur, 713209, West Bengal, India.*
[2]*Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, Uttar Pradesh, India*
**Corresponding author:* pr_banerjee@cmeri.res.in

Abstract

Functional metal–organic frameworks (FMOFs) have emerged as cutting-edge materials in energy application along with optical sensing, leveraging their exceptional luminescence, structural versatility, and tuneable surface properties for high-precision of catalytic activity and toxic analyte detection. Recent innovations focus on nanoscale engineering, yielding FMOFs nanosheets and composites with superior stability and morphological adaptability. Since last decade, FMOFs have been pivotal in addressing critical environmental challenges like energy crisis and also enabling the detection of nitroaromatic compounds (NACs) along with environmental contaminants that pose significant ecological and health threats. Furthermore, a future outlook envisions the paradigm-shifting integration of artificial intelligence (AI) and machine learning (ML) techniques with FMOF-based next-generation energy materials along with enabling superior quantification of toxic analytes.

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Carbon based nanoscale capacitor

Utpal Sarkar

Department of Physics,
Assam University, Silchar-788011, India
(E-mail: utpalchemiitkgp@yahoo.com)

Abstract

The miniaturization of electronic device with desired properties is required for the advancement of nanoscience and engineering. To develop the next generation charge and energy storage system with high power density, short charge/discharge time, carbon-based material is an alternative. Carbon is helpful in developing a vast multitude of materials that exists in 0, 1, 2 and 3 dimensions and can tune its properties of interest which find applicability in different applications of daily life. In this talk, several hybridized carbon allotropes *e.g.* graphyne, pentagraphene, pentagraphyne, twin-graphene *etc.* will be discussed in connection with its application in the field of energy storage, specifically the nanoscale capacitor. The atomistic insights that stems from the quantum nature of the system will be discussed in terms of its structural and electronic properties, occasionally augmented by optical properties.

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Light, Camera, Action

Prof Urbasi Sinha

Professor,
Raman Research Institute

Abstract

Quantum mechanics is a cornerstone of modern physics. Just as the 19th century was called the Machine Age and the 20th century the Information Age, the 21st century promises to go down in history as the Quantum Age. Quantum Computing promises unprecedented speed in solving certain classes of problems while Quantum Cryptography promises unconditional security in communications. In this talk, I will discuss the world of single and entangled photons and also discuss ongoing work towards quantum communications, quantum information and quantum computing in our Quantum Information and Computing lab at the Raman Research Institute, Bengaluru, India. I will end with our broad vision for the future, which includes establishment of long-distance secure quantum communications in India and beyond involving satellite based, fibre based as well as integrated photonics-based approaches towards the global quantum internet.

Edge computing for sustainable Internet of things

Prof. Debashis De

Professor, Department of Computer Science & Engineering,
Maulana Abul Kalam Azad University of Technology, West Bengal, India

Abstract

The quick spread of Internet of Things (IoT) devices has transformed a number of sectors, but it has also brought up serious issues with data management, energy use, and the environment. By facilitating localized data processing nearer to IoT devices and lowering reliance on energy-intensive centralized cloud systems, edge computing appears as a sustainable alternative. By restricting long-distance data transmissions, this paradigm improves data security, lowers latency, and uses less energy. Edge computing increases resource utilization and supports real-time analytics in sustainable Internet of Things applications including industrial automation, smart cities, and precision agriculture. The feasibility of edge computing in accomplishing sustainability objectives is further increased by important enabling technologies, such as federated learning, energy-efficient hardware, and integration of renewable energy. Notwithstanding obstacles such as interoperability and device restrictions, edge computing offers a real time IoT experience.

Multifaceted Applications of 2D Materials in Nonlinear Optical Devices and Renewable Energy Production

P. Kumbhakar*

Nanoscience Laboratory, Dept. of Physics, National Institute of Technology Durgapur, 713209, West Bengal, India
**Corresponding author: pkumbhakar.phy@nitdgp.ac.in*

Abstract

Thanks to the recent boom in developments of advanced nanostructured materials having multifaceted applications including in environmental remediation, and in development of sustainable technologies for attaining sustainable development goals (SDGs) of the United Nations. We shall present in this talk about different techniques of syntheses, and measurement of nonlinear optical and energy harvesting applications of some 0D-2D semiconductor nanostructured materials. Also, we shall present some highlights of recent research findings of our group.

Materials under challenging environment of nuclear Reactors

B. K. Panigrahi

Raja Ramanna Fellow, Institute of Physics , Bhubaneswar

Abstract

The fast-growing energy demand and concerns about climate changes require nuclear energy to play a role among other energy sources to satisfy future energy needs of India. Of the available technology options, Water Reactors and Fast Breeder Reactors with closed fuel cycle (recovery of fuel from the irradiated fuel and recycling of the fuel) is an inevitable technology option, to provide sustainable energy security for India. Materials in sodium cooled fast spectrum reactors and reprocessing plants are exposed to challenging environments of radiation, temperature, stress and chemicals, necessitating development of advanced fuels, structural and functional materials. The science and technology efforts required to realize fuel, structural materials and components of FBRs and associated reprocessing plants need carefully nurturing of a wide spectrum of knowledge base, expensive and rare facilities such as research reactors, hot laboratories and corrosion loops, expertise in a wide domain of interwoven interdisciplinary fields encompassing chemistry and physics of materials, computer simulation and modeling, manufacturing, repair and in-service inspection. Structural materials for fast reactor core components have evolved continuously over the years resulting in substantial improvement in the fuel performance. Major changes were made by changing percentage of major and minor elements and by modification of the microstructures by introducing cold work. For the future reactors with a design life of 2,00,000 MWd/t burnup of fuel, advanced ferritics and ODS alloys are being developed worldwide including India. The talk shall give an insight into the nature of R&D needed in developing advanced materials, including fundamental research to investigate basic physical and chemical phenomena occurring in normal and accidental operating conditions.

Next Generation Solar Photovoltaic Technology for Sustainable Future

Dr. Basudev Pradhan

Department of Energy Engineering, Centre of Excellence (CoE) in Green and Efficient Energy Technology (GEET), Central University of Jharkhand, Ranchi, India.
Email: basudev.pradhan@cuj.ac.in

Abstract

These days, the global energy crisis is emerging as one of the most significant issues facing humanity. In every year, the global electricity consumption also increases continuously, particularly in developing nations like our own where there is a severe lack of electricity. However, fossil fuels are limited, thought to run out and also are held responsible for increased concentration of carbon dioxide in the earth's atmosphere, which causes global warming. The consequences of the effect are already seen as an increase in the frequency and severity of natural disasters. These drew the attention to urgently develop environmental friendly renewable energy sources. One of the renewable energy sources is photovoltaic (PV) technology, which generates electricity directly from solar radiation. The photovoltaic cells have become extensively studied since the 1950s when the first crystalline silicon solar cell, which had an efficiency of 6%, was developed at Bell Laboratories. Since then, the efficiency has reached 26.3% for crystalline Si solar cells, which is already close to the theoretical predicted upper limit of 31%. Today's photovoltaic modules are extremely safe and reliable products, with minimal failure rates and projected service lifetimes of 20 to 30 years. Due to the high cost of crystalline silicon solar cells, different emerging new-generation solar cells based on different materials like organic, organic-inorganic hybrid perovskite, and different Quantum dot materials, are down the line to take over the PV market. Recently, the solution-processed organic tandem photovoltaic cell has achieved a record 17.3 % efficiency. The perovskite solar cells are also one of the most promising PV technologies, which has achieved 26.7 % efficiency in single cell structure in just over 15 years of R & D research all over the world. If the stability issues of perovskite solar cells are solved then it will be the first next generation solar PV technology, which will be commercialized very soon with very low production cost, clean, green, and sustainable energy solution for the future.

Quantum security enables unhackable communications with unbreakable key

Joyee Ghosh

Associate Professor

Quantum Photonics Group, Department of Physics,

Indian Institute of Technology (IIT) Delhi

https://web.iitd.ac.in/~joyee/

Abstract

Information and communication infrastructure is continually evolving, but ensuring long-term security is more challenging than ever. Quantum computing has put a clock on the effectiveness of cybersecurity, rendering even the strongest encryption vulnerable to future attack. This essentially calls for a secure and resilient communications infrastructure whose answer lies in quantum technology. Quantum secure communication is realized through Quantum Key Distribution (QKD) which is a technology designed to distribute the keys securely to different locations. It offers proven secrecy of encryption keys to reach long-term confidentiality while maximizing trust. QKD exploits fundamental principles and features of quantum mechanics – 1) observation causes perturbation and no-cloning – to exchange cryptographic keys over networks with provable security: an eavesdropper intercepting keys transmitted on the QKD quantum channel will necessarily cause perturbation that can be detected by the sender and receiver; 2) quantum entanglement – to ensure ultra-security through inherent randomness and absence of trusted nodes utilizing non-local quantum correlations that also offer long transmission paths. In this talk, we will focus on quantum entanglement based QKD which is the best technique for secured quantum communication. The QKD quantum channels are typically based on photons, also known as flying qubits as they can travel from one location to another. Thus, photonic qubits where information is encoded in the quantum state of the photons are an ideal choice for these applications, due to their speed, robustness and ease of manipulation. In particular, polarization- entangled photon pairs, due to their high entanglement purity and relative simplicity of generation, are key elements for many quantum communication (QC) applications, such as quantum networks, quantum key distribution and quantum teleportation. Nonlinear optical techniques like spontaneous parametric down conversion (SPDC) and spontaneous four wave mixing (SFWM) are widely used for their generation in bulk crystals or waveguides. While bulk crystals are preferable for free-space QC experiments (in the NIR optical band ~ 700-850-nm), all-fiber and WDM-based waveguide sources are more suitable for fiber-based QC experiments (in the telecommunication C-L bands ~ 1500-1600-nm). Covering these aspects, I will talk about the recent endeavours and results from our Quantum Photonics group in IIT Delhi.

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Invited Talk Abstracts

Plasmonic thin films: its application as transparent conductor, transparent heat reflector and plasmon-induced hot electron device

Bhola Nath Pal*, Sobhan Hazra, Satya Veer Singh and Sandeep Dahiya

School of Materials Science and Technology, Indian Institute of Technology (Banaras Hindu University), Varanasi-221005, India

Presenting Author's e-mail: bnpal.mst@iitbhu.ac.in

Abstract

Our group has developed a unique technique to grow the Ag clusters inside a TiO_2 matrix (Ag-TiO_2) through a low temperature (~100 °C) solution processed synthesis technique. This Ag-TiO_2 thin film has been used for various applications including developing transparent conductor, transparent heat reflector, SERS substrate, antibacterial coating, memristor devices and various plasmon-induced hot electron devices. For plasmonic transparent conductors (or transparent heat reflectors), it required a two steps deposition process. In the 1st step Ag-TiO_2 thin film is deposited in a solution processed technique, whereas in the second step either Ag or Au is deposited on top of Ag-TiO_2 film by thermal evaporation process. The optical transparency of Ag/ Ag-TiO_2 and Au/ Ag-TiO_2 thin film are ~70 % and ~85% respectively in the visible region whereas their conductivities are within the range 5-10 Ω/•. These optically transparent thin films have been used as electrodes for a photodetector and solar cell where these electrodes have dual roles. Because of their optical transparency, these electrodes allow visible light to enter inside the device. Besides, these electrodes also generate plasmon induced photocurrent that effectively enhances the photosensitivity of a photodetector and power conversion efficiency of a solar cell.

Keywords: Plasmonic thin film; hot electron; photodetector; solar cell; transparent heat reflector;

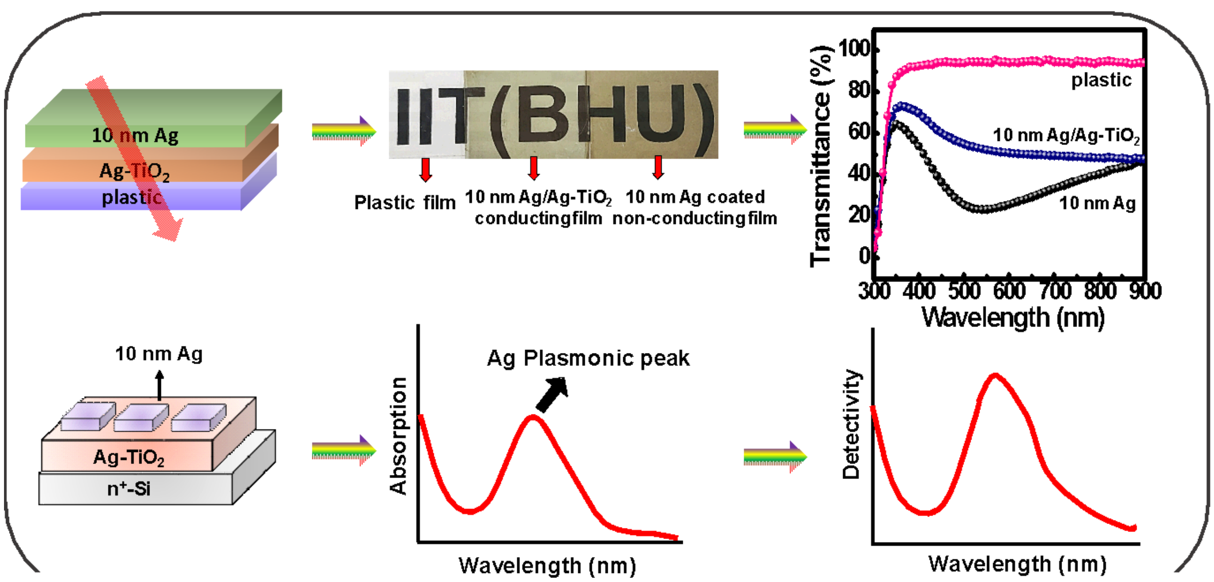

Figure 1: Schematic device structure of a typical plasmonic photodetector; Image of a Ag based plasmonic transparent conductor; Absorption spectra of plasmonic film; Detectivity of the devices that has similarity with absorption spectra.

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3. Sobhan Hazra, Satya Veer Singh, Sandeep Dahiya, Pijush Kanti Aich, Bhola Nath Pal, Solution Processed Ag/TiO2 Nanostructure-Based Schottky Junction Thin Films for Narrowband Hot-Electron Photodetectors, **ACS Appl. Nano Mater**. 2023 6 (16), 15119-15127
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Hydrovoltaics Power Generation from Nanostructured Materials

Sudip K Batabyal

Department of Sciences, Amrita School of Physical Sciences, Coimbatore, Amrita Vishwa Vidyapeetham, India.; Amrita Centre for Industrial Research and Innovation (ACIRI), Amrita School of Engineering Coimbatore, Amrita Vishwa Vidyapeetham, India.
**E-mail: s_batabyal@cb.amrita.edu*

Abstract:

Hydrovoltaic power generation is a recent research focused on sustainable energy harvesting. It is an innovative technology that harnesses electricity from the interaction between water and surface charges of nanostructured materials. This process involves capturing energy from natural water cycles, such as rain, waves, moisture, and evaporation. We investigated an ambient condition-based hydrovoltaics power generator which can give an excellent voltage and high amount of current in an ambient condition and it is boosted further when external energy (such as solar or wind) comes into play. Several practical applications were carried out to ensure the device's stability. It is to be noted that, the device can be able to give a stable output after one year of fabrication. Our group mostly focused on activated carbon, nano clay, and different metal oxide nanostructured for water vapor-induced power generation. For a typical example, activated carbon-based 3D hydrovoltaics devices show a maximum open circuit voltage of more than 0.9 V and a short circuit current of 0.72 mA [1-4]. These hydrovoltaics devices will be useful for powering the low power IOT-based devices.

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4. Streaming-Induced Hydrovoltaic Power Generation by Fluorinated Mg–Al Hydrotalcite Nanoclay; N Manikandan, SK Batabyal; ACS Sustainable Chemistry & Engineering, 2024, 12, 23, 8620–8629.

Rational Design of Cu-based Nanomaterials for Environmental Applications and Waste-Water Treatment

Kumar Babu Busi,[1] Shamili Bandaru,[1] Uday Kumar Ghorui,[1] **Sabyasachi Chakrabortty,**[1,*]

[1]Department of Chemistry, SRM University, AP – Amaravati, Andhra Pradesh, 522503 India
sabyasachi.c@srmap.edu.in

Abstract

In this talk, a versatile approach harnessing the unique properties of copper nanoclusters (Cu NCs)/Cu-based nanoparticles in the development of functional nanomaterials with applications in environmental sensing, photocatalytic hydrogen production and wastewater treatment, will be illustrated (**Figure 1**). In general, earth abundance, strong fluorescence in Cu NCs, aqueous colloidal stability, low toxicity, and cost-effectiveness made those Cu-based materials an active area of research.[1] In the first part, we will show a successful synthesis method for red-/green-color-emitting protein/amino-acid-mediated Cu NCs in an aqueous medium. Then, their usage as rapid, localized pH sensor development and an efficient optical probe for fluoride ion detection will be elaborated.[2] Later, the ability of such Cu NCs in photocatalytic hydrogen production will be discussed.[3] Finally, bovine serum albumin encapsulated - copper sulfide (BSA-CuS) NPs for efficient degradation of organic pollutants in water, will be explained. In particular, their efficiency in wide pH windows (unlike Fe-Fenton oxidation) and the role of H_2O_2 in such degradation process will be examined.[4]

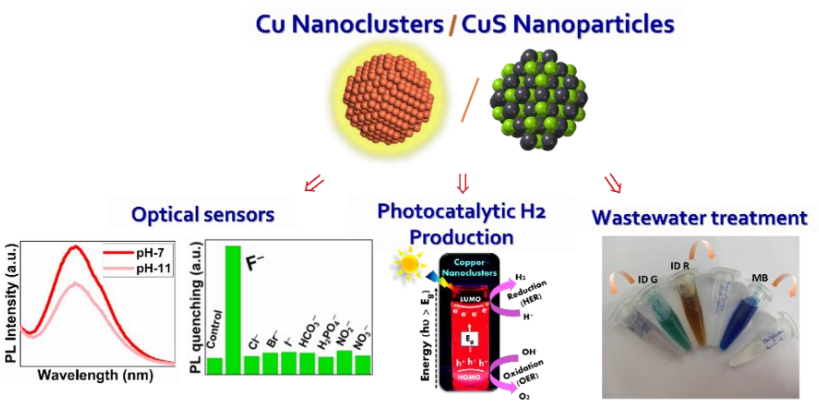

Figure 1: Cu-based nanomaterials for various applications

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Developing Safe, Cost Effective and High Energy Density Next-Generation Storage Systems

Dr. Avik Banerjee

Abstract

With the popularity of next-generation high-end electronic devices and the promotion of electric vehicles (EV), the cutting-edge lithium-ion battery (LIB) technology has continuously run into one bottleneck or another. Its main performance metrics (including energy density, power density, cycle life, safety, cost, etc.) have been unable to meet the ever-tightening demands for electrified transportation as well as renewable integration into the electricity grid. For electric vehicles, the most important application field of LIBs, it is necessary to reach an energy density of at least 400 Wh/kg at scale. After more than 25 years of commercialization, especially after large-scale production and applications in recent years, many components of LIBs (such as current collector, separator, packaging, and the like) have remained unchanged. Therefore, the important performance metrics of LIBs are mainly determined by the electrode material and electrolyte. And more importantly, next-generation LIBs need reasonable matching of electrode and electrolyte to achieve the best performance, including longer cycling and better safety. I have identified these underlying causes for cost-effective, sustainable, safe, high energy density Li-ion battery.

- Current Challenges with electrode materials of Li-ion battery.
- Next generation high energy and power density battery materials.
- Cost-effective cobalt-free Li-ion battery technology.
- Solid state (safe) battery technology.
- Advanced battery diagnostic tests and remanufacturing techniques.
- Advanced recycling systems that aim at expensive battery elements which include lithium, cobalt, nickel, manganese, etc.

These contributions are critical if energy storage technologies are to reach their full sustainability potential. Such studies will also enable Clean Technologies and Environmental Policy to continue its trajectory of growth in impact and global reach. I look forward to presenting these contributions in my upcoming talk.

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3. *Chem. Rev. 2020, 120, 14, 6878–6933*
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Development of Sustainable Environmental Gas Sensors: A Case Study of NO_x Gases

Dr. Ravindra Kumar Jha

Abstract

Microelectrochemical systems (MEMS)-based solid-state gas sensing devices have emerged as one of the important and reliable technologies in the post-Moore era. Advancement in this area has laid the foundation for several modern technologies like wearable devices, the Internet of Things, medical devices etc. However, these sensors have relatively shorter life spans and are usually discarded relatively sooner than other electronic devices like transistors. A sustainable approach towards its development and fabrication could have a potential impact on its contribution towards e-waste. In this talk, I will discuss a sustainable approach towards the development of gas sensors, particularly for NO_x gases. Not only the receptors but efforts can be made towards developing biodegradable substrates. Therefore, in the talk, the speaker will also discuss some of the NO_x sensing devices fabricated on a flexible biodegradable substrate.

Kitchen- bio waste-driven carbon electrode materials for efficient supercapacitor applications

Om Prakash Sinha[1]*

[1]Amity Institute of Nanotechnology, Amity University Uttar Pradesh, Noida, UP, India
*Corresponding author: *E-mail: opsinha@amity.edu

Abstract

The rising energy demand reduces the use of fossil fuels and degrades the environment. Researchers are increasingly interested in acquiring environmentally acceptable energy storage systems such as batteries, supercapacitors, fuel cells, and so on. Carbon and its composite compounds have gotten a lot of attention as effective electrode materials in this field. In this study, we began with a carbon composite electrode material. CV, GCD, and EIS are used to investigate the supercapacitor capabilities of these electrode materials. The ZnO/CNT composite has a capacitance of 67.5 F/g in 6M KOH electrolyte and a bulk resistance of 2.6 Ω. Later, kitchen bio-waste is employed to synthesize the eco-friendly carbon sphere with three different peels (potato, onion, and peas). Out of these, the potato peel-based carbon sphere shows the highest capacitance of 1987.5 F/g at 0.2 A/g current density in 2M H_2SO_4. Also, potato peels-based carbon have a retention capacity of 91.66%. Further the capacitance of potato peel is enhanced by the make its composite with the Nickel sulfide (NiS). NiS/C have a capacitance of 2038.5 F/g at 0.1 A/g current density with retention capacity of 95.04% after 20,000 continuous charge-discharge cycles, showing its exceptional cyclic performance. This study provides the gateway to study the bio-waste driven carbon and its composite for the electrode material in supercapacitor application.

Keywords: CNT/ZnO, bio-waste driven carbon, electrochemical studies

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MACHINE LEARNING ASSISTED DEVELOPMENT OF HIGH EFFICIENCY ORGANIC SOLAR CELL: RAPID SCREENING AND PROPERTY PREDICTION

Supravat Karak

Organic and Hybrid Electronic Device Laboratory, Department of Energy Science and Engineering, Indian Institute of Technology Delhi, New Delhi 110016, India
E-mail: supravat@dese.iitd.ac.in

Organic solar cell (OSC) has witnessed a rapid performance improvement due to the development of novel A-DA'D-A non-fullerene acceptor (NFA) with efficiency reaching 19%. With excellent opto-electronic properties, the NFA molecules could achieve high open circuit voltage and current at the same time. Theoretical estimations showed that the efficiency of OSCs can be increased up to 21% if the energy loss is lower than 0.4 eV, since voltage loss and low fill factor pose major performance limitations for such devices. To accelerate the discovery of functional organic semiconductors and rational device optimization, data-driven and experiment oriented machine learning (ML) approach could play crucial role. ML can provide an effective prediction model based on big data, avoiding the time-consuming high-throughput experiment, which has been proposed and validated in this study. Herein, we effectively predicted and screened the performance of OSCs based on various polymer:NFA combinations by employing a data-driven machine learning (ML) approach (shown in Figure 1) and successively validated the model by fabricating a set of highly efficient devices with a PCE up to 15.23%[1,2]. A dataset of 1242 experimentally verified donor:acceptor (D/A) combinations was constructed, and the corresponding material descriptors were generated to train and test five different supervised ML models. It was found that the random forest ML model performed best for predicting the PCE while the gradient-boosting ML model is better for the prediction of both J_{SC} and V_{OC}. The proposed ML approach provides an effective method for predicting and virtual screening of donor-acceptor pairs with minimal energy loss and would be useful for developing next-generation high-performance solar cell materials.

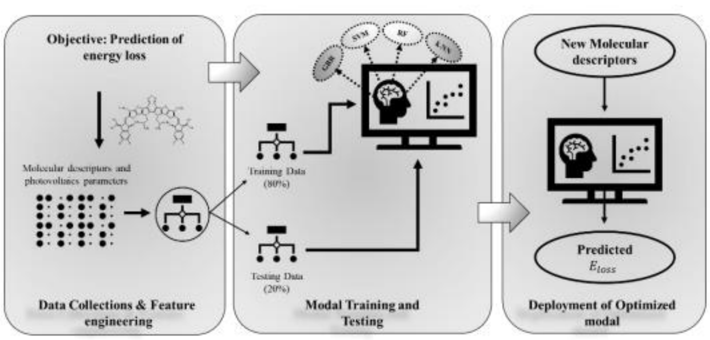

Figure 1 Schematic of the proposed ML model

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Minimizing Electronic Waste by Preventing Premature Device Failures: A Pathway to Sustainable Development

Monalisa Char, Amit Kumar Chakraborty, Abhijit Kar*

Department of Materials Science and Technology MAKAUT West Bengal 741249, India
Carbon Nanotechnology Lab, Department of Physics & Centre of Excellence in Advanced Materials, NIT Durgapur 713209, India
Jagadis Bose National Science Talent Search Kolkata, JB Centre of Excellence, Kolkata 700107, India
**Corresponding author: chatrak130@yahoo.co.in*

Abstract

The growing challenges of handling the electronic waste (e-waste) need special attention. Electrical interconnects made through soldering are an integral part of any electronic devices and its failure are now being a serious issue, since the implementation of lead-free solders by replacing the toxic Sn-Pb solders in electronic industries. This study introduces a new multilayer based solder joint design using a transient liquid phase-like soldering process. Introducing Sn multilayers in combination with Sn3.0Ag-0.5Cu (SAC305) paste, demonstrated improved interfacial characteristics such as, uniform intermetallic compound distribution along with their smaller crystallite sizes, and increased dislocation density at the joint interface. Nanoindentation and Finite Element Analysis (FEA) confirm enhanced durability of the interconnects. This would help reduce e-waste and achieve cleaner environment.

Development of Novel Optically Controlled *hybrid* Inorganic-Organic Spintronic heterostructure

Puja Dey[1,2], Apurba Pal[1] and Nitish Ghosh[1]
[1]*Department of Physics, Kazi Nazrul University, Asansol, 713340, W.B., India*
[2]*Centre for Organic Spintronics and Optoelectronics Devices, Kazi Nazrul University, Asansol, 713340, W.B., India*
Email: pujaiitkgp2007@gmail.com, puja.dey@knu.ac.in, +91-8119804409, +91-8910089756

Abstract

Organic Opto-Spintronics is a promising field of research that explore the integration of high-speed operation of Optoelectronics and data storage capability of Spintronics in a single device to achieve futuristic ***Multifunctional***, ***fast*** and ***Energy Efficient*** integrated memory-logic devices. Incorporation of organic-based materials addresses the problem of spin relaxation and poor spin injection, and promises ***Eco-friendly*** and ***Energy efficient*** devices.

Organic-based Opto-Spintronics combines the effect of light with the spins of charge carriers. Coupling of spintronics and optoelectronics has been carried out adopting two approaches, *i.e.*, ***Magnetic field tuning of photo current*** and ***Optical tuning of spin valve effect to obtain Optospintronic effect.*** In the first approach, in an attempt to obtain magneto-tunability of photocurrent, we have successfully deposited ZnO-Reduced graphene oxide (rGO) photodetector on ferromagnetic substrates. The heterostructures, thus formed are Si/$Zn_{0.3}Ni_{0.7}Fe_2O_4$/ZnO-rGO and Si/$NiFe_2O_4$/C_{60}/ZnO-rGO. We have studied tuning of photocurrent, generated in ZnO-rGO photodetector overlayer by the magnetization of the underlayer $Zn_{0.3}Ni_{0.7}Fe_2O_4$ and $La_{0.7}Sr_{0.3}MnO_3$ ferromagnetic substrate through magnetic field and light dependent A.C and D.C transport property. Both the heterostructures exhibit reasonably good opto-spintronic effect.

In the second approach, we have fabricated a coupled organic photodetector and organic spin valve, i.e., a single Magnetic Organic Photodetector (MOPD) heterostructure, ITO/V$[TCNE]_x$/(C_{60}/Rubrene)/Co/Au that exhibited both the photodetection and spin-valve effect, at room temperature. According to our experimental evidences, this MOPD shows photocurrent generation with 40% photocurrent to dark current ratio under illumination of 660 nm red laser light. Also, it exhibits negative magnetoresistance as high as -25.85% under dark. Moreover, spin valve effect with peak up to 3% spin valve magnetoresistance is shown. Thus, this device can operate as an individual spin valve, and a photodetector. Significantly, coupling between spin valve and photodetector characteristics is observed for the first time in one of this MOPD device. Such "cross-talk" between optical response and spin valve property in a single device are highly significant for future development of novel optically controlled integrated memory logic devices, such as LiFi and *Electro-Optical Hybrid Computing* technologies.

A route map on the development of Pt(II) based less toxic and more effective anticancer drug

Sharmista Chatterjee, Chandrika Das and Sankar Chandra Moi*
Department of Chemistry, National Institute of Technology Durgapur, Durgapur 713209 WB, India; Phone: +91-9434788062; E. mail: scmoi.ch@nitdgp.ac.in

Abstract:
Recently, cancer is going to be a challenging global threat and the second leading cause of unnatural human death. This sobering reality has encouraged to develop safer and more effective anticancer drugs, to prevent ultimately loss of human life. The serendipitous discovery of anticancer activity of cisplatin[1], $[Pt(NH_3)_2Cl_2]$ by B. Rosenberg, which was first recognized in 1978 by FDA, USA for the treatment of several types of cancer. However, cisplatin's notable side effects posed significant challenges. To reduce the side effect and toxicity[2,3], next generation drugs like carboplatin and oxaliplatin were recognized, but not fully devoid of toxicity. We have designed and synthesized heterocyclic diamine based Pt(II) complex $[Pt(diamine)Cl_2]$, **C1** and its hydrolysed product $[Pt(diamine)(OH_2)_2](NO_3)_2$, **C2**. The thiol containing L-cysteine (L-cys) and N-acetyl-L-cysteine (N-ac-L-cys) chelated Pt(II) complex $[Pt(diamine)(L\text{-}cys)]^+$, **C3** and [Pt(diamine)(N-ac-L-cys)], **C4** were synthesized from complex **C2** and were characterized for the same. The binding aptitude of the Pt(II) complexes (**C1**-**C4**) with bio-macromolecule DNA and BSA were performed to evaluate their binding mode and binding constants. The drug likeness property was evaluated by PASS prediction and molecular docking of the complexes were executed with DNA and BSA. The complexes have better anticancer activity against MCF-7 and MDAMB231 cancer cell lines and less toxic on human normal embryonic kidney cell line HEK293T. The complexes are less toxic on normal cells, whereas more effective on cancer cells compared to recognized anticancer drug cisplatin, carboplatin and oxaliplatin. The cells (MCF-7) undergo necrosis when treated with the complexes (**C1** – **C4**). Their lower level of ROS generation in MCF-7 cell lines are comparable with the recognized anticancer drugs. Their cell death mechanism was executed to conform the drug activity on cancer cell lines.

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Aspects of Development and Characterization of Two Different Devices: Eco-Friendly Cs2TiBr6- Based Perovskite Solar Cells and Na_2O Doped Solid State Battery Electrolytes

Sanjib Bhattacharya*
UGC-MMTTC (Physics), University of North Bengal, Darjeeling-734013, WB, India
**Corresponding author: ddirhrdc@nbu.ac.in, sanjib_ssp@yahoo.co.in*

Abstract

In the present paper, development and characterization of two types of devices has been addressed. Firstly, a novel lead-free compound Cs2TiBr6 based photovoltaic device has been presented here with a structure as FTO (fluorine-doped tin oxide)/TiO2 (titanium oxide)/ Cs2TiBr6 (cesium titanium bromide)/ P3HT (poly3-hexylthiophene)/Au (Gold) in an adjustment and construction of each layer using SCAPS-1D (solar cell capacitance simulator) software for maximum power-conversion efficiency. Secondly, Na_2O doped glassy electrolytes have been developed which serves as the electrolyte for NIBs in terms of exhibiting certain important features such as in electrochemical stability, sensors etc.

Technical Track I: Energy Conversion and Storage

IMPROVING THE ENERGY TRANSFER EFFICIENCY IN WPT-BASED ELECTRIC VEHICLE CHARGING USING HYBRID MAGNETIC COUPLING MATERIALS

Ankur Yadav[1], Tushar Kanti Bera[1,2]

Department of Electrical Engineering, NIT Durgapur, WB 713209, India
Centre for Advanced Research on Energy (CARE), NIT Durgapur, WB 713209, India
Email ID: tkbera77@gmail.com

Abstract

Two popular magnetic materials used for magnetic couplers of wireless power transfer systems in electric vehicle applications are nanocrystalline and ferrite. In this work, a hybrid coupler with nanocrystalline and ferrite on the receiving and transmitting sides is proposed, considering the benefits and drawbacks of those two types of magnetic materials, including temperature, weight, loss, and saturation. To analyze the impact of load and magnetic material on the magnetic coupler's efficiency for an S-S-compensated topology in a wireless power transfer system, first determined optimal load and then used an assessment method for magnetic materials in a wireless charging system. The proposed hybrid coupler structure is based on simulation comparison and actual application considerations. Finally, the Ansys twin builder is utilized to simulate the validity of the suggested hybrid coupler. The results demonstrate that the magnetic coupler with the proposed hybrid coupler can achieve 94.50% efficiency at 85kHz, which is 2.5% higher and marginally lower than that of the coreless magnetic coupler and magnetic coupler with ferrite material, respectively.

Keywords: Wireless Power Transfer (WPT), Ansys Maxwell, Ferrite, Nanocrystalline, Magnetic Coupler

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RF sputtered metal oxide thin films towards energy harvesting: Role of ion bombardment

Aparajita Mandal[1] and Tapobrata Som[1,2]

[1]*SUNAG Laboratory, Institute of Physics, Sachivalaya Marg, Bhubaneswar 751 005, India*

[2]*Homi Bhabha National Institute, Training School Complex, Anushakti Nagar, Mumbai 40094, India*

Email: aparajitaiacs@gmail.com

Abstract

The efficiency of a photo-conversion device is presently restricted by the effectiveness of carrier extraction or contact layers. Metal oxide thin films, allowing a wide range of work function adjustability, hold promise for efficient charge extraction from light-absorbing materials. However, a strict stoichiometric control remains pivotal for realizing their full potential. In this talk, we will examine structure-property relations in vanadium pentoxide (V_2O_{5-x}) thin films towards advancing heterojunction solar cell technology with a specific emphasis on silicon-based solar cells. Ion impingement during the reactive radio frequency (RF) sputtering growth, instigate the formation of a 2D-van der Waals-like layered structure in a room temperature-grown amorphous V_2O_{5-x} film by precise control of oxygen flow. Moreover, the layered and phase-pure films possesses the highest work function and band-gap values, rendering it as highly suitable as a transparent carrier extraction layer for photovoltaic devices. The talk concludes by discussing the crucial role of oxygen flow in shaping both the surface and 2D-layered-structure-mediated bulk properties of V_2O_{5-x} films, advancing its potential for diverse energy applications, while the adopted low-power, low-temperature growth conditions align well with the device fabrication needs.

Deciphering electrocatalytic hydrogen production in water through a bioinspired water-stable copper (II) complex adorned with (N_2S_2)-donor sites

Sangharaj Diyali and Bhaskar Biswas*

Department of Chemistry, University of North Bengal, Darjeeling-734013, India
Email- bhaskarbiswas@nbu.ac.in, rs_sangharaj@nbu.ac.in

Abstract

In this present work, with a keen focus on emulating the significance of hydrogenase-like active sites in sustainable H_2 generation, a meticulously designed and water-stable copper (II) complex, [Cl−Cu−L^{N2S2}]ClO_4, featuring the N,S-type ligand has been crafted and assessed for its prowess in electrocatalytic H_2 production in water, leveraging acetic acid (AcOH) as a proton source. Electrocatalyst achieved the high turnover number of 73.06 with a commendable Faradic efficiency of 94.2% for ~1.6 h. The synergy of electrochemical, spectroscopic, and computational studies endorses the proton-electron coupling mediated catalytic pathways, affirming the viability of sustainable hydrogen production.

Design and control strategy of a two-stage onboard charger with an improved power factor for high-power applications in electric vehicles

***Debolina Pradhan**

Calcutta Institute of Technology, Uluberia, Howrah

**Corresponding author: Pradhan.debolina@gmail.com*

Abstract

This paper introduces a two-step power conversion strategy for onboard chargers in plug-in electric vehicles, employing a bridgeless totem-pole power factor correction converter in continuous conduction mode. This approach enhances efficiency by utilizing Sic MOSFETs, which lower conduction and switching losses while reducing current ripple. An isolated DC-DC converter is then utilized for battery power regulation. Control of the converters is managed through a nonlinear method called constant frequency one-cycle control, ensuring adherence to dynamic voltage references during both transient and steady-state scenarios. The effectiveness of this control strategy is validated through MATLAB simulations, supported by a mathematical expression for the control topology.

Efficacy and Present Status of High Entropy Alloys (HEAs) as a Hydrogen Storage Material: A Critical Review

Pulak Biswas*, Atanu Debnath, Projjal Basu

Department of Metallurgical Engineering, Kazi Nazrul University, Asansol, W.B. 721302

**Corresponding Author Contact : pulakbiswas441@gmail.com*

Abstract

Hydrogen energy has already proved as one of the most sustainable energy drivers for humankind in the coming days. Intensive R&D programs have been taken up all across the globe towards the development of the so called "Hydrogen Economy" in which storage of hydrogen plays a pivotal role. Hydrogen storage in liquid state or as compressed gas both have their associated drawbacks, e.g., application of cryogenic temperature, ultra-high pressure, hydrogen embrittlement, etc. Use of metal hydrides offers potentially efficient, safe, sustainable, and economic process for hydrogen storage. For conventional metal hydrides (MHX), a hydride-forming element (Ti, Zr, V, Nb, Hf, Ta, La, Ce, Ni) is used even though with varying extents of adsorption and desorption characteristics. An innovative category of materials, known as high-entropy alloys (HEAs), have emerged recently that consist of at least five principal elements in near-equiatomic composition, and these materials have complex microstructures that can be beneficial for improving hydrogen absorption/desorption kinetics, as well as improving storage capacity and cycling durability under hydrogen loading. The hydrogenation and dehydrogenation of HEAs are the basis for their utilization in hydrogen storage. HEA with body-centered cubic (BCC) structure presents a high potential for hydrogen storage due to the high hydrogen-to-metal ratio (up to H/M = 2), but hydrogen desorption is still an issue. To overcome this problem, some other elements (Mn, Fe, etc.) are added, which lead to precipitation of laves phase and with its increasing precipitation, the desorption rate also increases. HEAs such as TiVZrNbHf, TiVZrNbTa, and TiZrVCrNi have already exhibited promising attributes for high-storage-capacity with good hydrogen absorption, fast kinetics, and good cyclic stability. To improve upon this technology, continued theoretical and experimental activities are demanded. There are also other obstacles which are yet to overcome to exploit the full potential of HEAs in hydrogen storage. Controlling phase stability to promote initial hydride formation over unwanted phases, optimizing alloy compositions for combined hydrogen kinetics and mechanical properties, and suppressing embrittlement and capacity fade during thermochemical cycling represent primary issues. Additionally, the price and supply of some of the alloying elements may be an issue for which concerns could also arise for the economic/test scalability of HEA based hydrogen storage. The present paper summarizes a comprehensive review and critical analysis about the possible use of HEAs in the field of hydrogen storage.

Electrocatalytic reduction of CO_2 using 2D graphitic carbon nitride embedded copper doped-In_2S_3: Study of copper doping percentages on selectivity of products

Anirban Mukherjee[a], Niwesh Ojha[b], Kamal Kishore Pant[b], Amitava Banerjee[c], Susanta Sinha Mahapatra[d], Bidhan Chandra Ruidas[a]*

[a]Department of Chemical Engineering, Birla Institute of Technology, Ranchi 835215, India
[b]Department of Chemical Engineering, Indian Institute of Technology, Roorkee 247667, India
[c]Department of Metallurgical & Materials Engineering, Indian Institute of Technology, Jodhpur 342030, India
[d]Department of Chemistry, Birla Institute of Technology, Ranchi 835215, India
**Corresponding author; E-mail: bidhanruidas@gmail.com*

Abstract

Over the past few years, the increasing concerns regarding air pollution and global warming have stimulated extensive research on CO_2 sequestration and carbon capture development. Significant climate changes have been attributed to substantial increases in the concentration of greenhouse gases, specifically CO_2, in the atmosphere. Consequently, the conversion of abundant CO_2 to next-generation fuels such as formic acid and methanol/ethanol has become an attractive prospect and the primary focus of research and development. The electrochemical reduction of CO_2 to value-added chemicals using renewable energy represents one approach to address this issue. In this study, a series of two-dimensional (2D) graphitic carbon nitride embedded with Cu-doped In_2S_3 (Cu-In_2S_3/gC_3N_4) was synthesized via a hydrothermal approach to enhance CO_2 adsorption and facilitate its selective reduction to formic acid (liquid product) and carbon monoxide and hydrogen (gaseous products) at a relatively low overpotential (-1.6 V_{RHE}). The electro-reduction of CO_2 was conducted in an H-cell configuration under aqueous conditions, with 1^H NMR analysis of the liquid product and GC analysis of the gaseous products. The factors underlying the changes in selectivity and Faraday efficiency are examined in relation to the copper doping percentages and morphology of the catalysts. Furthermore, HR-TEM, FESEM, XRD, XPS, FTIR, RAMAN, and computational investigations demonstrated that the synergistic effect between Cu atoms and the In_2S_3 lattice is crucial for producing formic acid with high FE at lower applied potential. Finally, chronoamperometric measurements validate the exceptional stability of the composite material.

Adaptation Challenges of Biomass Energy in India by Multi Experts based Decision-Making Approach

Tripti Basuri[1,*], Srabani Guria Das[2], Kamal Hossain Gazi[3], and Sankar Prasad Mondal[3]

[1]*Uttar Dum Dum Vidyapith (Girls) Primary section, Birati, West Bengal, India*
[2]*Department of Basic Science, NSHM Knowledge Campus, Durgapur, West Bengal, India*
[3]*Maulana Abul Kalam Azad University of Technology, West Bengal, India*
**Corresponding author: triptibasuri92@gmail.com*

Abstract

India, as a developing nation, is facing significant compulsion to diversify its energy portfolio for ensuring sustainability and energy security. Biomass energy, a renewable resource abundant in India, has the potential to contribute to these goals. However, its adaptation faces several challenges, including technological, socio-economic and environmental barriers. There are various benefits of using biomass energy, such as reducing greenhouse gas emissions, helping to manage waste, and maintaining bio-diversity. In this paper, our object is to construct a model to identify the challenges related to the use of biomass energy in India. We will use Decision-Making Trial and Evaluation Laboratory (DEMATEL) techniques for finding the importance of each criterion and understand on which criteria we have to focus more.

Keywords: *Biomass energy; Renewable energy; Intuitionistic fuzzy set; DEMATEL*

Identifying Alternative Energy Sources in Eastern India: An Intuitionistic Fuzzy MCDM-based Study

Asesh Kumar Mukherjee[1,*], Shashi Bajaj Mukherjee[2], Kamal Hossain Gazi[3], and Sankar Prasad Mondal[3]

[1]*Department of Mathematics, Haringhata Mahavidyalaya, West Bengal, India*
[2]*Dr. B.C. Roy Engineering College, Durgapur 713206, West Bengal, India*
[3]*Maulana Abul Kalam Azad University of Technology, West Bengal, India*

*Corresponding author: aseshmukherjee2014@gmail.com

Abstract

This paper identifies renewable energy sources, excluding hydroelectric power, in eastern India and evaluates their sustainability using a Multiple-criteria decision-making (MCDM) approach, considering multiple conflicting criteria. The proposed study is performed using MCDM techniques, specifically entropy and VIekriterijumsko KOmpromisno Rangiranje (VIKOR) method in an intuitionistic fuzzy set (IFS) environment. Criteria are weighted based on their highest priority. The outcome has versatile applications, such as evaluating the feasibility of renewable energy technologies in homes, pinpointing appropriate locations for solar and wind farms in India, finding the proper renewable energy resources for generating electricity in industrial settings and more.

Keywords: *Renewable energy; Challenges for adopting renewable energy; Intuitionistic fuzzy set; Entropy; VIKOR*

Mxene Nanosheets Anchored Nickel Doped Tin Oxide For Superior Energy Storage Applications

Anurup Chakraborty[1], Mitali Patra[1], Koushik Bhunia[1], Amit K. Chakraborty[1,2]*

[1]*Energy Research Laboratory (ERL), Department of Physics, National Institute of Technology, Durgapur, 713209, INDIA*
[2]*Centre of Excellence in Advanced Materials, National Institute of Technology, Durgapur,713209, INDIA*
**Email of the corresponding author: amit.chakraborty@phy.nitdgp.ac.in*

Abstract

In this work we have demonstrated the synergistic effect of tin oxide and carbon material, by one step hydrothermal synthesis of nickel doped tin oxide on Mxene nanosheet. FE-SEM image have clearly shown the hierarchical morphology and the doping has been confirmed from XRD patterns. Nickel doped Mxene composite material have shown a very high charge storage capacity of $3.3F/cm^2$ (~ 1100F/g) than the undoped material, which have a sp. areal capacity of $0.4F/cm^2$ at a fixed current density of $3mA/cm^2$.

Manganese Infused Sodium Titanate for Advanced Sodium Ion Hybrid Capacitor application

Mitali Patra[1], Anurup Chakraborty[1], Koushik Bhunia[1], Amit K. Chakraborty[1,2] *

1. *Energy Research Laboratory (ERL), Department of Physics, National Institute of Technology Durgapur-713209, West Bengal, India*
2. *Centre of Excellence in Advanced Materials, National Institute of Technology Durgapur-713209, West Bengal, India*

**Email of corresponding author: akchakraborty.phy@nitdgp.ac.in*

Abstract

In this work, we have presented the potential application of sodium titanium oxide (NTO) as one of the electrodes in sodium ion hybrid capacitor. In this work we have developed manganese doped NTO of single phase $Na_2Ti_6O_{13}$ via low-cost, facile and scalable solid-state route. The electrochemical performance has been optimized by tuning the Mn concentration in NTO. The sodium storage performance has been explored by fabricating a hybrid capacitor with Mn doped NTO as anode. The main highlight of this work is the adaptation of a low-cost and scalable route for synthesizing NTO which can have a scope of large-scale production and commercialization in future.

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AI-Based Battery Management System (BMS) for Electric Vehicle (EV) Technology

Bimlesh Tiwari[1] Irfan Ahmed[1], Tushar Kanti Bera[1,2]

[1]*Department of Electrical Engineering, NIT Durgapur (NITDgp), M G Avenue, Durgapur, WB 713209, INDIA*
[2]*Centre for Advanced Research on Energy (CARE), NIT Durgapur (NITDgp), M G Avenue, Durgapur, WB 713209, INDIA*
Corresponding Author's Email: tkbera77@gmail.com

Abstract

Electric Vehicles (EVs) are found very promising automobile technology as the EVs are found operating with zero emission in running condition. The battery electric vehicles (BEVs) and the plug-in hybrid electric vehicles (PHEVs) are driven by the electric power stored inside the battery bank. Battery banks are required to be charged regularly to obtain a designed driving range. Battery management system (BMS) is an electronic hardware which is required to measure the battery parameters and monitor, assess and control the battery operation. The battery voltage, current charge, state of charge etc. are studied by the BMS. In recent time the artificial intelligence (AI) techniques are associated with the BMS to make the monitoring more smart, efficient and effective. The AI and Machine Learning are found playing an important role in enabling the predictive maintenance within the BMS systems. The integration of Artificial Intelligence (AI) and Machine Learning (ML) into Battery Management Systems (BMS) has transformed the electric vehicle (EV) industry not only by improving performance but also it has enhanced dependability, and safety. It utilizes real-time data and advanced type algorithms to create intelligent systems which is capable of pre fault analysis, adaptive control, and robust decision-making. AI and ML has overcome the challenges shown by the complex behaviour of batteries, which are influenced by temperature, State of Charge (SOC), State of Health (SOH), load dynamics, and aging. AI also enables the real-time battery health monitoring and failure prediction by analyzing data patterns like voltage and temperature trends. AI-powered BMS addresses key EV concerns such as range the predictive, adaptive, and proactive capabilities, sponsored by AI system are set to bring a revolution in battery management, ensuring safety, reliability, and long-lasting energy storage. Hence AI based BMS has Improved Battery Lifespan, Increased efficiency, enhanced safety, reduced maintenance cost. In this paper the need and application of AI tools in battery management system have been studied. Machine learning assisted BMS for EVs is studied. The advantages and challenges of AI-based BMS is summarised.

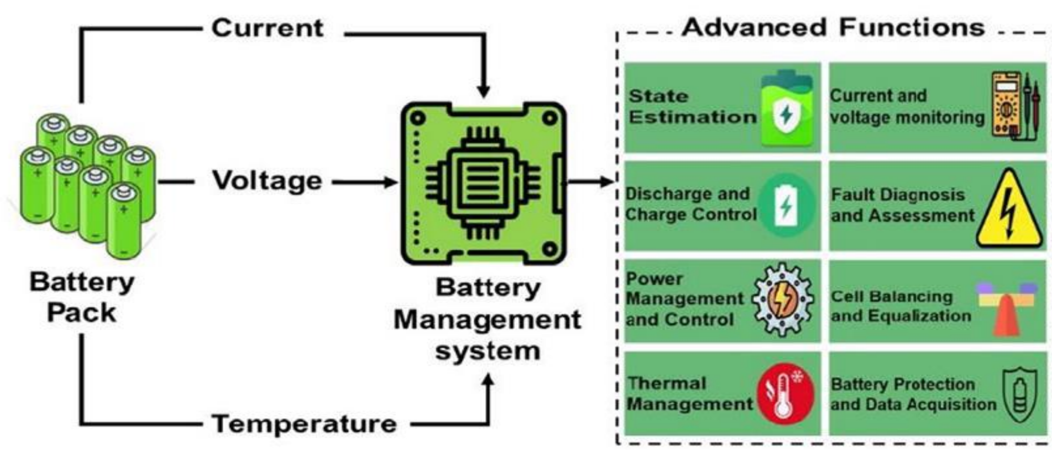

Fig. 1: AI assisted Battery Management System.

Innovative Pathways for CO_2 Emission Reduction in Iron Making

Bishwaprit Mitra

(NIT DGP, mitrabishwaprit@gmail.com), Radha Raman Abhyuday (TATA STEEL)

Abstract

Iron and steel production is responsible for 7–9% of global CO_2 emissions, making decarbonization essential. This paper examines hydrogen-based direct reduction (H2-DRI) and carbon capture and storage (CCS) as key technologies for reducing emissions. H2-DRI achieves 95% metallization with 0.41 MWh energy input per tonne, utilizing renewable electricity. CCS captures up to 800,000 metric tons of CO_2 annually. A case study of Tata Steel demonstrates practical implementation of these technologies, achieving up to a 30% reduction in CO_2 emissions. These approaches provide scalable, cost-effective solutions for sustainable steel production.

Effectively Tuning the Electrocatalytic Performance of Au-Ni/MWCNT Catalysts in Borohydride Fuel Cell Applications

Chandan Kumar Raul*, Ajit Kumar Meikap

Department of Physics, National Institute of Technology, Durgapur-713209, India

**Corresponding author: ckr.19ph1102@phd.nitdgp.ac.in*

Abstract

Direct borohydride fuel cells (DBFCs) surpass other direct liquid fuel cells in terms of open circuit voltage and energy density, though their performance strongly relies on the quality of advanced anode catalysts. This study focuses on improving the borohydride oxidation reaction (BOR) kinetics using some Au–Ni/MWCNT catalysts. The addition of Ni creates a synergistic effect that alters the electronic structure of Au, leading to better OH-adsorption. The $Au_{50}Ni_{50}$/MWCNT catalyst demonstrated the best electrocatalytic performance for BOR, achieving a peak power density of 67 mW.cm^{-2} and a current density of 70 mA.cm^{-2} at 303 K in a DBFC with a Pt mesh cathode.

Study of electrochemical properties of chemically synthesized $NiCo_2O_4$ thin film for potential electrode material

Roupya Gopal Ghosh[1], Shradha Roy[2] and **Ayan Mukherjee**[2*]

1. *Dept of Physics, The University of Burdwan, Burdwan-713104*
2. *Dept of Physics, College of Commerce, Arts and Science, Patna-800020*

**Corresponding author: ayan@cocaspatna.ac.in*

Abstract

Globally, there is a sharp rise in the demand for renewable energy. A good renewable energy system requires an efficient storage system whose efficiency depends on electrodes. Therefore, creating better electrode materials is essential to creating cutting-edge energy storage systems. In this work, we have successfully synthesized a binder-free $NiCo_2O_4$ thin film via the electrodeposition method on stainless steel substrate at different annealing temperatures. The structural, morphological, and electrochemical characterization has been done. CV curves show a good specific capacitance of 750 F/g at the current density of 1 A/g at 2M KOH solution.

Is aging a key to better electro-catalytic water splitting: Mn incorporated ZIF 8 for enhanced hydrogen production

Satyaki Mondal, Amit Kr. Chakraborty,*

Energy Research Laboratory, Department of Physics, National Institute of Technology, Durgapur-713209, West Bengal, India
**Corresponding author: amit.chakraborty@phy.nitdgp.ac.in*

Abstract

In the present work, we have presented a transition metal incorporated zeolitic imidazolate framework (ZIF-8) through one pot room temperature synthesis technique using co-precipitation method. The samples are aged for different time periods to find out starking differences in their electrochemical performance. The physicochemical properties of the synthesized samples are confirmed to be ZIF-8 by powder XRD, FESEM, and FT-IR analysis.

Keywords*: HER, MOF, OER and ZIF*

Sodium vanadate nanosheet wrapped carbon microsphere for high performance supercapacitor

Kousik Bhunia, Amit K Chakraborty*

Energy Research Laboratory, Department of Physics, National Institute of Technology Durgapur
**Corresponding author: amit.chakraborty@phy.nitdgp.ac.in*

Abstract

In the present work, we have demonstrated sodium vanadate (NVO) nanosheet wrapped carbon microsphere (MicroC) as electrode materials for electrochemical energy storage application. The NVO@MicroC trapped charge species between the interphase of NVO nanosheet and MicroC, thereby showing higher performance compared to the bare NVO nanosheet and MicroC. The current study highlighted the importance of hetero interphase microstructure to improve the energy storage ability of the device. The NVO@MicroC integrated asymmetric supercapacitor device is fabricated and performance is measured. Finally, the NVO@MicroC integrated device is demonstrated for practical application.

MUF-15/Polyamide (PA) Based Mixed-Matrix Membranes For Enhanced CO_2/CH_4 Gas Separation

Barun Kumar Mondal and Soumendu Bisoi*

Department of Chemistry, Narajole Raj College, Vill+PO: Narajole, Paschim Medinipore, West Bengal, India, Pin: 721211

**Corresponding author: soumendubisoi@gmail.com*

Abstract

Targeting CH_4, N_2, O_2 and CO_2, a new mixed-matrix membrane (MMM) was developed and evaluated for its gas separation properties. It is made up of semi-fluorinated aromatic polyamide (PA) and MUF-15 nanosheets, a Metal-Organic Framework (MOF) filler, from Massey University Framework (MUF). The PA matrix was filled with MUF-15 nanosheets at three different weight percentages: 0%, 5%, and 10%. The 10 wt% MMM showed a CO_2 permeability and a selectivity of 44.20 for CO_2/CH_4, showing enhanced separation performance because of the submicron fillers. The homogeneous integration of MUF-15 nanosheets into the PA matrix was verified by SEM imaging.

2D Functional Material Synergy with Bismuth Complexes for Enhanced and Long-Lasting Hydrogen Evolution

Debojyoti Kundu[1,2], Naresh Chadra Murmu[1,2]*, Priyabrata Banerjee[1,2]*

[1]*Electric Mobility and Tribology Research Group, CSIR – Central Mechanical Engineering Research Institute (CMERI), Mahatma Gandhi Avenue, Durgapur, 713209, West Bengal, India.*
[2]*Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, Uttar Pradesh, India*

**Corresponding author:* murmu@cmeri.res.in; pr_banerjee@cmeri.res.in

Abstract

Transitioning from fossil fuels to renewable energy, with hydrogen at the forefront through electrocatalytic water-splitting (EWS), is not just crucial—it's inevitable. Contextually, an in-situ synthesized graphene oxide (GO) and bismuth metal complex (BMC) composite serves as a highly efficient electrocatalyst for the hydrogen evolution reaction (HER). Among the as synthesized electrocatalyst, BMGO5 shows outstanding performance with a low overpotential (105mV@10 mA.cm^{-2}) and Tafel slope(44mV.dec^{-1}) in 1M KOH. The BMGO composites were thoroughly investigated for hydrogen production from river water also, offering a sustainable solution to freshwater scarcity. This unique approach could assist future research endeavours towards designing efficient electrocatalyst for sustainable renewable energy generation.

Recent development of plant mediated metallic nanoparticles synthesis- A green process

Kanika Ghosh

Department of Chemistry, Bidhan Chandra College, Asansol-713304, West Bengal, India

Abstract

Recently, a biological process to synthesize materials via environmentally friendly green techniques including natural materials such as plants, bacteria, fungi, seaweed and algae has been employed as an unconventional method for the synthesis of metallic nanoparticles (M NPs). In recent years, the development of producing nanoparticles (NPs) by plant extracts has become a major attention of researchers as these NPs have low hazardous effect on the environment and low toxic in the human body. Synthesized NPs from plants are not obviously more stable in terms of size and shape, and also the yield of this process is larger than the other methods. Plant extracts have been utilized as reducing agent and stabilizer of NPs as an alternative of chemical reagents. In this way we can reduce the toxicity in the environment. Moreover, some specific substances are present in plant extracts that could be beneficial for the human body. For example, polyphenols may have antioxidant effect that has the potential for capturing free radicals, before radicals can react with other biomolecules to create serious damage. This review article focuses on of the most common plants which have been utilized in last decade to synthesize M NPs along with various methods of synthesis.

Harnessing the hydrogen evolution reaction (HER) through the electrical mobility of an embossed Ag (I)-molecular cage and a Cu(II)-coordination polymer

Ananya Debnath[a], Sangharaj Diyali[a] and Bhaskar Biswas[a]*

[a]*Department of Chemistry, University of North Bengal, Darjeeling, 734013, India*
Corresponding author: bhaskarbiswas@nbu.ac.in

Abstract

Transitioning from fossil fuels to renewable sources of energy has attracted growing interest among scientific community all across the world**.** Green hydrogen, produced from electrolysis, possesses enormous potential to decarbonize many sectors and requires highly efficient catalysts. Currently, hydrogen in the industrial sector is generated through electro-catalytic water splitting under alkaline conditions.[1] After much cogitation, we have designed the metal organic cage and coordination polymer (Ag_{MOC} and Cu_{CP}) for hydrogen-powered clean energy. We have synthesized Ag_{MOC} and Cu_{CP} with a premeditated N, O-type ligand and its parental amine with thiocyanate, respectively.[2] Porous Ag(I)-molecular cage, Ag_{MOC} and Cu(II)-coordination polymer, Cu_{CP} were structurally characterized by single crystal XRD, FT-IR, PXRD, FE-SEM, EDX, and BET analysis. Both the complexes rendered useful electrical mobility-driven hydrogen production in 1M KOH (Fig-1). Porosity-induced electrically conductive Ag_{MOC} emerge as a better electrocatalyst with Tafel slope, 104 mV/decade over Cu(II)-polymer's slope,128 mV/decade**.**

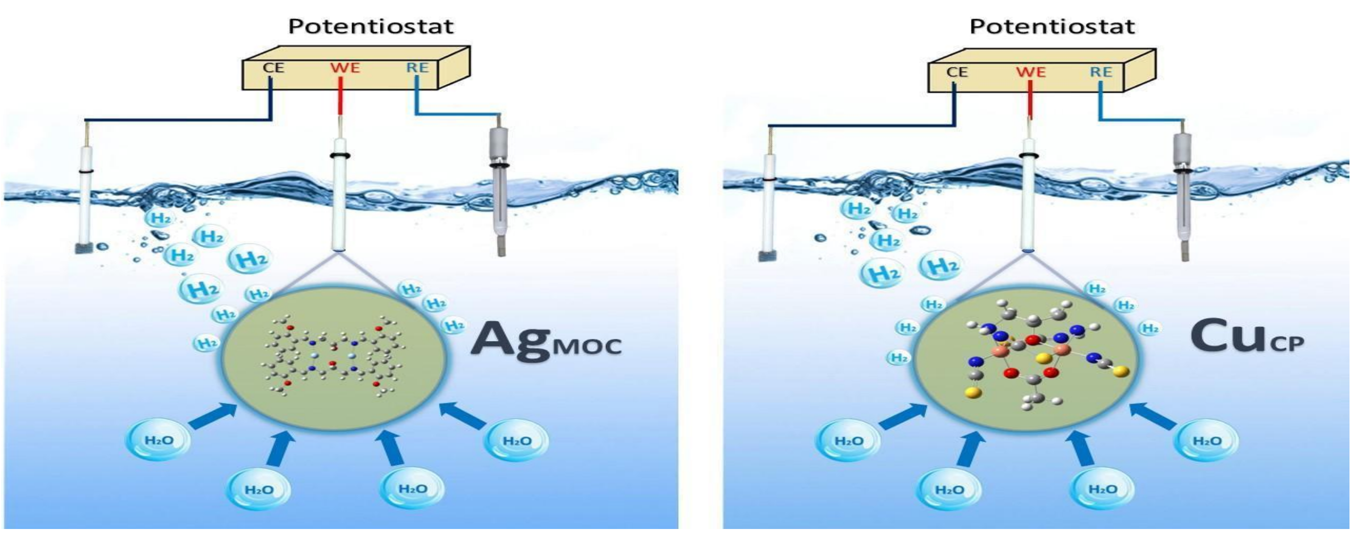

Figure 1: HER of Ag_{MOC} and Cu_{CP} complexes in basic medium respectively.

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NiCo-LDH@FeOOH Core-Shell Structures for High Performance Supercapacitor Applications

Arnab Acharya, Kousik Bhunia, Amit Kumar Chakraborty*

Energy Research Laboratory, Department of Physics, National Institute of Technology, Durgapur.
**Corresponding author: amit.chakraborty@phy.nitdgp.ac.in*

Abstract

In this present work, we synthesized NiCo-layered double hydroxide decorated FeOOH (NiCo-LDH@FeOOH) core-shell nanostructures for electrochemical energy storage device. NiCo-LDH nanosheet decorated FeOOH nanocapsule is prepared by two step wet chemical synthesis methods. The physicochemical properties of the synthesized NiCo-LDH@FeOOH is summarized by powder XRD and FESEM analysis. The NiCo-LDH@FeOOH core-shell exhibited higher specific capacitance than the bare FeOOH nanocapsule due to the improved Faradaic oxidation reduction reaction and faster ions diffusion at the surface of the core-shell electrode surface. The current study demonstrates a simple strategy to synthesized highly active electrode materials for electrochemical energy storage application.

Synthesis and electrical analysis of silver sulfide

Jian-Xiang Lin *, Der-Yuh Lin,Yu-Tai Shih, Xian-Qi Chen , Chi-Chao Wang,Hung-Pin Hsu, Seng-Beng Hwang
National Changhua University of Education 1. Jian-Xiang Lin *2.* Der-Yuh Lin *3.* Yu-Tai Shih *4.* Xian-Qi Chen 5. Chi-Chao Wang *6.* Hung-Pin Hsu *7.*Seng-Beng Hwang
* Jian-Xiang Lin*: Big2497653@gmail.com*

Abstract

This experiment involves depositing a silver film on a glass substrate and transforming it into a silver sulfide film with memristor characteristics using chemical vapor deposition (CVD) techniques. We used scanning electron microscopy (SEM) and X-ray diffraction (XRD) to examine the film's surface growth quality and crystal structure. Measurements of the current-voltage (I-V) characteristics showed that Ag_2S films exhibit memristive effects and can form n-Ag_2S/p-silicon diodes. Ongoing photoconductivity measurements indicate that the sample demonstrates good performance under specific frequency conditions.

Current Developments and Possible Future Prospects for Floating Photovoltaic (FPV) Solar Energy-powered Electric Vehicle Charging Stations

Mukul Banerjee[1*], Sourav Saha[1], Sukanta Roy[1, 2]

[1]Department of Mechanical Engineering, National Institute of Technology, Mizoram
[2]Department of Mechanical Engineering, Curtin University Malaysia, CDT 250, Miri, Sarawak, Malaysia
*Corresponding-banerjeeindia.10@gmail.com

Abstract

In many parts of the world, a lack of energy lowers people's quality of life and hinders advancement in general. A desirable substitute for solar energy utilization is the installation of floating photovoltaic (FPV) systems, especially when land access is limited. EVs are growing in popularity, but the global power system is under strain due to their demanding requirements. This entirely renewable EVCS also reduces the energy expenses by 74% to compare another energy sources. According to the study's findings, the floating solar PV-based EVCS had the lowest energy expenses, effects on the environment, cost effectiveness and prospective future developments.

Self-powered n-Ag_2Se/p-Si heterojunction photodetector

Xian-Qi Chen, Der-Yuh Lin*,Yu-Tai Shih*, Jian-Xiang Lin*, Chi-Chao Wang*,Hung-Pin Hsu*
National Changhua University of Education
1. Xian-Qi Chen
2. Der-Yuh Lin* *3.* Yu-Tai Shih * *3.* Jian-Xiang Lin * *4.* Chi-Chao Wang **5.* Hung-Pin Hsu *
* Xian-Qi Chen *:* *a0966532962@gmail.com*

Abstract

This paper investigates the growth of an Ag_2Se thin film using a chemical vapor deposition system, focusing on its crystal structure, photoelectric, and thermoelectric properties. An n-Ag_2Se/p-Si heterostructure diode was formed by growing the film on a p-type silicon substrate, and its photoelectric characteristics were analyzed under simulated sunlight (AM1.5). The junction capacitance was measured using C-V, confirming diode behavior. The component demonstrates self-powering capability and functions as a photoelectric sensor. Additionally, measurements of the photocurrent distribution in its MSM structure suggest potential for light point position sensing.

Zinc oxide-based Nanomaterial for Sustainable Energy Applications

Anshikha Nautiyal[1*], Subodh Barthwal[1], SK Sansaniwal[2]

[1]Mechanical Engineering Department, Amity University, Greater Noida, Uttar Pradesh, India.
[2] Associate Fellow at The Energy and Resources Institute, New Delhi, India
Corresponding author: anshikha.nautiyal@gmail.com

Abstract

Despite recent significant advances in energy harvesting and sustainability, there is an important research gap in maximizing the potential of nanomaterials for use in energy conversion, storage and environmental remediation processes. This review closes this gap by examining how nanomaterials have a strong transformative role, exhibiting unique properties including high surface area, quantum effects and adjustable chemical and physical properties. However, nanomaterials are well suited as fundamental building blocks for the improvement in the efficiency of energy conversion and storage technologies. New sustainable energy solutions include nanomaterials capability of converting mechanical energy to electrical energy for small scale electronics. In addition, ZnO materials possess useful properties, including thermal conductivity, UV protection, and antimicrobial activity, making them applicable to a wide range of fields from bio-mimetic membranes to energy storage devices. With increasing availability of nanomaterials, there has been a push toying the application of nanomaterials in sustainable catalysis and environmental remediation – including water treatment utilization to remove pollutants and pathogens. As the catalytic efficiency of nano-metal based photocatalysts and nano-sorbents show promising paths to clean energy production and environmental sustainability. Finally, future research for energy applications with nanomaterials is focused on the development of a nanomaterial which improves energy storage and conversion, sense the light and heat efficiently to harness energy, and improve energy systems in terms of environmental sustainability. Researchers are using these unique properties to chart new paths for future sustainable energy solutions.

Comparative study of simple and Semi Frustrum Type Solar Air Heater based on Thermo-Hydraulic Performance

1. ***Ramit Choudhury, Mechanical Engineering, NIT Durgapur, Durgapur-713209, India***
2. *Abhimannyu Sharma, Mechanical Engineering, NIT Durgapur, Durgapur-713209, India*
3. *Apurba Layek, Mechanical Engineering, NIT Durgapur, Durgapur-713209, India*

**Corresponding author: Ramit Choudhury, rc.20me1107@phd.nitdgp.ac.in*

Abstract

Solar air heaters (SAHs) are the simplest in terms of design and installation. SAH converts incident solar radiation into heat energy. In order to improve the heat transfer coefficient over the absorber plate of SAH, the bottom sides of the absorber plate are roughened with artificial ribs. In this study, thermal behaviour of SAH with Semi Frustum roughness has been investigated. A 3D model of a duct with a SFSAH roughness is created. The transport equations are solved using a realizable k-ε turbulence model. Comparison of Nusselt number and friction factor for roughened duct with smooth SAH is presented at a constant heat flux of 1000 W/m^2 for Reynolds number varying from 2000 to 24000. Maximum thermal-hydraulic performance was found to be 2.14.

Enhanced visible-light photoelectrochemical activity of anodized WO_3 by hydrothermal surface modification

P. Chatterjee[a], D. Piecha[a,b], S. Kotarba[a], K. Syrek[a], M. Pisarek[c], G. D. Sulka[a]*
[a]*Department of Physical Chemistry and Electrochemistry, Faculty of Chemistry, Jagiellonian University, Gronostajowa 2, 30387, Krakow, Poland.*
[b]*Doctoral School of Exact and Natural Sciences, Jagiellonian University, Lojasiewicza 11, 30-348 Krakow, Poland*
[c]*Laboratory of Surface Analysis, Institute of Physical Chemistry, Polish Academy of Sciences, Kasprzaka 44/52, Warsaw 01-224, Poland*
*Corresponding author: sulka@chemia.uj.edu.pl

Abstract

WO_3 is a visible light active n-type semiconductor with valence band maximum favorable for water oxidation. We report a novel hydrothermal treatment to grow iron tungstate on highly reproducible anodized WO_3 on W. This resulted in increased photocurrent and visible light response compared to unmodified WO_3, especially at low bias. Increased oxygen vacancies and a heterojunction formation of WO_3 with $FeWO_4$, a p-type semiconductor, has been found to cause enhanced charged transfer properties.

A Review of the Estimation of State of Charge and Remaining Useful Life of Lithium-Ion Batteries

Atul Kumar*[1], Akansha Dager[2], Ankur Baliyan[3], Vinit Kumar[4], Sudhanshu Sharma[5]

[1]Department of Electrical and Electronic Engineering, Amity University, Greater Noida 201308, India
[2]Graduate School of Nano bioscience, Yokohama City University, 22-2 Seto, Kanazawa-Ku, Yokohama 236-0027, Japan
[3]NISSAN ARC, LTD, 1-Natsushima-cho, Yokosuka, 236-0061, Japan
[4]Amity University, Sector-125, Noida, UP-201313, India
[5]Department of Chemistry, Indian Institute of Technology Gandhinagar, Gandhinagar, Gujrat 382055, India

**Corresponding author: atul206@gmail.com,akumar3@gn.amity.edu*
Email: ankurbaliyan@gmail.com; vinitiitr@gmail.com; vkumar25@amity.edu; ssharma@iitgn.ac.in

Abstract

Li-ion batteries received more and more attention in comparison to others due to the advantage of high energy density, high power density, eco-friendly and long service life but also risk of explosion due to overheating and short circuiting. To overcome failure issues, continuous monitoring as well as optimization of battery health indicators and prediction of state of health (SOH), state of charge (SOC) and Remaining useful life is necessary. This paper reviews various methods of state of charge (SOC) and Remaining useful life with health indicators, which may help in improvement of predicting battery parameters accurately and in optimizing battery parameters in useful scenario.

Keywords— Battery Health Indicators, Li-ion battery, SOC, SOH, RUL Prediction.

Upcycling LDPE Plastic into Porous Sulfurized Carbon Anodes for High-Performance Sodium-Ion Batteries

Pathak Rajkumar Babunar [1,2], Sanchit Badodekar [1], Ananta Sarkar[1] *

1. Department of Chemical Engineering, Indian Institute of Technology Kharagpur
Kharagpur-721302, West Bengal, India
2. School of Energy Science and Engineering, Indian Institute of Technology Kharagpur
Kharagpur-721302, West Bengal, India
**Corresponding author: ananta@che.iitkgp.ac.in*

Abstract

The growing need for sustainable energy solutions and effective waste management has inspired innovative approaches to energy storage materials. This study presents a method for converting low-density polyethylene (LDPE) plastic waste into porous sulfurized carbon for sodium-ion battery (SIB) anodes. Through sulfurization and calcination under a nitrogen atmosphere, LDPE waste is transformed into high-performance carbon with enhanced porosity and electrochemical properties. This work showcases the dual potential of reducing plastic waste and advancing SIB technology.

SCAPS-1D simulation on Charge Transport/ Absorber Interface of Lead-free Perovskite Solar Cell

Sachchidanand[1*], Anoop Kumar Pandouria[2]

[1]*Dept. of Electronics and Communication Engineering, SRM University-AP, Amaravati, India*
[2]*Dept. of Mechanical Engineering, SRM University-AP, Amaravati, India*
**sachchidanand.a@srmap.edu.in*

Abstract

An inorganic lead-free $Cs_3Sb_2Br_9$ based thin-film PSC is studied under the influence of capture cross-section (CCS) of electrons and holes along with the interfacial defect density at Absorber/ETL and HTL/Absorber interfaces by using SCAPS-1D in terms of power conversion efficiency (PCE). By varying the CCS of electrons and holes and their defect density at both interfaces, it is noticed that Absorber/ETL is more sensitive as compared to HTL/Absorber for the performance of proposed thin-film PSC. The optimal values of CCS of electrons and holes are chosen as 1×10^{-19} cm^2. Whereas the optimal interfacial defect density at both interfaces is chosen as 4×10^9 cm^{-2}. Thus, to highlight the effective performance of the proposed lead-free inorganic thin-film PSC the lower CCS of electrons and holes with lower interfacial defect density at the Absorber/ETL interface is important.

Keywords—$Cs_3Sb_2Br_9$, lead-free, inorganic, capture cross-section, interfacial defect density, perovskite solar cell.

Current Approaches for Solar Cooling PV Modules & its Assessment Systems: An Overview

Sourav Saha[1*], Mukul Banerjee[1], Sukanta Roy[1, 2]
[1]Department of Mechanical Engineering, National Institute of Technology, Mizoram
[2]Department of Mechanical Engineering, Curtin University Malaysia, CDT 250, Miri, Sarawak, Malaysia
*Corresponding-sourav.saha36@gmail.com

Abstract

In many parts of the world, insufficient energy lowers people's quality of life and hinders progress. Solar PV, as a renewable energy source, is gaining popularity. An overview of solar PV cooling technology and current trends is given in this paper. Before examining cooling techniques for solar photovoltaics, this study addresses the consequences of global warming and the significance of renewable energy by utilizing extra thermal energy for PV/T systems and heating applications. The possible challenges of developing hybrid and multipurpose novel systems were also reviewed. It makes future projections on various cooling methods that increase solar PV systems' efficiency.

Photoelectric properties of P-CuI/N-Si heterjunction

Chi-Chao Wang*, Der-Yuh Lin, Yu-Tai Shih, Jian-Xiang Lin, Xian-Qi Chen, Hung-Pin Hsu, Sheng-Beng Hwang
National Changhua University of Education 1.Chi-Chao Wang*
2. Der-Yuh Lin *3.*Yu-Tai Shih *4.* Jian-Xiang Lin *5.* Xian-Qi Chen *6.* Hung-Pin Hsu *7.* Sheng-Beng Hwang
* Chi-Chao Wang *:* *Wang04135629@gmail.com*

Abstract

This paper uses air iodination to grow P-CuI thin film on N-type Silicon substrate. In this way, we can get a P-CuI/N-Si heterostructure diode, we will analyze its crystal structure, photoelectric and diode properties. A sunlight simulation light will be used to a source of light, when measuring I-V curve, so we can evaluate conversion efficiency and fill factor FF. Then, we use C-V to measure the junction capacitance of the heterostructure diode, and use PPC we can measure our sample's rise time and fall time in different frequence.

Effect of Joule heating on rotating electro-osmotic flow in a sinusoidally varying micro-channel

Amit Mondal
Department of Mathematics,
Bidhan Chandra College, Asansol, India

Abstract

In the present endeavor, we investigate the impact of rotational forces, such as centrifugal and Coriolis forces, on heat transfer in a non-uniform micro-channel with unsteady electroosmotic flow and entropy generation. We solve a system of non-linear partial differential equations using the finite difference method by employing a Crank-Nicolson numerical scheme to obtain velocity distribution. Our analysis focuses on understanding how different rheological parameters affect the transport characteristics by examining the velocity profiles. Our findings indicate that entropy generation is mainly influenced by the Joule heating resulting from the electro-osmotic parameter. Furthermore, we explore the relationship between fluid temperature and rotational forces to draw important insights that can improve the design of microfluidic platforms, particularly lab-on-a-disk-based systems. We have validated our numerical results by comparing them with earlier studies and have found them to be in good agreement.

Recent advances in efficiency enhancement of solar cells through zinc oxide nanomaterials synthesized via chemical co-precipitation route

Anshikha Nautiyal[1a]*, Subodh Barthwal[1a], SK Sansaniwal[2b]
[a] Mechanical Engineering Department,Amity University, Greater Noida, Uttar Pradesh, India
[b] Associate Fellow at The Energy and Resources Institute, New Delhi, India
*Corresponding author's email address: anshikha.nautiyal@gmail.com

Abstract

Zinc Oxide (ZnO) nanoparticles have gained prominence in the search for efficient and sustainable solar energy systems because of their exceptional optical, electrical, and structural characteristics. This study focuses on the efficiency enhancement of solar cells using zinc oxide (ZnO) nanomaterials synthesized via the chemical co-precipitation route. The synthesis method allows precise control over ZnO nanomaterial characteristics, such as size, morphology, and crystallinity, which are critical for optimizing solar cell performance. Various strategies, including doping with different elements and surface modification techniques, have been explored to enhance light absorption, charge separation, and overall efficiency. The study compares various morphologies and their effect on efficiency to further investigate how these ZnO nanoparticles affect solar cell performance. According to the existing research, the chemical co-precipitation process is a practical and affordable way to produce high-quality ZnO nanoparticles, which could result in important breakthroughs in the field of solar cell technology. This work opens the door for the actual application of ZnO nanomaterials in improving solar cell efficiency while also making significant contributions to our understanding of their synthesis.

Keywords: Nanomaterials; Zno Nanocomposites; solar cells; chemical co-precipitation

Performance Analysis of A DC Microgrid with Different Storage Management Schemes

Snehashis Ghoshal, Sunil Kumar Choudhary*, Arindam Mondal
Department of Electrical Engineering
Dr. B.C.Roy Engineering College
Durgapur, West Bengal, India
Corresponding author: sunee.world@gmail.com

Abstract

In the present work, a performance analysis of a DC microgrid system was analysed with different storage systems. Mainly, a battery and a supercapacitor were used as the energy storing device. The system integrates a battery and a supercapacitor to efficiently manage varying load demands. The battery provides a steady energy supply with a gradual decline in its state of charge, while the supercapacitor handles rapid power fluctuations. This coordinated operation reduces battery stress by offloading peak demands to the supercapacitor, improving overall efficiency and extending the battery's lifespan.

Technical Track II: Solid State Devices and Materials

Predicting corrosion inhibition performance of heterocyclic organic molecules using ML for mild steel in aqueous HCl medium

Pradeep Kumar Rout and Subhas Ghosal*

Department of Chemistry, National Institute of Technology Durgapur, Durgapur, WB 713209
**Corresponding author: sghosal.ch@nitdgp.ac.in*

Abstract

We have used Density Functional Theory (DFT) and Molecular Dynamic (MD) simulation methods to estimate the corrosion inhibition properties of a large number of heterocyclic organic molecules on mild steel in aqueous HCl medium. These molecules were identified using chemical intuition and Machine Learning (ML) techniques from eight different heterocyclic structural moieties with different electron withdrawing and electron donating substituents. The calculated inhibition properties were compared and calibrated with small number of experimentally available data. New molecules have been proposed having better corrosion inhibition properties subject to experimental verification.

I. Introduction

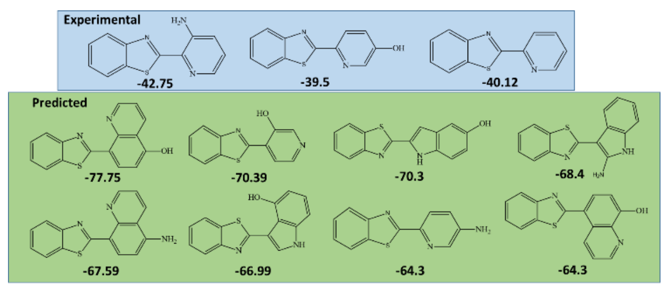
Heterocyclic organic molecules and their derivatives have been known for their good corrosion inhibition properties in acidic media [1]. Most of these molecules are cheap, have relatively low toxicity and easily bio-degradable. Recent experimental studies from our laboratory [2] have shown that various benzothiazole molecules can be used as corrosion inhibitors on mild steel in aqueous HCl medium. However, screening larger number of similar molecules for their anti-corrosion activates is experimentally challenging. Therefore, we have proposed a large set of benzothiazole derivatives through chemical intuition and machine learning techniques to theoretically study their corrosion inhibition properties. The benzothiazole derivatives were designed with increasing π-electron conjugation and having electron donating and withdrawing substituents.

II. Results

DFT calculations were performed to optimize the geometry of the inhibitor molecules and electron distribution in the frontier molecular orbitals (HOMO and LUMO). The interaction energy between the inhibitor molecules and the (1 1 0) plane of the Fe surface has been calculated using Molecular Dynamics simulation as

$$E_{interaction} = E_{total} - (E_{solvent} + E_{inhibitor})$$

. In general, the more negative interaction energy, higher will be the molecular interaction and hence the inhibition efficiency. However,



the results were calibrated with

Fig 1: List of predicted benzothazole derivatives to have better corrosion inhibition efficiency compared to experimentally studied ones.

III. Conclusion

It has been observed with increasing conjugation and substituting with electron donating groups (-OH or –NH_2) the corrosion inhibition efficiency increases. Eight molecules are shortlisted for the database for experimental verification.

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Effect of Process Parameters on the mechanical properties of Ti-6Al-4Nb implant material manufactured through powder metallurgy

Sarfaraj Ansary*, Mukandar Sekh, Shamim Haidar

Department of Mechanical Engineering, Aliah University, Kolkata 700156, India
**sarfarajansary@gmail.com*

Abstract

In this study the powder mixture was compacted using a uniaxial press, followed by sintering in a controlled atmosphere furnace. The sintered samples were then subjected to comprehensive mechanical testing to evaluate their wear rate, hardness, and fracture toughness. The results revealed that the process parameters significantly influenced the mechanical properties of the Ti-6Al-4Nb alloy. Overall, this study provides valuable insights into the effect of process parameters on the mechanical properties of Ti-6Al-4Nb implant material manufactured through powder metallurgy. The findings can aid in optimizing the manufacturing process to obtain implants with superior mechanical performance, thereby advancing the development of biomaterials for biomedical applications.

Emerging Nanomaterials Used for Latent Fingerprint Development in Forensic Science

Disha Debnath, Subhashis Samanta*

Department of Forensic Science and Technology
Maulana Abul Kalam Azad University of Technology, West Bengal
** Corresponding author: subhashis.samanta@makautwb.ac.in*

Abstract

Nanotechnology, which involves manipulating matter at nanoscale, has wide applications across various-fields, including forensic science. Integration of nanotechnology-based knowledge and applications into crime-scene investigations has given rise to an emerging field nano-forensics. One important area of application is the development of latent fingerprints, where conventional methods such as fingerprint powders and chemical techniques often face various challenges. Nanomaterials, born from nanotechnology offer a promising solution to these limitations. Novel materials like gold, silver, zinc oxide, silicon oxide, carbon, quantum dots etc. have all shown success in enhancing fingerprint visibility across different surfaces. Present manuscript discusses modifications, merits, demerits, and future potential of emerging nanomaterials in fingerprint-development.

Magnetic Memory Effect in $CoSb_2O_4$

Anupam Banerjee[1,2] *, M.K. Mondal[2], D. De[3,4], S. Das[2], S. Goswami[3] and P.K. Chakrabarti[2]

1. Department of Basic Sciences, NSHM Institute of Engineering & Technology, NSHM Knowledge Campus, Durgapur, W.B. 713212, India
2. Department of Physics, Burdwan University, Burdwan 713104, India
3. MSR Lab, The Neotia University, Sarisa, D.H. Road, 24 Pgs (South), West Bengal 743368, India
4. Department of Physics, Sukumar Sengupta Mahavidyalaya, Keshpur, West Medinipur 721150, India
*Corresponding author: *anupam697@gmail.com*

Abstract

This work discusses the magnetic memory effect in a variety of time (t) and temperature (T) dependent protocols in nanocrystalline $CoSb_2O_4$ (CSO). TEM and SEM studies revealing particle size 96 nm. Magnetic measurements propose a canted antiferromagnetic (AFM) ground state with three magnetic transitions around 79, 50 and 11 K. Considerable orbital moment contribution has been confirmed through Curie-Weiss moment estimation. Strong signatures are present in memory measurements through FC, ZFC protocols and isothermal remanent magnetization (IRM) mechanism. Finite size effect and strong dipolar interaction in the nanoparticle assembly manifest super spin-glass (SSG) like state in this system.

Optimization of Silica Extraction from Rice Husk and Straw Using Regression Analysis of Leaching Time and Calcination Temperature on Surface Area and Yield

Subhajit Roy[1], [2]Deepshikha Datta*, Sampurna Santra[3], **Manodip Bouri[4]**, Bimal Das[4],

[1] Department of Biotechnology, Brainware University, Barasat, Kolkata, West Bengal
[2] Department of Chemistry, Brainware University, Barasat, Kolkata, West Bengal
[3]Department of Electronics and Communication Engineering, Murshidabad College of Engineering & Technology, Berhampore
[4] Department of Chemical Engineering, National Institute of Technology Durgapur, West Bengal
**Center for Multidisciplinary Research & Innovations (CMRI), Brainware University, Barasat, Kolkata, West Bengal 700125, India*
Corresponding author mail id: deepa.datta81@gmail.com

Abstract

The optimization of surface area and yield percentage in material processing was investigated by evaluating the effects of calcination temperature and leaching time. A third-order polynomial model was developed using regression analysis to describe the relationship between these process parameters and the responses. The results revealed that surface area reaches its maximum of 500 m^2/g at 800°C, while the yield achieves 95% at 750°C with a leaching time of 4 hours. The regression model accurately captures the complex, non-linear interactions, providing optimized conditions for material synthesis and valuable insights for enhancing process efficiency.

Design and Performance Enhancement of F-Shaped GNR TFETs for Energy-Efficient Digital Applications

Jayabrata Goswami[1], Kanishka Majumder[2], Subham Pramanik[3], Aritra Acharyya[4]

1. Institute of Radio Physics & Electronics, University of Calcutta, Kolkata-700009, India
2,3. Academy of Technology (AOT), G.T.Road (Adisaptagram), Aedconagar. Hooghly-712121, India
4. Kalyani Government Engineering College, Kalyani, Nadia, India
**Corresponding author: jayabratagoswami80@gmail.com*

Abstract

F-Shaped Graphene Nano Ribbon (GNR) Tunnel Field Effect Transistors (TFETs) are designed and modeled in order to maximize device performance for low-power digital applications. Computer-based software Silvaco (TCAD) tools are used to determine the device drain current. The F-Shaped GNR TFET's channel length, ribbon width, and gate oxide thickness are all tuned to produce short intrinsic gate delay, a greater on-off current ratio, minimal subthreshold swing, and high on or drain current. Additionally, the device's performance characteristics are tuned for a 20 nm gate length and a 5 nm ribbon width. GNR TFETs are hence attractive next-generation semiconductors for low-power digital applications.

Understanding the transport of voltage-induced quantum dots in nanowire channel field-effect-transistors

Nilayan Paul[1], Sanatan Chattopadhyay[1,2] *
1. Department of Electronic Science, University of Calcutta, India.
2. Centre for Research in Nanoscience and Nanotechnology, University of Calcutta, India.
**Corresponding author: scelc@caluniv.ac.in*

Abstract

In this work, the transport properties of a gate voltage-induced quantum dot in the channel of a nanowire field-effect-transistor is studied. Such quantum dots are created by both geometrical and localized voltage-induced confinements. A Schrodinger-Poisson self-consistent framework in non-equilibrium Green's function (NEGF) formalism is developed to study the transport. The study suggests that conduction is predominantly resonant tunneling controlled, with significant resonance broadening for quantum dot-to-drain distance below 5 nm. On the other hand, thermionic transport dominates in devices with channel length < 12 nm. Therefore, this work provides the design criteria to realize quantum dots in nanoscale FETs.

Detection of A Faint Optical Signal Using Stochastic Resonance Phenomena in PBTTT-C14-Based Organic Field Effect Transistor

Bishwajit Mandal, Santosh Kumar*, Samarendra Pratap Singh*

Department of Physics, Shiv Nadar Institution of Eminence, Gautam Buddha Nagar, UP-201314, India
E-mail: skumar.physics@gmail.com, samarendra.singh@snu.edu.in

Abstract

Stochastic Resonance (SR) is an interesting phenomenon where noise, often considered detrimental in the context of signal detection, can actually enhance the ability to detect signals that would otherwise remain undetectable. This research specifically investigates the SR-mediated detection of low-intensity optical signals (below 130 nW/cm^2) utilizing PBTTT-C14-based organic field-effect transistors (OFETs). Our focus is on the detection of a periodic optical signal at a frequency of 5 Hz and its higher harmonics, employing PBTTT-C14-based OFETs in the presence of an optimal level of Gaussian noise (characterized by a noise bandwidth of 1 Hz and noise amplitudes of 2.0, 4.0, 6.0, and 7.5 V). The detection of higher harmonics of an optical signal through the SR phenomena has not been previously explored within the realm of OFETs. This study reveals significant insights into the detection of both the fundamental frequency and its higher harmonics. The straightforward approach adopted in this research demonstrates considerable promise for harnessing the SR phenomenon in a variety of practical applications.

Analysis of noise performance of the all-optical Chiral-MZI based XOR logic gate

Arindam Changder*[1,2], Kousik Mukherjee [3,4] and Jitendra Nath Roy [1,4]
[1] Department of Physics, Kazi Nazrul University, Asansol 713340, W.B, India
[2]Department of Physics, Raniganj Girls' College, Raniganj 713358, India
[3]Department of Physics, Banwarilal Bhalotia College, Asansol 713303, India
[4]Centre for Organic Spintronic and Optoelectronic Devices (COSOD), Kazi Nazrul University, Asansol 713340, India
**E-mail: changderarindam96@gmail.com*

Abstract

All-optical switching at low power and high speed is the most desirable technology but to achieve this at high transmission rate is also very challenging. Logic gates play an important role in high-speed signal processing. In this communication, we have made a further study on the effect of the noise signal on CMZI based all-optical XOR gate. From the SCILAB simulation, the values of SNR and Shannon channel information capacity (in Gbps) have been calculated. These values will define the maximum amount of error-free data that was transmitted over a communication channel in a given interval of time.

Keywords: All-optical Switching, XOR logic gate, Chiral material, Signal-to-noise ratio, Shannon channel information capacity, Pseudo eye-diagram.

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Development of 2D THz imaging and Spectroscopy Techniques for Characterization of Organic and Semiconductor Materials

A.K. Chaudhary
DIA-CoE (ACRHEM), School of Physics, University of Hyderabad, Hyderabad-500046, India
**Corresponding author: akcsp@uohyd.ac.in ,anilphys@yahoo.com*

Abstract

We report some new developments related to the use of Terahertz (THz) technology for the development of 2D imaging and spectroscopy systems for the identification and characterization of premium explosives and concealed metallic objects along with Zinc Sulfide quantum dots (ZnS QDs) embedded with Polyvinyl Alcohol (PVA) composites films at room temperature. The samples' optical characterizations such as refractive index, absorption coefficients & dielectric constants were measured in the 0.1-3.0 THz range.

Magnetic Field-induced Tuning of Photocurrent in p-Si/$Zn_{0.3}Ni_{0.7}Fe_2O_4$/rGO/CuPc/Au Heterostructure at Room Temperature

Mrinal Kanti Mondal[1,2 *], Nitish Ghosh[1], Md. Minhaj Ali[3] and P. Dey[1,3]

[1] Department of Physics, Kazi Nazrul University, 713340, Asansol, WB, India.
[2]Department of Physics, Triveni Devi Bhalotia College, 713347, Raniganj, WB, India.
[3]Centre for Organic Spintronics and Optoelectronics Devices, Kazi Nazrul University, 713340, Asansol, WB, India.
*Corresponding author email: physics.mkm@gmail.com

Abstract

We have studied magnetic field-induced tuning of photocurrent of p-Si/$Zn_{0.3}Ni_{0.7}Fe_2O_4$(ZNFO)/rGO/CuPc/Au heterostructure at room temperature. Positive magnetoresistance is evident in magnetic field-dependent I-V characteristics, possibly due to high degree of positive spin polarization in ZNFO/rGO/CuPc interfaces. A notable photo response has been detected in the I-V characteristics analysis under red laser light illumination of different intensities, which is due to Frenkel exciton generation within the CuPc bulk layer and subsequent dissociation at the ZNFO/rGO/CuPc interfaces. When light and magnetic field are applied simultaneously, the I_{photo}/I_{dark} ratio increases significantly with magnetic field and then decreases as the magnetic field is further increased.

Enhanced Magnetoresistance Effect and Optical Modulation DC Transport Property of NiFe2O4 /CuPc/Au Heterostructure at Low Temperature

Nitish Ghosh[1],* and Puja Dey[1,2]

[1]Department of Physics, Kazi Nazrul University, Asansol, 713340, WB, India
[2]Centre for Organic Spintronics and Optoelectronics Devices, Kazi Nazrul University, Asansol, 713340, WB, India
*nitishphy91@gmail.com

Abstract

The magnetic/OSC interface in opto-spintronics devices has great research potential in the field of information technology. In this report, we have fabricated NFO/CuPc/Au heterojunction device on p-type Si substrate and investigated Optospintronics effect at low temperature. We have observed a drastic change in magnetoresistance at very low temperatures. We have also observed substantial photogeneration effects at room temperature which are found to be diminished at low temperature. These different significant effects at low temperatures in a single NFO/CuPc/Au heterojunction device might be utilized in space science and technology.

Naturally Occurring Halloysite Nanotubes for Photostable Random Lasing and Charge Selective Photocatalysts

Ashim Pramanik[1]*, Marco Reale[1], Giuseppe Lazzara[1], Pooria Pasbakhsh[2], Alice Sciortino[1], and Fabrizio Messina[1]*

1. Dipartimento di Fisica e Chimica,
Università degli Studi di Palermo, 90123 Palermo, Italy.
2 School of Engineering, Monash University Malaysia, Subang Jaya 47500, Selangor, Malaysia.
**Corresponding author: ashim.pramanik@unipa.it, fabrizio.messina@unipa.it*

Abstract

Here, natural halloysite nanotubes (HNTs) of two different dimensions have been employed as passive scatterers for the generation of random laser (RL) emission from colloidal solution of dye. Interestingly, the HNTs improves the photostability of dye molecules under intense visible laser irradiation. The quality of the as generated RL emission is analyzed statistically. An obvious photonic paramagnetic to spin-glass transition for an optical system is experimentally demonstrated. Moreover, the outer (inner) and anionic (cationic) surfaces of HNTs influences the attachment site of organic dye molecules having a distinct charge state, which is utilized here for UV light driven photocatalytic application.

Optimized Terahertz Twin Core Surface Plasmon Sensor for Detection of Wide Range Refractive Index

Sudip Chakraborty[a], Tanmoy Basu[b*], Rudra Sankar Dhar[a], Arindam Biswas[c], Amit Banerjee[e*]

a. Electronics & Communication Engineering Department, NIT Mizoram, Chaltlang, Aizawl-796012, Mizoram, India.

b. Centre for Quantum Engineering, Research and Education (CQuERE), TCG-Centres for Research and Education in Science and Technology (TCG-CREST), Sector V, Salt Lake, Kolkata-700091, INDIA.

c. Centre for IoT and AI Integration with Education-Industry-Agriculture, Department of Mining Engineering, Kazi Nazrul University, Asansol 713340, West Bengal, India.

d. Microsystem Design-Integration Lab, Physics Department, Bidhan Chandra College, Asansol 713303, West Bengal, India;

[*] amitbanerjee.nus@gmail.com,
[*] tanmoy.basu@tcgcrest.org

Abstract

This study proposes a twin-core terahertz surface plasmon resonance (SPR) sensor based on photonic crystal fiber with a double-sided polished structure. Using COMSOL Multiphysics software, the coupling mechanism, loss characteristics, and refractive index sensing are analyzed. Silver (Ag) as a plasmonic element is deposited on the fiber to detect changes in the surrounding medium, while titanium dioxide (TiO2) prevents its oxidation and enhances coupling. The SPR frequency exhibits a redshift, which occurs linearly as the refractive index of the analyte increases from 1.1 to 1.5. An average frequency sensitivity of 245.21 GHz/RIU is recorded. The design is suitable for terahertz biomedical and biochemical detection.

Keywords: Photonic Crystal Fiber (PCF), Sensor, THz frequency range

Acknowledgments

This research is partially supported by the Device Development Programme (DST/TDT/DDP-38/2021), by the Department of Science Technology, Ministry of Science and Technology, Government of India.

Comparative analysis on the extraction of nanosilica from rice straw and rice husk for its effective application in the fabrication of electrochemical sensor used for arsenic detection in ground water

Subhajit Roy[1], Deepshikha Datta[2,3], Sampurna Santra[4], Manodip Bouri[5], Bimal Das[5]

[1] Department of Biotechnology, Brainware University, Barasat, Kolkata, West Bengal
[2] Department of Chemistry, Brainware University, Barasat, Kolkata, West Bengal
[3] Center for Multidisciplinary Research & Innovations (CMRI), Brainware University, Barasat, Kolkata, West Bengal 700125, India
[4] Department of Electronics and Communication Engineering, Murshidabad College of Engineering & Technology, Berhampore
[5] Department of Chemical Engineering, National Institute of Technology Durgapur, West Bengal
Corresponding author mail id: deepa.datta81gmail.com

Abstract

Agricultural wastes like rice husk and rice straw, although abundant and renewable, pose significant environmental challenges when improperly disposed of. Both are potential sources for producing nanosilica, useful for fabricating electrodes for arsenic detection. This study compares the extraction and characterization (SEM, XRD, FTIR, BET, TGA) of nanosilica from these by-products. Nanosilica sizes are 280 nm from rice straw and 102 nm from rice husk. Rice straw nanosilica has a larger surface area (189.64 cc/g) compared to rice husk (176.78 m^2/g). Morphological analysis shows higher particle size distribution in rice husk nanosilica. Pore volumes are 0.462 cc/g for rice straw and 0.317 cc/g for rice husk. The higher surface area and pore volume of rice straw nanosilica enhance its use in fabricating electrochemical sensors for arsenic detection.

Tailoring resistive switching properties of GaO_x: Role of growth parameters

Ankita Ghosh [1, 2], Rupam Mandal [1, 2], Aparajita Mandal [1], Tapobrata Som [1, 2, *]

[1]*SUNAG Laboratory, Institute of Physics, Sachivalaya Marg, Bhubaneswar 751 005, India*
[2]*Homi Bhabha National Institute, Training School Complex, Anushakti Nagar, Mumbai 400 094, India*
***Corresponding Author; E-mail**: tsom@iopb.res.in*

Abstract

In recent years, resistive random-access memory (ReRAM) devices have emerged as a prominent subject of research and exploration within the realm of emerging non-volatile memory technologies, particularly for their applications in high-density storage and in-memory computing. We report on controllable resistive switching (RS) properties of gallium oxide (GaO_x)-based devices (configuration: Ag/GaO_x/p^{++}-Si) deposited through rf magnetron sputtering. In order to tailor the RS behaviour, the influence of two key factors, viz., the growth angle and thickness of the oxide layer is investigated. The results indicate that the GaO_x-based devices grown at a glancing angle (80°) exhibit bipolar resistive switching behaviour with a significantly higher ON/OFF ratio and larger endurance cycles compared to the on-axis grown films. On the other hand, stable bi-directional threshold (volatile) switching characteristics are observed by tuning the film thickness. The observed RS attributes and tunability in the switching mechanism in glancing angle deposited films can be linked to the stoichiometric modifications of the GaO_x films in the case of glancing angle deposition. These findings represent a significant step towards optimizing the performance of gallium oxide-based RS devices, holding promise for applications in cross-bar array structures of ReRAM devices. Finally, with the help of various microscopic analyses, an attempt has been made to explain the physical mechanism behind the experimentally observed RS properties.

Keywords: Resistive switching, ReRAM, gallium oxide;

Exploring Optical Electronegativity in Ternary Chalcopyrite Compounds Through Phillips-Van Vechten-Levine Theory

[1]**Apurba Paramanik,** [2]Kalyan Kumar

[1]*Bidhan Chandra College, Asansol, Paschim Bardhhaman, West Bengal 713304*
[2]*Durga Soren University, Bompas Town, Deoghar, Jharkhand 814114*

Abstract

Ternary chalcopyrites compound materials exhibit exceptional optoelectronic properties that make them ideal for various applications like solar cells, LEDs, photodetectors etc. The PVL (Phillips-Van Vechten-Levine) theory is a significant model in solid-state physics and materials science. The application of PVL theory to ternary chalcopyrite compound materials has been instrumental in predicting their electronic and optical properties. By using the concept of PVL theory and least square fitting method we have suggested here a simple empirical relation to predict the numerical values of optical electronegativity of different I-III-VI 2 and II-IV-V 2 type chalcopyrite semiconductor compounds. The obtained values of optical electronegativity by this method closely match the established values and a comparison between our current findings and those published in existing literature is also provided.

Keywords: Ternary Chalcopyrite compound, PVL theory, optoelectronics, electronegativity, principal quantum number, optical electronegativity

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Investigation of sputter-grown TiN-based memristive devices for non-volatile memory applications: Role of N_2 flow rate

Shanu Bandyopadhyay, Aparajita Mandal, Rupam Mandal, Tapobrata Som*

Institute of Physics Bhubaneswar, Sachivalaya Marg, 751005, India
**Corresponding Author: tsom@iopb.res.in*

Abstract

In modern era, memristor has great potential in memory storage application due to its high performance, high storage capability, low voltage, and high-speed operation. Apart from oxide-based memory device, nitride-based device shows promising results in storage and computing application, however there are limited works on it. In our work we investigate TiN based memory resistive device having configuration: Ag/TiN/p^{++}Si/Ag as a function of Nitrogen (N_2) flow rate during growth by magneto sputtering technique. Result shows a forming free, non-volatile (NVM), Bipolar RS behaviour. In particular, high ON/OFF ratio, low SET RESET voltage along with high stability has been achieved by optimising the N_2 flow rate. In addition, optimized TiN memristor exhibits bio synaptic function like potentiation and depression which is essential for neuromorphic computing. The charge conduction process is space charge limited current (SCLC) via the N_2 vacancies, however no ohmic type conduction is observed in LRS. Hence, working as an electrode material, TiN can also be used as a potential candidate in memory application.

Development of Room temperature Multiferroic behavior in Barium-hexa ferrite nanoparticles

Mita Karmakar[1*], Soumen Basu[1*], Mrinal Pal[2]
[1]NIT Durgapur, [2]CSIR-CGCRI Kolkata
** Email: mita.physics10@gmail.com, sbasu.phy@nitdgp.ac.in,*

Abstract

In this present work described the multiferroic property of nanocrystalline pure barium-hexa ferrite material. The pure-BaM nanoparticles were prepared by ceramic route. The phase formation and microstructure behavior and morphology are studied using X-ray diffraction (XRD) and transmission electron microscope (TEM) and FESEM respectively. The average particle size of synthesized pure BaM has been calculated from XRD and TEM.

Probing the Opto-Organic-Spintronic effect *hybrid* Inorganic-Organic-based $ITO/Co/C_{60}/V(TCNE)_2/C_{60}/Co/Au$ Dual Spin Valve Devices

Subhadip Paul[1,], Nitish Ghosh[1], Debajit Deb[2], Puja Dey[1,3]*
[1]Department of Physics, Kazi Nazrul University, Asansol, 713340, WB, India
[2]Department of ECE, Koneru Lakshmaiah Education Foundation, Vaddeswaram, 522302, AP, India
[3]Centre for Organic Spintronics and Optoelectronics Devices, Kazi Nazrul University, Asansol, 713340, WB, India
**spaul74242@gmail.com*

Abstract

The multifunctionality of Organic inorganic-based spin valve devices has great potential in the spintronics and magnetic sensor industries. In this work, we have fabricated and investigated $ITO/Co/C_{60}/V(TCNE)_2/C_{60}/Co/Au$ *hybrid* inorganic-organic Dual Spin Valve devices. Current-voltage (*I-V*) characteristics study reveals huge magnetoresistance (MR) (more than 100%) at room temperature. Furthermore, investigation of *I-V* characteristics in the presence and absence of 660 nm red laser light illumination revealed positive photo generation in the sample. Positive photo-generation, calculated using $(\frac{I_L - I_D}{I_D})$ X 100 %, has been found to be 50 %.

Resourceful Shallow Clock Tree Synthesis with Lightweight Optimization Methods

*** Dr. Sowmya K B, Amogh Yogesh Naragund, Nischay B S, Santhosh V**

RV College of Engineering, Bengaluru, Karnataka, India
*Corresponding author: sowmyakb@rvce.edu.in

Abstract

The Clock tree synthesis (CTS) is crucial for ensuring proper timing and power efficiency in chip designs. However, using licensed EDA tools like Synopsys and Cadence to verify the clock tree introduces challenges in adapting functions and scrutinizing the process. Discrepancies between the chip design and its specifications can result in incorrect CTS outcomes, leading to increased costs if modifications are required. Currently, there is no method to check clock tree synthesizability during placement and routing using only Register Transfer Level. This study aims to approximate the results of Clock Tree Synthesis by inserting temporary logic into the RTL before routing. This method optimizes clock tree implementation by anticipating Clock Tree synthesis requirements, thus reducing resource usage and enhancing integrated circuit efficiency and performance. The clock distribution algorithm must follow design rule checks, including constraints on maximum transition, capacitance, and fanout while minimizing skew and insertion delay in the target clock tree. This involves strategically placing buffers to optimize timing closure, especially for high fanout signals, thereby reducing skew. However, the increase in the size of integrated circuit designs increases the demand for clock signal distribution nodes, which in turn extends calculation times. Achieving optimal results requires extensive calculations to meet various constraint conditions within the complex distribution algorithm. If these conditions are not met after RTL design, modifications are necessary, leading to additional time and costs due to the need to address constraints, circuit stability, and performance considerations. To streamline the Clock Tree Synthesis (CTS) process, a simplified clock tree has been developed that relies solely on the register transfer level (RTL) source. This approach eliminates the need for licensed EDA tools. Previous research works have focused on CTS within the data path, specifically from input to D flip-flop, but have struggled with large and complex designs.

Keywords: Clock Distribution, Clock Tree Synthesis (CTS), EDA tools, Register Transfer Level (RTL), Shallow CTS

Thermal and Electronic Properties of AgInX2 (X=S,Se,Te) Ternary Chalcopyrites: A First-Principles Study

Dr. Ajay Kumar Sharma

Assistant Professor, Bidhan Chandra College, Asansol

Abstract

In this study, I have present a comprehensive first-principles investigation of the thermal and electronic properties of AgInX2 (X=S,Se,Te) ternary chalcopyrite compounds using density functional theory (DFT) as implemented in the Quantum ESPRESSO package. The structural, electronic, and thermal properties were calculated using the Generalized Gradient Approximation (GGA) with the Perdew-Burke-Ernzerhof (PBE) exchange-correlation functional. The results reveal systematic trends in the electronic band structure, density of states, and thermal properties across the chalcogen series, providing valuable insights into their potential applications in optoelectronic devices.

Keywords- Ternary Chalcopyrites, DFT, GGA, PBE.

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Jute fibre reinforced unsaturated polyesters laminate preparation using egg shell filler

Deepshikha Datta[a], K S Deepak[b], Bimal Das[b] , Sayanton Mazumder

[a]*Department of Chemistry, Brainware University, Barasat, Kolkata, West Bengal 700125*
[b]*Department of Chemical Engineering, National Institute of Technology, Durgapur-713209, India*

Abstract

The current work aims to evaluate the properties of unsaturated polyester laminates reinforced with discontinuous randomly oriented chopped jute fibre matrix filled with microsized (57.8 μm) eggshell filler. Laminates with 2 and 3 layers of jute fibres were prepared by hand lay-up process. The mechanical properties like tensile strength, impact strength, and flexural strength was enhanced from 20.16 to 25.8 MPa, 1.42 to 3.98 KJ/m^2 and 35.54 to 57.84 MPa, respectively, when the eggshell filler (surface area - 72.64 m^2/g, pore volume - 0.297 cc/g) content was increased from 0 to 2.5 % in the matrix for the three-layered laminate. The increase in filler content to 5% enhanced the hardness from 21.95 to 90.35 Rockwell L-scale (2-layered laminate); however, there was a declination of the other mechanical properties at a high filler content. The microsized filler has significantly decreased the voids and improvised the homogeneity, microstructure, crystallinity and contact angle [from 70.98 (unfilled) to 74.72 (filled)] of the produced filled laminates, as substantiated by SEM, AFM, XRD and Contact angle measurements. As continuation to the previous work done, the result obtained from the recent studies shows that the R-sq value is 94.46%, R-sq(adj) value is 75.91%,R-sq (pred) is 74.1%, P-Value for filler content is 0.048 and the F-vale is increasing. Thus the fabricated laminates can be efficiently utilised as an eco-friendly, high-strength, low-cost, light material for fabricating automobile dashboards.

***Keywords**:* Laminates; jute fibre; unsaturated polyester; eggshell; hydrophobic; hardness

Structural and Mechanical Studies on Cubic Zirconium Oxide (c-ZrO_2) by DFT+GGA Scheme

1. Rahul Mandal*, 2. Rahul Das

1, 2, Department of Physics, The University of Burdwan, West Bengal 713104, India
**Corresponding author: 94rahulmandal@gmail.com*

Abstract

In this work, we investigate the structural, and mechanical properties of cubic zirconium oxide using first-principle calculations by the Quantum Espresso suite. The equation of state fitting gives the optimized values as lattice constants a=b=c= 5.1 Å, α=ɤ=β= 90˚, the density= 6.1 g/cm^3, and the unit cell volume= 134.18 $Å^3$. The estimated elastic stiffness constants (C_{ij}) confirm the mechanical stability of the c-ZrO_2 structure. The average Young's modulus is 315.8 GPa. The 2D and 3D spatial variations of Young's modulus reveal that the Young's modulus is anisotropic for c-ZrO_2.

Exploration of Underlap with High-K Spacers in GS GAAFET for Enriched DC Performance

Sneha Singh, Rudra Sankar Dhar*, Amit Banerjee, **Priya Devi**
Department of Electronics and Communication Engineering
National Institute of Technology Mizoram
Aizawl, Chatltang, India
Corresponding email: rudra.ece@nitmz.ac.in

Abstract

This research thoroughly examines a gate underlap GaN-based channel GS rectangular gate all around FET with high-K spacers designed to exceed the performance requirements of the IDRS 2025, 2nm technology node. The integration of gate underlap with high-k dielectric materials in the spacer region effectively reduces short channel effects (SCEs) and minimizes parasitic resistance. By controlling the electric field distribution and improving electrostatics integrity, this design achieves better current drive and leakage suppression. The analysis explores device metrics such as g_m, I_{on}, I_{off}, switching ratio (I_{on}/I_{off}), SS, and DIBL, illustrating the advantages of high-k spacer-induced gate underlap in GAAFET structures. These findings suggest that the proposed structure offers significant performance improvements, making it a strong candidate for next-generation digital and RF applications.

Electrochemical Detection of Cinnamic Acid in Green Tea using Graphite Paste Electrode

Ipshita Bhattacharjee[1], A.H.M. Toufique Ahmed[2], Shreya Firdoushi[1], Samhita Dasgupta[1], Hemanta Ghosh[1], Sumani Mukherjee[3], Rajib Bandyopadhyay[1], Bipan Tudu[1] *

1. Department of Instrumentation and Electronics Engineering, Jadavpur University, Kolkata700106
2. Department of Electronics and Communication Engineering, Aliah University, Kolkata 700160
3. Department of Electronics and Communication Engineering, St. Thomas' College of Engineering and Technology, Kolkata, 700023
**Corresponding author: bipantudu@gmail.com*

Abstract

In this present work, detection of cinnamic acid (CA) in green tea using a simple graphite paste electrode (GPE) is described. A 3-electrode based system has been used to detect CA in green tea where GPE is used as working electrode (WE), Ag/AgCl electrode as reference electrode (RE) and Platinum electrode as counter electrode (CE). Experimental studies has been carried out using cyclic voltammetry (CV) and differential pulse voltammetry (DPV) techniques which shows a satisfactory linear range i.e. 5 µM to 400 µM with a limit of detection of 38 nM. In real sample analysis, satisfactory recovery rates of 98.6% and 94.2% with RSD values of 1.72 and 2.13 obtained respectively for 10 µM and 20 µM spiking.

Yellow to deep red sub-emissive band formation on optically porous nano-structured hydrophobic silica

Joy Mukherjee[1], Debi Prasad Datta[1,2], Tapobrata Som[1,3,*]

[1]SUNAG Laboratory, Institute of Physics, Bhubaneswar Odisha 751 005, India
[2]Department of Physics, Sripat Singh College, Jiaganj, West Bengal 742 123, India
[3]Homi Bhaba National Institute, Training School Complex, Anushaktinagar, Mumbai 400 094

Abstract

Low-energy ion bombardment in the range of 10-100 keV induces the spontaneous formation of surface nanostructures, leading to significant modifications in electronic properties. When energetic inert ions impinge on an insulating surface at off-normal angles, they drive self-organization, resulting in the formation of large-area nanostructures oriented either parallel or perpendicular to the direction of the ion beam. This study investigates the growth dynamics of nanostructures induced by 100 keV Ar^+ ion irradiation on insulating SiO_2 surface at off-normal angles. The evolution of nanostructures with ion fluence reveals a transition from nano-ripples to facet-like structures at higher fluences. These nanostructures enhance the optical absorbance (200-1000 nm) of SiO_2 substantially. Additionally, they alter the optical porosity of SiO_2 surfaces, leading to increased opacity with higher ion fluence and a transition from hydrophilic to hydrophobic behavior. Photoluminescence spectroscopy of the nanostructured SiO_2 surfaces exhibits emissions ranging from yellow to deep red under different excitation wavelengths. Moreover, changes in the intensity of various vibrational modes, including symmetric stretching, breathing, and bending modes, are observed with varying ion fluence and implantation angle. The underlying physicochemical changes in the SiO_2 surfaces are investigated in terms of estimating the plasma frequency and carrier density ratio with effective mass. Overall, this study sheds light on the evolution of nano-patterns on insulating SiO_2 surfaces induced by ion bombardment, providing insights into ion-solid interactions and potential applications.

Keywords: Ion-induced sputtering and mass redistribution, nano-patterning, SiO_2, optical absorption.

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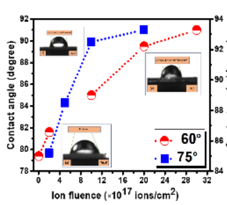

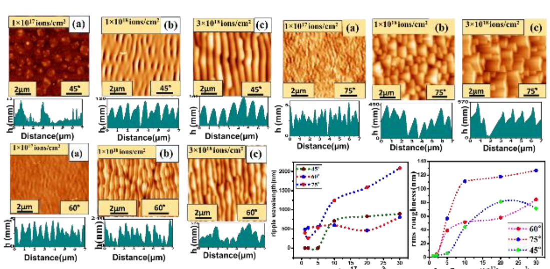

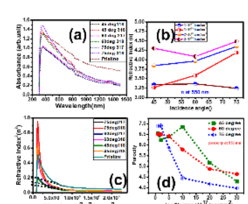

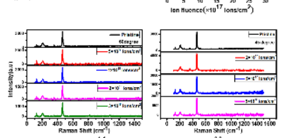

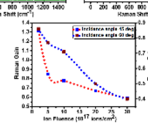

Layered Verification Environment for Cache Controller using Transaction-Level Modeling

***** Dr. Sowmya K B, **Aditya Varma, Meghana P Manru, Santhosh V, Syed Abdur Rahman**

RV College of Engineering, Bengaluru, Karnataka, India
**Corresponding author: sowmyakb@rvce.edu.in*

Abstract

This work focuses on developing a comprehensive testbench for a cache controller, structured similarly to Universal Verification Methodology (UVM). The cache controller handles load/store operations, manages cache hits and misses, and coordinates with an L2 cache for data transfers. The core design includes a finite state machine (FSM) with states like Idle, CompareTag, WriteBuffer, and Allocate to efficiently manage cache line allocation, dirty data handling, and communication with the L2 cache. The primary objective is to create a UVM-like testbench that integrates components such as agents, drivers, monitors, generators, and scoreboards. These components work together to simulate various cache operations and verify the controller's behavior. The testbench generates randomized transactions and applies them to the Device Under Test (DUT), ensuring that the controller performs correctly under different conditions. The scoreboard compares the expected and actual outcomes, highlighting errors and ensuring the design's robustness. The verification environment effectively mimics UVM principles, providing a reusable and scalable framework for validating the cache controller design.

Keywords: Cache Controller; Coverage; Constrained Random Verification; Finite State Machine; Verification Environment.

Comprehensive Analysis of $CuAlO_2$ Synthesized via Ball-Milling: Structural and Optical Properties

Apurba Sarkar[1] ,Soumya Mukherjee[2*] ,Md Jamil Akhtar[3] ,Shibayan Roy[3] and Nandan Pakhira[1]

[1]*Department of Physics, Kazi Nazrul University, Asansol, India*

[2]*Department of Metallurgical Engineering, Kazi Nazrul University, Asansol, India*

[3]*Material Science Centre, Indian Institute of Technology, Kharagpur, India*

**Corresponding author: smmukherjee4a@gmail.com,*

Abstract

This study presents a comprehensive analysis of the structural and optical properties of $CuAlO_2$ synthesized by ball-milling process, focusing on its UV-Vis absorption and photoluminescence (PL) spectra. X-ray diffraction (XRD) confirms the formation of the rhombohedral delafossite phase, demonstrating high crystallinity. FTIR reveals characteristic Cu-O and Al-O stretching vibrations, validating the successful synthesis of $CuAlO_2$. The UV-Vis absorption spectrum reveals a direct bandgap of 3.7 eV, indicating that $CuAlO_2$ is a wide-bandgap semiconductor suitable for optoelectronic applications. Photoluminescence spectroscopy shows a strong emission peak at 433 nm, corresponding to the blue region of the visible spectrum. The high intensity and sharpness of the peak suggest high crystallinity and purity of the synthesized material. The combined structural and optical characterization underscores the efficacy of the ball-milling method in producing high quality $CuAlO_2$ with promising applications in UV LEDs, photodetectors, and other optoelectronic devices.

Comprehensive Analysis of $CuAlO_2$ Synthesized via Ball-Milling: Structural and Optical Properties

Apurba Sarkar[1] ,Soumya Mukherjee[2*] ,Md Jamil Akhtar[3] ,Shibayan Roy[3] and Nandan Pakhira[1]

[1]Department of Physics, Kazi Nazrul University, Asansol, India

[2]Department of Metallurgical Engineering, Kazi Nazrul University, Asansol, India

[3]Material Science Centre, Indian Institute of Technology, Kharagpur, India

**Corresponding author: smmukherjee4a@gmail.com,*

Abstract

This study presents a comprehensive analysis of the structural and optical properties of $CuAlO_2$ synthesized by ball-milling process, focusing on its UV-Vis absorption and photoluminescence (PL) spectra. X-ray diffraction (XRD) confirms the formation of the rhombohedral delafossite phase, demonstrating high crystallinity. FTIR reveals characteristic Cu-O and Al-O stretching vibrations, validating the successful synthesis of $CuAlO_2$. The UV-Vis absorption spectrum reveals a direct bandgap of 3.7 eV, indicating that $CuAlO_2$ is a wide-bandgap semiconductor suitable for optoelectronic applications. Photoluminescence spectroscopy shows a strong emission peak at 433 nm, corresponding to the blue region of the visible spectrum. The high intensity and sharpness of the peak suggest high crystallinity and purity of the synthesized material. The combined structural and optical characterization underscores the efficacy of the ball-milling method in producing high quality $CuAlO_2$ with promising applications in UV LEDs, photodetectors, and other optoelectronic devices.

Detection of Latent Fingerprints on Various Surfaces Using ZnO

Subhashis Samanta*, Gaurab Som

Department of Forensic Science and Technology
School of Applied Science and Technology
Maulana Abul Kalam Azad University of Technology, West Bengal

**Corresponding author: subhashis.samanta@makautwb.ac.in*

Abstract

Latent fingerprints serve as important evidence in the field of forensic science and technology, helping in personal identification. However, their detection on challenging surfaces remains a persistent issue. Zinc oxide (ZnO) nanostructures, with their unique optical and surface properties, offer significant potential in improving latent fingerprint visualization. This paper explores the preparation of ZnO nanostructures via chemical methods and their application in detecting latent fingerprints on diverse surfaces. The study demonstrates the efficacy of ZnO in producing high-contrast fingerprint patterns on porous, non-porous, and semi-porous surfaces under UV illumination.

A Brief Review on The Impact of Gaussian White Noise on the Oscillator Strength of Impurity-Doped Quantum Dots

Surajit Saha
Department of Chemistry, Bidhan Chandra College,
Asansol,WB, 713304

Abstract

This comprehensive review paper explores the oscillator strength profiles of a doped quantum dot in the presence and absence of Gaussian white noise. Here we will review a system where the quantum dot is doped with a repulsive Gaussian impurity, where noise is applied both additively and multiplicatively to the system. Additionally, a perpendicular magnetic field is incorporated, along with the application of a static external electric field. Drawing from an extensive collection of literature, this review offers insights into the challenges and opportunities of the oscillator strength profile while varying several critical parameters, including confinement energy, electric field strength, dopant location, magnetic field strength, dopant potential, noise strength, aluminium concentration, and the mode of noise application. The resulting profiles exhibit significant subtleties, often revealing enhancements and maximizations of oscillator strength due to the presence of noise. These findings contribute valuable insights into the linear and nonlinear optical properties of doped quantum dot systems, which have substantial technological relevance.

Analysis of Dot product using Floating point system and Posit Dot Product Unit

***** Sowmya K B, **Chirukuri Uttam**, Gokul Krishnan V, Hithesh S, **Peketi Reshma**, Shilpa D R

RV College of Engineering, Bengaluru, Karnataka, India
**Corresponding author: sowmyakb@rvce.edu.in*

Abstract

The work explores the dot product calculation with a traditional floating-point system and the designed PDPU for better accuracy and precision. One of the applications of the dot product is the perceptron. The implementation would depend on the specific floating-point design and the available posit arithmetic modules. The perceptron takes input features, multiplying each by a learned weight, summing these products, adding a bias term, and then applying an activation function to determine the output. This implementation uses a step function for activation, making it suitable for binary classification tasks. A layered testbench in SystemVerilog is an advanced approach used to model testbenches, especially for complex designs like processors, communication protocols, or neural networks. It separates different aspects of the testbench (stimulus generation, response checking, and reporting) into different layers, making it more modular and reusable. An open-source posit dot-product unit (PDPU) designed for deep learning applications. The PDPU aims to provide a resource-efficient, high-throughput hardware implementation for dot product operations using the posit number format. Key features include a fused and mixed-precision architecture and a fine-grained 6-stage pipeline, which improve computational efficiency and reduce hardware overhead. This dot product unit can be used in hardware accelerators for Machine learning algorithms (e.g., matrix multiplications in neural networks). DSP tasks such as filtering or convolution. Graphics or image processing tasks where vector operations are involved. Extending the Design for pipelining or parallel processing, can modify the design to handle larger vectors or integrate with a larger DSP system. To handle floating-point numbers, the design could be adjusted to work with floating-point units (FPUs) or fixed-point arithmetic, depending on your hardware requirements. The results of the dot product using the traditional floating-point system and using PDPU are compared and it's found that the posit system tends to give more accurate values for dot products and similar computations due to its dynamic precision and reduced rounding errors. However, it is important to consider the trade-offs in terms of hardware and software support when choosing between posits and traditional floating-point arithmetic.

Keywords: Dot product, Perceptron, Posit, PDPU, SystemVerilog, Testbench

Impact on DC and Analog/RF Performance of Gate Underlap Induced High-K Spacer with GaN GS GAAFET

Sneha Singh, Dr Rudra Sankar Dhar, Amit Banerjee, **Priya Devi**
Department of Electronics and Communication Engineering
National Institute of Technology Mizoram
Aizawl, Chatltang, India
Email id: rudra.ece@nitmz.ac.in

Abstract: Gallium Nitride (GaN)-based Gate Stack (GS) Gate-All-Around Field Effect Transistors (GAAFETs) are promising candidates for next-generation energy-efficient electronics due to their exceptional material properties, such as high electron mobility, wide bandgap, and superior thermal stability. This study focuses on the performance evaluation of GaN-based GS GAAFETs for both DC and AC characteristics, incorporating high-k dielectric spacers and source/drain underlap engineering. The DC analysis examines parameters such as subthreshold slope, threshold voltage, drain current, and leakage current, while the AC analysis evaluates key figures of merit, including transconductance, cutoff frequency, and parasitic capacitances. Through advanced TCAD simulations, it is observed that the high-k spacer significantly enhances electrostatic control, reducing short-channel effects and improving the subthreshold slope to 61.20 mV/decade. Meanwhile, the optimized underlap minimizes parasitic capacitance, leading to a 20% increase in cutoff frequency and improved AC performance. These findings underscore the potential of GaN-based GAAFETs with high-k spacer and underlap designs for low-power, high-speed applications in green and sustainable electronics, particularly for IoT and 5G technologies. The integration of gate underlap with high-k dielectric materials in the spacer region effectively reduces short channel effects (SCEs) and minimizes parasitic resistance. By controlling the electric field distribution and improving electrostatics integrity, this design achieves better current drive and leakage suppression. These findings suggest that the proposed structure offers significant performance improvements, making it a strong candidate for next-generation digital and RF applications.

SPI Communication System with Integrated Clock Gating in SystemVerilog

* Dr. Sowmya K B, **Yugasni S,** Kiran Kumar J Purad, Keerthana V, Venu Kumar V

RV College of Engineering, Bengaluru, Karnataka, India
**Corresponding author: sowmyakb@rvce.edu.in*

Abstract

This energy-efficient Serial Peripheral Interface (SPI) communication system, crafted in SystemVerilog, utilizes clock gating to reduce power consumption during idle times. It features an SPI master module for transmitting data and a slave module for receiving it. Notable aspects include a clock gating module that employs a negative-level sensitive latch and an AND gate, a state-based SPI master, and a comprehensive testbench for validation and performance assessment. Waveform analysis shows effective clock gating, with the gated clock active solely during data transactions. The testbench also evaluates the static probability of the gated clock, offering quantitative insights into power efficiency. This design strikes a balance between functional SPI communication and energy-efficient operation, making it ideal for low-power applications that require serial data transfer. When all the assertions are grouped and included in the successful prototype and verification, it causes the capabilities of a power-saving architecture used for an application that has the need for a fully secure data transfer application with SPI serial communication circuitry.

Keywords: Clock Gating, Low Power Design, Serial Peripheral Interface, SystemVerilog

Dual port RAM Verification with Multiplier Functionality using SystemVerilog

***** Dr. Sowmya K B, **Akshay Pattar, Chaitra V K,** Mayavati, Priyanka C R

RV College of Engineering, Bengaluru, Karnataka, India
**Corresponding author: sowmyakb@rvce.edu.in*

Abstract

DP-RAM plays an important role in digital systems, as many applications involve reading and writing operations simultaneously. Therefore, the verification of reliability has to be performed with highest rigor. A paper that discussed the verification of a dual-port RAM integrated with read, write, and multiplication operations is presented. A SystemVerilog testbench was developed to run simulations of various scenarios-including independent actions on the two ports in order to validate the integrity of the data and how conflicts are resolved. Moreover, an 8-bit multiplier was implemented to verify the usability of the RAM in real computation applications. The simulation results were analyzed by waveform analysis using VCD files, which confirm that RAM and a multiplier work properly. Neither integrity of data was hampered while doing a read/write operation at the same time, nor the correctness of multiplication results. These clearly indicate that this RAM is designed to support multiple accesses concurrently and its integrated multiplier functions work accordingly. Work presented herein provides an efficient means of memory module verification with complexity that can later be integrated into wider digital systems.

Keywords: Conflict Handling, Data Integrity, Dual-Port RAM (DP-RAM), SystemVerilog, Testbench Environment.

Synthesis, characterization of Calcium Copper Titanate by modified solid state process: An effect of agate mortar activation

Sapatarshi Mukherjee[1)], Soumya Mukherjee[1)]*, Souvik Chatterjee[2)], Rajib Mondal [2)]

1. Department of Metallurgical Engineering, Kazi Nazrul University, Asansol-713340, West Bengal, India

2. UGC DAE Consortium, Kolkata Centre, Kolkata-700106, West Bengal, India

**Corresponding author: smmukherjee4a@gmail.com, soumya.mukherjee@knu.ac.in,*

Abstract

CCTO is prepared after having agate mortar activation for 15 hours followed by annealing at 950°C for 24 hours duration. Phase analysis reveals the required phase developed with crystallite size about 59nm, followed by bonding analysis by FTIR. SEM morphology reveals dense interlocking structure with spade, polygonal shape of particulates while particle size analysis by DLS reveals agate mortar activated samples to have 91-610nm particle size distribution.

I. Introduction

Calcium copper titanate ($CaCu_3Ti_4O_{12}$ / CCTO) has attracted considerable attention in materials science, electronics and is becoming an important material for device applications due to its high dielectric constant at room temperature ($\geq 10^5$). The dielectric value is found to be stable in constant from 100 to 600 K. The CCTO structure is a variation of the perovskite structure ($AB_3Ti_4O_{12}$) which possesses TiO_6 octahedra clusters and has a square planar coordination with B. The perovskite structure can be considered flexible, and most of the distortion on this structure is based on tilting of TiO_6 octahedra which causes a displacement in the 180° angles of O–Ti–O bonds. The disordered structure of the perovskite contributes to PL emission at room temperature; this effect can be observed by exciting the material with wave-lengths of higher energy than the band gap. [1-2]

II. Results

XRD reveals CCTO phase with optimized phase, minor precursors after agate mortar dry activation and annealing. Bonding analysis reveals Ca-O, Cu-O, Ti-O-Ti bonds of M-O coordinations verifying XRD results. Microstructure reveals interlocking structure with spade, polygonal shape particulates with particle size distribution by laser flash Dynamic Light scattering method reveals particles in the domain 91-615nm with sufficient percentage of particles close to about 120nm.

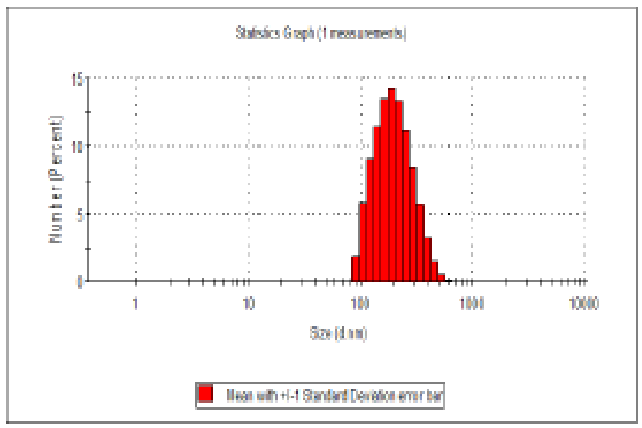

Fig 1: Particle size distribution by DLS of CCTO by agate mortar activation and annealing at 950°C 24 hours

III. Conclusion

We have demonstrated an easy low cost method to synthesize CCTO based ceramics in ultrafine particle range. Microstructure is dense, hence possibility to have good dielectric & mechanical hardness properties for possible device applications.

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Development of Dielectrically Influenced TG-FinFET for Biosensing applications

Abhishek Saha [1,2], Rudra Sankar Dhar, Amit Banerjee[3]

[1] Department of ECE, National Institute of Technology, Aizwal, Mizoram-796012, India
[2] Department of ECE, Dream Institute of Technology, Kolkata-700104, India
[3] Microsystem Design-Integration Lab, Physics Department, Bidhan Chandra College, Asansol 713303, West Bengal, India

Abstract

As a biological sensor (Bio-Sensor) operating in the 14 nm channel regime, this research has demonstrated a GaN-based Dielectrically Modulated TG-FinFET (DMTGFinFET) that is equipped with dielectric modulation. In order to get a higher switching ratio for the device, the proposed biosensor renders use of a dielectric constant of 25 for the gate dielectric. As a consequence, the switching ratio of the device is improved. To immobilize or paralyse the biomolecules, a nanocavity of 4 nm in size has been included beneath the gate region. The purpose of this work is to identify biomolecules by analyzing electrical features such as switching ratio, energy band profile, and changes in potential and electric field. Following this, the sensitivity of these properties is evaluated in terms of drain current and threshold voltage, both of which have been improved by more than 25 percent. Different biomolecules, such as uricase (k=1.54), streptavidin (k=2.1), ChOx (k=3.3), DNA (k=8.7), cellulose (k=6.1), biotin (k=2.63), glucose (k=45), and blood (k=78), are causing variations in gate capacitance, which are being measured. These gate dielectrics are experiencing current variations as a result of these changes, which are being monitored simultaneously. The Blood Biomolecules have a higher degree of sensitivity when compared to other types of biomolecules. Along with this, a comparative examination of sensitivity is also analyzed in relation to the absence of biomolecules (air). Increasing the sensitivity results in an increase in the possibility of detecting biomolecules present. Furthermore, it has been shown that the transconductance (g_m) in the proposed biosensor experiences a significant rise with respect to the increase in the dielectric constant of the biomolecule. A comparison is being formed between the electrical property of a biomolecule and the absence of a biomolecule in the cavity. It is possible for the device to recognize biomolecules that are neutral.

Technical Track III: Quantum Science and Technology

Polymer-Based Waveguides for Low-Cost PIC applications

Midhun Murali[1,2]*, Amit Banerjee[3], Tanmoy Basu[1,2]*

[1]Centre for Quantum Engineering, Research and Education, TCG CREST, Salt Lake, Kolkata 700091, India
[2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad- 201002, India
[3]Microsystem Design-Integration Lab, Physics Department, Bidhan Chandra College, Asansol, West Bengal 713303, India
**Corresponding authors' email: midhun.murali.161@tcgcrest.org, tanmoy.basu@tcgcrest.org*

Abstract

In this work, we study polymer-based photonic waveguides for various photonic integrated circuit (PIC) based applications using COMSOL Multiphysics and Lumerical software packages. Through rigorous optical analysis, we demonstrate single-mode light propagation conditions in Epoxy-based negative photoresist (SU-8) polymer-based planar slab waveguide structures. The study also comprises of the optimization of evanescent wave coupling for enhanced sensitivity. Key parameters such as effective refractive index, evanescent wave coupling, and sensitivity are systematically investigated to optimize sensor device design and performance. The results demonstrate the potential of polymer-based waveguides as cost-effective, high-sensitivity platforms for various sensing and computing applications.

Quantum Sensing using Optically Transparent Microstrip Patch with NV Centers

Anupam Patra[1,2]*, Amit Banerjee[3], Tanmoy Basu[1,2]*

[1]Centre for Quantum Engineering, Research and Education, TCG CREST, Salt Lake, Kolkata 700091, India
[2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad- 201002, India
[3]Microsystem Design-Integration Lab, Physics Department, Bidhan Chandra College, Asansol, West Bengal 713303, India
**Corresponding authors' email: anupam.patra.137@tcgcrest.org, tanmoy.basu@tcgcrest.org*

Abstract

Nitrogen vacancy (NV) centers in diamond provide multimodal sensing capabilities on a single solid-state platform. These optically addressable qubits in diamond can be coherently manipulated using a resonant microwave (MW) enabling the transfer of population from $m_s = 0$ to $m_s = \pm1$ state. However, the coupling between MW and NV centers should be optimized properly to achieve higher sensitivity. In this work, we propose a novel microstrip patch antenna designed with optically transparent elements to facilitate fluorescence microscopy using NV centers for quantum sensing applications. This proposed design will help in reducing the surface reflections and interference, leading to a better signal-to-noise ratio.

A comparative study on probe pulse propagation through three-level and four-level ladder-type atomic systems with five-level inverted-Y type atomic system

Surajit Goldar[1], **Kalan Mal[2*]**, Galib Islam[1], Suman Garain[1], Suman Mondal[3] and Amitava Bandyopadhya

1. Department of Physics, Visva-Bharati, Santiniketan, PIN 731235, West Bengal
2. Department of Physics, Suri Vidyasagar College, Suri, PIN 731101, West Bengal
3. School of Physics and Astronomy, University of Birmingham, Edgbaston, Birmingham, B15 2TT, United Kingdom
**: amitava.bandyopadhyay@visva-bharati.ac.in, kmsvc08@gmail.com*

Abstract

In the present work, A comparative study on probe pulse propagation [1] through a three-level ladder-type atomic system [2], a four-level ladder-type atomic system and a five-level inverted Y-type atomic system is conducted numerically. It has shown that the five-level inverted Y-type system can support probe pulse propagation through the atomic medium without any attenuation. The three-level ladder-type system does attenuate the probe pulse to some extent but the four-level ladder-type system undergoing three-photon transition attenuates the probe pulse to the highest degree out of all the three cases.

Investigating the magnetocaloric effect under the influence of noise in dopped *GaAs* quantum dot: An insight from Shannon entropy

Bhaskar Bhakti[1], Swarnab Datta[2] and Manas Ghosh[1]*

1. Department of Chemistry, Physical Chemistry Section, Visva-Bharati University, Santiniketan, Birbhum-731235, West Bengal, India.
2. Eklavya Model Residential School, Kanksa, West Burdwan-713148, West Bengal, India.
**Corresponding author: manasghosh.chem@visva-bharati.ac.in*

Abstract

Present study meticulously analyzes the *Shannon entropy-based magnetocaloric effect* (*MCE*) of *GaAs quantum dot* (*QD*) containing *Gaussian impurity* and in presence of *Gaussian white noise* (*GWHN*). Two diverse paths for the application of GWHN viz. *additive* and *multiplicative* are assumed. The inspection unfurls highly subtle and complex interplay between temperature, GWHN, the noise mode and the nature of the physical quantities involved that eventually shapes the MCE profiles. Under some typical conditions the MCE maximizes which merits important technological relevance. In most cases, additive and multiplicative noise diminishes and enhances the MCE, respectively, with respect to the noise-free ambience.

Computational Exploration on Coupling Formic Acid Production with Propylene Synthesis via Catalytic Transfer Hydrogenation

Anjali Ganai and Pranab Sarkar*

Department of Chemistry, Visva-Bharati University, Santiniketan 731235, India
**Corresponding author: pranab.sarkar@visva-bharati.ac.in*

Abstract

Previous studies on CO_2-assisted oxidative dehydrogenation of propane (CO_2−ODHP) have shown that the role of CO_2 is to consume the produced H_2 molecules via reverse water gas shift reaction (RWGS). Since the ultimate fate of CO_2 is to get reduced, we herein propose an unexplored role of CO_2 beyond the RWGS reaction in ODHP -- CO_2 hydrogenation to formic acid. With the objective of investigating the feasibility of this process, we, for the first time, carry out a computational investigation using a Ti-alkoxide-functionalized UiO-67 metal−organic framework. Analysis using the distortion/interaction model confirms the feasibility of this process.

Quantum Computing: Current scenario and Future prospect

Sanchari Guha
Kyoto Institute of Technology

Abstract

Quantum Computer (QC) development is a revolutionary shift in computation technology. QC have two major parts namely real temperature and cryogenic temperature region. Outputs of QC are in Qubits which have superposition and entanglement properties. IBM is one of the biggest pioneers of the QC. All the recent developments are done with considering the cryogenic temperature (kelvin and milli kelvin) as constant and focusing on increasing on number of qubits. Qubits are non-robust in nature and effected by noise easily. Achieving qubits highly clean and noise free signals for optimal output is crucial. Error correction and quality improvement of qubits are most researched on topics. In QC MOSFET development there is AC and DC bias voltages in QC, among which dc bias characteristics are mostly worked on. If we develop AC characteristics in QC maybe it will help us in scaling QC and may even help us in overcoming cryogenic temperature issue. As maintaining cryogenic temperature is very power consuming and also increase carbon footprint. Developing robust, compact and real temperature compatible is desired. If realized, quantum computers could revolutionize fields such as cryptography, materials science, medicinal discovery, and artificial intelligence by solving complex problems that are currently intractable, thus opening new frontiers in computation.

Technical Track IV: Data Science, Machine learning and AI

Predicting Thunderstorm, Rainfall and Temperature in mega city Kolkata Using Machine Learning Technique

Debapriya Nandi[1*], Vikas Vaibhav[2], Hirok Chaudhuri [1, 3], Sayantari Ghosh[1]

1Department of Physics, National Institute of Technology-Durgapur, Mahatma Gandhi Avenue, Durgapur - 713209, West Bengal, India
2Department of Mathematics, National Institute of Technology-Durgapur, Mahatma Gandhi Avenue, Durgapur-713209, West Bengal, India
3Center for Research on Environment and Water, National Institute of Technology-Durgapur, Mahatma Gandhi Avenue, Durgapur - 713209, West Bengal, India

* *dn.21ph1501@phd.nitdgp.ac.in*

Abstract

The research work uses an LSTM neural network for thunderstorm, rainfall and temperature forecasting in mega city Kolkata, enhancing uncertainty representation through Monte Carlo simulation. The model predicts future thunderstorm, rainfall and temperature patterns, addressing high variance in data. The model's efficacy in short-term weather trends prediction is demonstrated, facilitating stakeholder planning.

Prediction of scour depth around bridge piers using neuro-fuzzy interference and artificial neural network

Pradyut Chowdhury[1*], Shouvik Debnath[1], Agradip Acharyya[1], Rajib Das[2]

1. Department of Mechanical Engineering, Brainware University, Barasat 700125, India
2. School of Water Resources Engineering (SWRE), Jadavpur University, Kolkata 700032, India
**Corresponding author: pradyutchowdhury14@gmail.com*

ABSTRACT

The design of hydraulic structures is widely regarded as a significant challenge for design engineers. A large number of Studies on the bridge failures reveals the fact that scours is one of the prime factor leading to bridge damage. To address the Complex characteristic of scour process a number of studies has been conducted, where the ultimate aims to facilitate the bridge design with appropriate information on scour geometry. This study focuses on analyzing the influence of the densimetric Froude number (Fr_{d50}) and relative flow depth (h/b) on scour depth estimation. The scour depth around bridge piers is predicted using two advanced artificial intelligence techniques: the Adaptive Neuro-Fuzzy Inference System (ANFIS) and Artificial Neural Networks (ANN). The results demonstrate a strong potential correlation, highlighting the effectiveness of these methods in understanding and predicting scour depth. By accurately predicting scour depth, this study contributes to the sustainability of hydraulic infrastructure by reducing the risk of bridge failures, minimizing resource-intensive repairs, and enhancing the resilience and longevity of critical transportation systems.

Enhancing Adult Learner Motivation in Computer- Based Learning: Solutions to Key Challenges

Ananya Sarkar[1*], Avick Kumar Dey[1]

1. *DSMS College of Tourism and Management*

**Corresponding author: ananya.sarkar@dsmsindia.org*

Abstract

This research is motivated due to the purpose of providing solution to the various difficulties faced by the ALs in CBL environment. Some of these are self-regulation and time management problems, digital literacy, the inability to relate with materials acquired in school, lack of peer collaboration, and the receipt of little or no feedback and rewards. These are some of the questions this study sought to answer the challenges and how these could be addressed with the aim of improving learner engagement and motivation in CBL contexts. The method consists of a systematic analysis of literature on adult learning difficulties and possible solutions to these difficulties. Proposed solutions include incorporating time management mechanisms in CBL platforms, make friendly and accessible interfaces, and provide technical assistance for enhancing user proficiency. Further, it is suggested to personalize the learning content and integrate the social learning elements to manage the content relevance and interaction between the students. It is recommended to incorporate real-time feedback with elements of gamification to increase engagement due to the immediate perception of the task completion. Based on the study, it is clear that with well-directed efforts towards overcoming these challenges, adult learners' interest and performance in CBL settings can be enhanced. Through the application of these strategies, it is possible to enhance the role of CBL platforms in relation to the education of the targeted adult learners and take the learning experience to another level in terms of relevance, engagement, and realized motivation.

Inorganic compound's refractive index prediction: A machine learning approach

Sadhana, Barman; Utpal, Sarkar*
Department of Physics, Assam University Silchar, Silchar-788011, Assam, India

Email Address: sadhanabarman158@gmail.com

Abstract

Refractive index calculation of inorganic material is very important in determining its applicability in industries for optical devices like optical fiber, modulators, thin films *etc.* Researchers across the world are determined to get novel materials suitable for these devices. In this work, we implemented machine learning approach to predict the refractive index of several types of inorganic compounds by investigating the correlation study between features. With the highest correlated features, we have determined the model's performance and achieved highest R^2 of 82.26 % with support vector regressor model that represents a noticeable sign to depict the refractive index estimation of inorganic compounds that is useful for device design.

Remote real-time monitoring of diabetes-related health parameters in women with high parity using IoT wearable devices

Moubani Das, Dr. B.Vasumathi*, Dr. Ima Hussain***,** Dr. Rahul Kumar Ghosh*

1. Department of Computational Sciences, Brainware University
2. Department of Computational Sciences, Brainware University
3. Department of Computational Sciences, Brainware University
4. Department of Computational Sciences, Brainware University
**Dr. B.Vasumathi: vasumathibaskar@gmail.com*
**Dr. Ima Hussain: imahussain2002@gmail.com*
**Dr. Rahul Kumar Ghosh: rahulghosh.0101@gmail.com*

Abstract

The increasing diabetes rate in high-parity women highlights the need for innovative early detection methods. This study investigates how IoT wearable devices can facilitate tracking real-time glucose levels, BMI, and other health indicators. We identified trends and correlations among these factors by analyzing a secondary dataset with Python. Our findings emphasize the significance of continuous monitoring to reduce diabetes-related complications and support the integration of wearables in diabetes care. Despite limitations due to the lack of real-time data, this research paves the way for future IoT applications in chronic disease management.

Prediction of hardness and phases in high entropy alloys by using a data-driven machine learning framework

Agradip Acharyya[1,3*], **Atanu Debnath[2]**, Syed Mohammad Ali Jafri[4], Projjal Basu[2], Pravash Chandra Chakraborti[1]

1. Department of Metallurgical & Material Engineering, Jadavpur University, Kolkata 700032, India
2. Department of Metallurgical Engineering, Kazi Nazrul University, Asansol 713340, India
3. Department of Mechanical Engineering, Brainware University, Barasat 700125, India
4. Department of Computer Science and Engineering, Brainware University, Barasat 700125, India

**Corresponding author: agradip.juphd@gmail.com*

Abstract

High Entropy Alloys (HEAs) represent a new frontier in sustainable materials, combining at least five diverse elements to enhance properties and stability. In this work, more than 200 hardness and microstructural phase related experimental data were collected from several literatures and 14 characteristic input features have been employed to analyse them. The Generative Adversarial Network (GAN) model has been utilized to generate over 3,000 datasets. These datasets have been employed as training and testing data in various Machine Learning (ML) models to predict the hardness and phases of HEAs. This study demonstrates that both the random forest and gradient boosting models exhibit strong performance in phase prediction, while the Artificial Neural Network (ANN) emerges as a promising candidate for accurately predicting hardness of this type of emerging complex alloys.

A Convolution Neural Network with Optimal Filter Set for Medical Image Processing

Dr. Goutam Sarker*,

1. National Institute of Technology, Durgapur

**Corresponding author: gsarker.cse@nitdgp.ac.in*

Abstract

This work primarily involves threemedical applications namely (1) Detection of Malignant and Benign Cancer Cells. (2) Classifying ECG on the basis of types of Arrhythmia. (3) Tuberculosis Detection. We have used Convolution Neural Network, where we have optimized the Filter Number and Filter Set for learning a Medical Data Set of Malignant and Benign Cancer Cells, ECG Data Set and Tuberculosis Data Set. We have extracted the Optimal Filter Set for each of the above medical data set, during the training of the Convolution Neural Network. The present paper thus focuses into the optimal set of filters in a Convolution Neural Network model which is bound to exhibit the maximum overall accuracy of classification in all of the above medical data set learning.

Transforming Healthcare with the Internet of Things (IoT)

Institute name- NSHM Institute of Engineering and Technology, Durgapur
** Corresponding author: soumipal.22@nshm.edu.in*
(B Tech CSE 3rd Year)
Angshu Kumar Sinha, **Soumi Pal[2]**, Neha Deora[3], Sanchita Sarkar[4], Srabani.Guria Das [5], Aniruddha.Samanta [6]
[1]*angshu.sinha@nshm.com, Department of Mathematics,*
NSHM Knowledge Campus, Durgapur, West Bengal, India
[2]*soumipal.22@nshm.edu.in, B. Tech, 3rd year, Computer Science,*
NSHM Knowledge Campus, Durgapur, West Bengal, India
[3]*nehadeora.21@nshm.edu.in, B. Tech, 4th year, Computer Science,*
NSHM Knowledge Campus, Durgapur, West Bengal, India
[4]*sanchita.sarkar@nshm.com, Department of Mathematics,*
NSHM Knowledge Campus, Durgapur, West Bengal, India
[5]*srabani.das@nshm.com, Department of Mathematics,*
NSHM Knowledge Campus, Durgapur, West Bengal, India
[6]*aniruddha.samanta@nshm.com, Department of Mathematics,*
NSHM Knowledge Campus, Durgapur, West Bengal, India

Abstract

The integration of IoT into the healthcare sector intends to enhance patient care, improve health outcomes, and enhance the efficiency of healthcare systems. IoT achieves these objectives through the use of connected devices sensors, and data analytics, which enable real-time monitoring, remote patient management, and predictive analytics. Key benefits of IoT adoption in healthcare include early identification of medical conditions, development of individualized treatment plans, and improved chronic disease management. Moreover, IoT technology facilitates continuous data collection, allowing healthcare providers to make well-informed, timely decisions, thereby enhancing patient outcomes and reducing costs. Studies have demonstrated the effectiveness of IoT in various areas of healthcare, such as emergency response, geriatric care, and remote monitoring, showing a significant reduction in hospital readmissions and healthcare expenditures. By leveraging wearable sensors, smart medical devices, and remote monitoring systems, healthcare organizations can optimize resource allocation, streamline workflows, and deliver proactive care services, ultimately improving the quality of care and operational efficiency.

Phishing detection through URL analysis using machine learning techniques

[1]Brijesh Kumar Choudhury, [2]Purba Mukhopadhyay, [3]Santanu Modak

[1]Dept. of CSE, Bengal College of Engineering and Technology, Durgapur, West Bengal, India
[2,3]Dept. of IT, Bengal College of Engineering and Technology, Durgapur, West Bengal, India

Abstract

This paper presents a comprehensive study on phishing detection through URL analysis using machine learning techniques. The work begins with an extensive literature review covering the evolution of phishing attacks, various types of phishing, and existing detection methods. A comparative analysis of current machine learning approaches for URL-based phishing detection is provided, highlighting the strengths and limitations. To address identified research gaps, a novel machine learning model is proposed that incorporates an advanced set of URLs features, including length-based characteristics, character counts, security indicators, domain properties, and checks for phishing keywords. The model utilizes a Random Forest classifier, chosen for its effectiveness in handling high-dimensional data. Using a large dataset of over 549,000 URLs, the proposed model achieves a high accuracy of 96% in distinguishing between legitimate and phishing URLs. Additionally, a real-time classification system is implemented, providing detailed feature reports and probability scores for user-input URLs. This paper concludes by comparing the model's performance with existing approaches and discussing potential for future directions to enhance phishing detection capabilities.

Keywords: Cybersecurity, Phishing, Anti-Phishing, Email, URL, Machine Learning

Leveraging Artificial Intelligence and Machine Learning for Sustainable Solutions in Environmental Pollution Mitigation

Sumana Roy
*Corresponding Author: Dr.Sandip Kumar Lahiri*****
NIT, Durgapur
**Corresponding Author: sklahiri.che@nitdgp.ac.in*

Abstract

Artificial Intelligence (AI) and Machine Learning (ML) are transforming environmental science by providing advanced tools for data analysis, modelling, and decision-making. As global challenges like pollution and resource depletion intensify, AI and ML are being employed to develop sustainable solutions for clean water, energy, and environmental protection. These technologies improve the prediction of environmental changes, optimize energy systems, and enhance waste management. By analyzing large datasets, AI-driven models offer greater accuracy in identifying patterns and predicting outcomes. This paper highlights recent AI and ML advancements in mitigating pollution, advancing renewable energy, and improving water treatment, contributing to a sustainable future.

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Robust identification of key genes from the gene expression profiles of triple-negative breast cancer using machine learning techniques

*1. **Partho Bosu**, Department of Mathematics, NIT Durgapur, India*
2. Tonmoy Adhikary, Department of Mathematics, Jagannath University, Dhaka-1100, Bangladesh*
**Corresponding author: tonmoyadhikary002@gmail.com*

Abstract

In this study, we utilized the microarray gene expression dataset GSE38959 to identify key TNBC-associated genes and their pathogenic processes for diagnosis and therapeutic intervention. We identified DEGs by applying a machine learning model to the aforementioned dataset. We employed three machine learning models that emphasize genetic selection. The significant genes selected in the LIME, SVM, and RF models, based on machine learning, and yielded results when 105 genes were applied. Through the use of PPI network and module analysis, ten key genes (E2F1, MCM4, RAD51, PLK1, UQCRFS1, BUB1, YWHAG, PTPN11, EMG1, and PSMA2) with the highest scores were identified.

I. Introduction

Triple-negative breast cancer (TNBC), a subtype of breast cancer, is characterized by the absence of estrogen receptor (ER), progesterone receptor (PR), and/or human epidermal growth factor receptor-2 (HER2) expression [1]. Moreover, TNBC accounts for 15–20 percent of all breast cancer variants; however, it is a more aggressive, proliferative, and highly metastatic form of breast cancer with a higher mortality rate [2]. Conventional treatment modalities for this type of cancer include surgical intervention, radiation therapy, and chemotherapy. In recent years, bioinformatics has gained prominence in the study of the molecular origins of diseases and the identification of disease-specific biomarkers, which are increasingly utilized for precise diagnosis and treatment of illnesses owing to the rapid advancement of bioinformatics technology [3]. Accurate management and therapy are essential for improving patient outcomes; however, this necessitates a more comprehensive understanding of the underlying pathogenesis of the disease and the development of appropriate biomarkers and therapeutic targets. For this study, we conducted a comprehensive bioinformatics analysis and machine learning (ML) approach (Fig 1) to identify differentially expressed genes (DEGs) in published microarray datasets of TNBC patients from the Gene Expression Omnibus (GEO) database (GSE38959).

II. Results

This study identified 105 differentially expressed genes (DEGs), protein-protein interactions (PPI), 10 key genes, and five transcription factors (TFs). By integrating these two interaction types, the potential drug targets were determined. Pathway enrichment analysis was subsequently performed to elucidate the pathways associated with triple-negative breast cancer (TNBC).

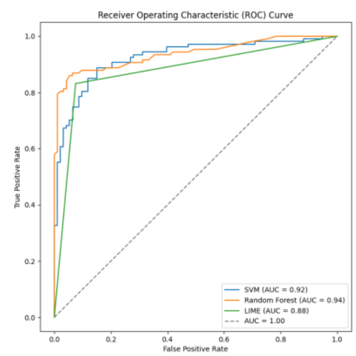

Fig 1: ROC curve for ML-based prediction models with key genes.

III. Conclusion

This study identifies ten significant genes utilizing three machine learning models. These genes are implicated in TNBC. Subsequently, drug recommendations were formulated based on these identified genes.

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Data-Driven Smart Fault Detection and Diagnosis for Chemical Reactor in Process Industry Using Machine Learning and Explainability Techniques

Pratyush Kumar Pal*, Dr. Abhiram Hens, Sumana Roy, Narottam Behera, Dr. Sandip Kumar Lahiri**
pkp.21ch1502@phd.nitdgp.ac.in; ahens.che@nitdgp.ac.in; sr.19ch1501@phd.nitdgp.ac.in; nb.20ch1504@phd.nitdgp.ac.in; sklahiri.che@nitdgp.ac.in;
National Institute of Technology, Durgapur, West Bengal, India
**Corresponding author:*
Dr. Sandip Kumar Lahiri, Department of Chemical Engineering,
National Institute of Technology, Durgapur, West Bengal, India
Email: sklahiri.che@nitdgp.ac.in

Abstract

This study proposes a Fault Detection and Diagnosis (FDD) system for chemical reactors using advanced machine learning and explainable AI (XAI) techniques. Datasets are generated through steady-state and dynamic simulations in Simulink under normal and faulty conditions. Machine learning models, including Decision Trees, k-nearest Neighbours, Ensemble Classifiers, SVM, and Neural Networks, are trained and optimized using the MRMR algorithm for feature selection. A stacked classifier system, incorporating a voting mechanism, enhances detection reliability. XAI techniques such as LIME and SHAP improve model transparency. Results demonstrate improved fault detection accuracy, offering a robust solution for chemical reactor reliability and broader industrial applications.

Keywords: Machine Learning, Explainable AI, Fault Detection and Diagnosis

The Role of Artificial Intelligence and Machine Learning on Odontological Evidence Analysis in Forensic Science

Rahul Mukherjee, Subhashis Samanta *, Gaurab Som, Sandip Karmakar

Department of Forensic Science and Technology
Maulana Abul Kalam Azad University of Technology, West Bengal
** Corresponding author: subhashis.samanta@makautwb.ac.in*

Abstract

Artificial Intelligence (AI) and Machine Learning (ML) have revolutionized various fields, including forensic science. ML employs neural networks to analyse complex datasets and provide solutions without human intervention. In forensic odontology, AI and ML have become invaluable, especially in mass disaster scenarios where only minimal remains, such as teeth, are recovered. Since teeth can withstand extreme temperatures (up to ~1600°C). Traditional methods of reconstructing facial details from Odontological evidences are challenging. However, by integrating AI and ML, forensic scientists can achieve greater accuracy and reliability in cases of mass disasters. This manuscript highlights, advancements of AI and ML in evidence analysis of Forensic Odontology and allied areas of investigation.

A Gender-Focused Analysis of Alzheimer's Disease Detection Using Supervised Machine Learning Algorithms

Pranab Hazra[1,2], Ashis Kumar Dhara[1], Tushar Kanti Bera[2,3,*]

[1]*Dept. of Electrical and Communication Engg., Narula Institute of Technology, Kolkata, WB 700109, INDIA*
[2]*Department of Electrical Engineering, NIT Durgapur (NITDgp), Durgapur, WB 713209, INDIA*
[3]*Centre of Biomedical Engg. & Assistive Tech. (BEAT), NIT Durgapur (NITDgp), WB 713209, INDIA*
[*]Corresponding Author's Email: tkbera77@gmail.com

Abstract

Alzheimer's disease, a debilitating neurological disorder affecting millions worldwide, underscores the critical need for early detection to enable effective treatment strategies. This study investigates the efficacy of supervised machine learning algorithms in the early-stage detection of Alzheimer's disease, utilizing an MRI dataset comprising patients with Alzheimer's, mild cognitive impairment, and healthy controls. Seven algorithms were trained and evaluated: Logistic Regression, Decision Tree, Random Forest, Support Vector Machine (SVM), Gradient Boost, AdaBoost, and K-Nearest Neighbors. Among these, the SVM algorithm demonstrated superior performance, achieving an accuracy of 97.7% and an area under the curve (AUC) of 0.901. A gender-stratified analysis revealed that the algorithms performed equally well in detecting Alzheimer's disease in male and female participants. Moreover, the study provides insights into the early age of detection for both genders, highlighting the importance of gender-specific evaluations in clinical research. These findings validate the potential of supervised machine learning in advancing early Alzheimer's detection and emphasize the need for inclusive and diverse approaches in medical AI applications.

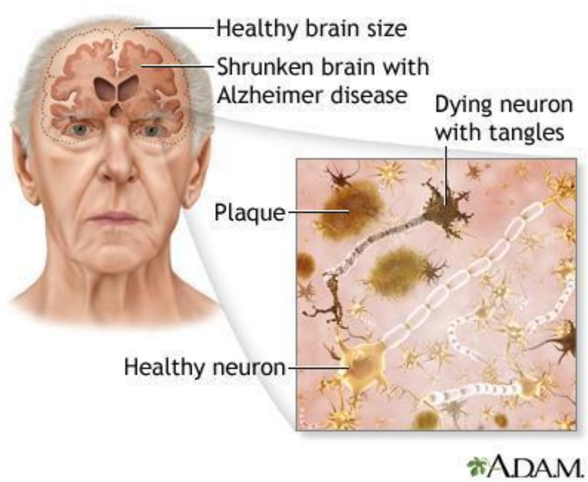

Fig. 1: Nural degradation in Alzheimer's disease.

Rainfall Prediction using Machine Learning and Python

Shaghaf Saba, Ritwika Chatterjee (B. Tech Computer Science Engineering)

Kazi Nazrul University, Asansol, WB-713340.
**shaghafsaba12@gmail.com*

Abstract:

In the present work, we have presented a machine learning-based model for rainfall prediction, aiming to enhance the accuracy and reliability of forecasts. Traditional methods often struggle to capture complex, non-linear patterns in climatic data. Our approach utilizes historical weather data, including temperature, humidity, wind speed, date, pressure, rainfall, and season, as features for machine learning algorithms. Techniques like regression analysis, decision trees, and deep learning are employed to uncover hidden patterns. The model's performance is evaluated using real-world datasets, showing improved precision and adaptability compared to traditional methods. This research emphasizes the potential of AI in meteorological prediction.

AI-Based Electrocardiography (ECG) Signal Analysis for Cardiac Arrhythmia Detection: A Computational Study Using Open-Source ECG Data

Suman Dasgupta[1,2], Suman Halder[1,3], Tushar Kanti Bera[1,3,*]

[1]*Department of Electrical Engineering, NIT Durgapur (NITDgp), Durgapur, WB 713209, INDIA*
[3]*Dept. of Electrical Engineering, Dr. B C Roy Engineering College, Durgapur INDIA*
[2]*Centre of Biomedical Engg. & Assistive Tech. (BEAT), NIT Durgapur (NITDgp), WB 713209, INDIA*

[*]Corresponding Author's Email: tkbera77@gmail.com

Abstract

Cardiac arrhythmia is one of the major health risks in modern days. Early accurate detection of any cardiac arrhythmia is becoming increasingly important in post-COVID-19 scenarios as due to COVID-19 rate of occurrence of heart diseases has increased significantly. From the ECG record of a person any sort of abnormalities in the heart blood pumping mechanism can be detected, but sometimes even for an expert cardiologist it becomes difficult to spend a sufficient amount of time and attention to the ECG report of a patient, specially 24 hour or 48 hour ambulatory ECG data obtained from Holter Monitor, leading to lack of correct diagnosis of any sort of heart abnormalities including arrhythmia. Automatic machine detection of arrhythmias is therefore indispensable, which can give a first-hand preliminary impression of the ECG signal characteristics obtained from a patient, which can then assist the Doctors for further detailed study and investigation for identification of all sorts of abnormalities present in the ECG report. Of special importance is if such automated systems can be integrated with Holter Monitoring devices recording the abnormalities on a runtime basis. One problem in designing any algorithm to interpret ECG signals is the lack of availability of sufficient numbers of signals from healthy and unhealthy persons having different categories of heart abnormalities or arrhythmia present in the set. Physionet provides some data in this regard like MIT-BIH arrhythmia database, MIT-BIH AF database, PTB-XL database etc. but the amount of data is insufficient to train any machine to be able to extract features from the ECG signals from where different kinds of arrhythmia can be predicted by the machine. In this paper the main objective of the work is to predict different types of arrhythmias from existing publicly available databases present on Physionet and other sources. ECG data are collected from the data open-source websites and the data are processed in Matlab. The noises are removed using filtering technique. Cardiac arrhythmia informations are searched and extracted from the Processed-ECG-Data. Results demonstrate that the ECG data are denoised. Cardiac arrhythmia information is found.

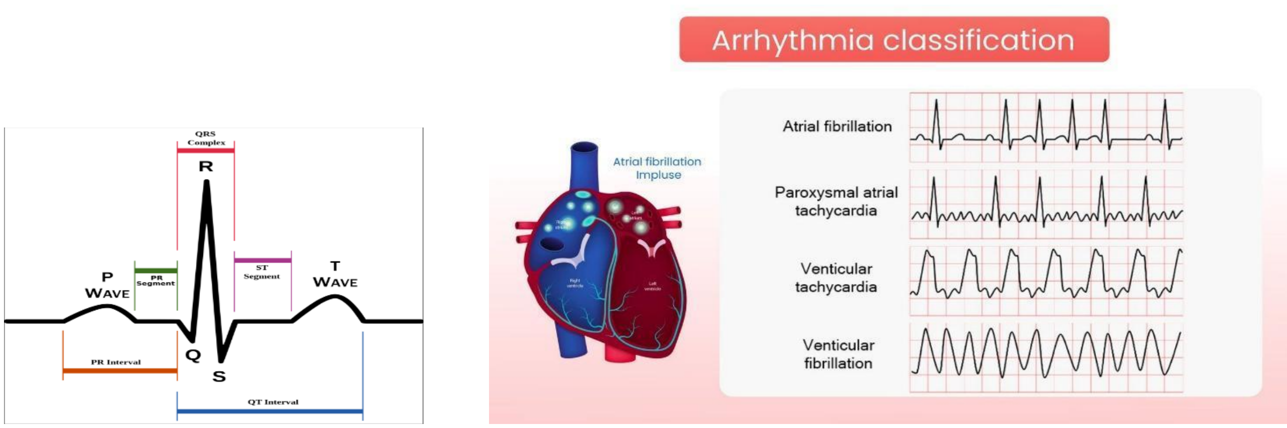

Fig. 1: AI-Based Electrocardiography (ECG) Signal Analysis for Cardiac Arrhythmia Detection (a) a normal ECG signal, (b) ECG signals for different types of cardiac arrhythmias.

Design and Development of An Arduino Based Student Attendance Monitoring System Using RFID Sensing: A New Approach

Sandip Low[1], Anindya Rudra[1], Tushar Kanti Bera[1,2]*
[1]*Department of Electrical Engineering, NIT Durgapur (NITDgp), Durgapur, WB 713209, INDIA*
[2]*Centre of Biomedical Engg. & Assistive Tech. (BEAT), NIT Durgapur (NITDgp), WB 713209, INDIA*
*Corresponding Author's Email: tkbera77@gmail.com

Abstract

Attendance recording, attendance monitoring and management [1-2] are crucial parts of an academic organization/ educational institute. Traditional manual attendance monitoring and recording system needs a lot of time which is generally taken from the class hour and hence the time of the class for teaching is reduced. In this direction an Arduino-based automatic student attendance monitoring and recording system (ASAMRS) has been developed using RFID sensing to record and monitor the attendance system for a class room. ArduinoUNO and the RFID MFRC522 Module The SQLite database was integrated in the system to keep track of time for the users. Passive tags were used in this study due to their cost-effectiveness. The reader that was used in this project is the RC522 which is a 13.6MHz RFID module that is based on an MFRC522 controller from NXP semiconductor. After reading the tag, the reader sends the data received to the Arduino and the Arduino then sends the data to the host computer through serial communication and the software interface on the host computer verifies the data to our database where the information of all the students is recorded. Then the software sends the allows and denies response to the Arduino accordingly. Then the Arduino sends that signal to the smart door via which it does the open and close function of the door. The results show that the system developed is fast, user friendly and cost effective and can be implemented in any academic, industrial or any other organizations especially for the organization with high number attendees. It is observed that that this process will bring a lot more pace into the data collection system of any of the schools, colleges, offices, etc. But the problem that arose from this prototype is that when we tried to take both in and out data from one RFID- RC522 it took in the same reading, and we had to make changes in the program to take in and out on the first and second reading of the user. And the future development of this as it is very difficult. So, we have proposed this new configuration which will use the Arduino Mega 2560 version, which will provide us with considerably more pin slots, which will have a positive effect on its future changes and development.

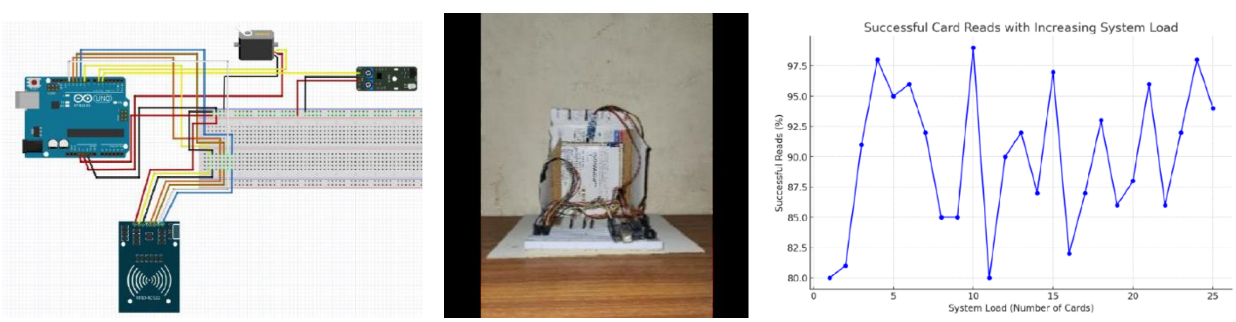

Fig. 1: Arduino based student attendance monitoring system using RFID sensing (a) the schematic of the proposed system, (b) developed RFID based student attendance monitoring system, (c) response attendance recording system with time using RFID card reads.

Electrical Impedance Tomography (EIT) for Concrete Structure Imaging: Prospects and Challenges

Tushar Kanti Bera[1,2,*], Soham Banerjee[1]

[1]*Department of Electrical Engineering, NIT Durgapur (NITDgp), Durgapur, WB 713209, INDIA*
[2]*Centre of Biomedical Engg. & Assistive Tech. (BEAT), NIT Durgapur (NITDgp), WB 713209, INDIA*
[*]Corresponding Author's Email: tkbera77@gmail.com

Abstract

Electrical Impedance Tomography (EIT) is a promising non-invasive imaging technique which can be utilized for material characterization, non-destructive testing (NDT) and structural health monitoring (SHM). Due to several unique advantages of EIT, it has been applied to solve a number of practical problems in biomedical and medical engineering, healthcare technology, material engineering, mechanical engineering, manufacturing technology, chemical engineering, civil engineering, biotechnology, and a number of other applied sciences. An EIT imaging system is generally developed with an electronic instrumentation interfaced with the PC through a graphical user interface. The object under test is interfaced with the instrumentation through the surface electrode array. The EIT instrumentation injects a low amplitude low frequency alternating current signal and measures the developed voltage signal through the surface electrodes. The boundary voltage-current data are collected and are supplied to a computer algorithm called image reconstruction program (IRP) which reconstructs the conductivity (or resistivity) distribution profile of the object domain under test in the form of tomographic images. Since recent past, the EIT and related electrical imaging techniques are rapidly emerging as transformative tools for material studies. The EIT has also been found as a promising low-cost technique for non-destructive evaluation of concrete and cementitious materials. This review synthesizes insights from nine pivotal studies on EIT-based concrete imaging and highlights the major advancements in monitoring the moisture ingress, crack detection, and structural health assessment in civil structures. It is observed that, EIT demonstrates its effectiveness in 3D visualization of internal defects, real-time monitoring under varying environmental conditions. The EIT is also found applicable in the monitoring in the self-sensing concrete technologies. However, challenges such as resolution enhancement, modelling complexities, and electrode optimization remain critical for widespread applications. Recent innovations, including edge intelligence systems, cost-efficient designs, and advanced image reconstruction algorithms, are now showing the way for scalable applications in structural health monitoring, including pavements and large-scale infrastructure. This review provides a comprehensive analysis of current methods and future prospects of EIT, highlighting valuable insights for researchers, engineers, and young researchers how EIT could helps the field of civil engineering and materials science.

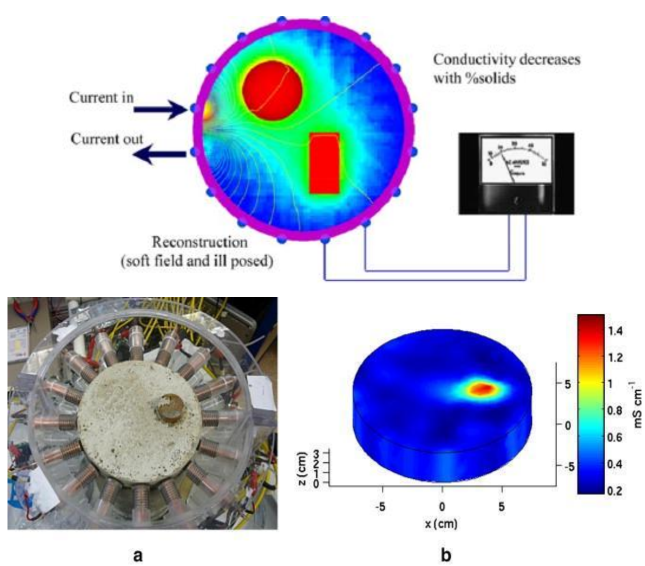

Fig. 1: Electrical Impedance Tomography (EIT) for concrete (a) EIT schematics, (b) EIT based concrete structure imaging.

Gram-Schmidt Orthogonalization Process in Soft Inner Product Space

Indubaran Mandal

Department of Mathematics
Bidhan Chandra College, Asansol
Email: indubaran707@gmail.com

Abstract:
In this present paper we have studied the Gram-Schmidt Orthogonalization Process, which allow us to transform a set of linearly independent soft vectors into a set of orthonormal soft vectors, by analysing the orthogonality of soft vectors in a soft inner product space. Furthermore, we have discussed some examples and applications of Gram-Schmidt Orthogonalization Process. The starting point of this work is analysing the Soft Hilbert spaces and orthonormality in Soft Hilbert spaces.

Keywords: Soft Inner Product Spaces, Orthogonal, Orthonormal, Gram-Schmidt Process.

Algorithmic Approach of Comparison to Time Complexity in Persistent and Non-Persistence Data Structures

Soubhik Ghosh , Pijush Kanti Kumar *

Bengal College Of Engineering And Technology, Durgapur
Government College of Engineering Textile Technology,Serampore
pijush752000@yahoo.com

Abstract

In the present work, we propose element update in a list in data structure and persistence data structure using linked list and also check any difference between them and find the time complexity. In non-persistent data structures, updates to a linked list modify the existing structure, potentially overwriting previous values and losing historical state. Conversely, persistent data structures maintain historical versions of the data even after updates. In the context of linked lists, this means that each update results in a new version of the list, while the old versions remain accessible.

Academic Engagement Scale for University Students: Development and Validation in the Context of Bihar

Priyanka Singh and Sonia Sharma*
Department of Education, Lovely Professional University, Punjab, India
**Corresponding author: soniasharma7oct@gmail.com*

Abstract

Bihar ranks lowest in NITI Aayog's Sustainable Development Goal (SDG) 4 report on Quality Education, where undergraduate academic achievement is a key indicator. This study examines the impact of academic engagement on academic achievement among B.Sc. students in Bihar. Given the absence of a standardized academic engagement tool in Bihar's context, a Likert scale survey was developed with five dimensions: cognitive, behavioral, emotional, social, and technological engagement. Responses from 213 students in Purba Champaran and Nalanda districts were analyzed, showing high reliability (Cronbach's alpha $\alpha = 0.98$). Exploratory factor analysis highlighted behavioral and cognitive engagement as the most impactful dimensions.

Low-light Object Detection with Image Enhancement using Deep Learning

Supriyo Gain, *Rupan Paul, Sampriti Saha, Rahul Gorai, Sahadeb Shit, Pratima Chatterjee, Surajit Das.

Institute name 1. Dept. of Computer Science & Engg., Kazi Nazrul University, Asansol, West Bengal – 713340.

Abstract

Disasters and fatal-accidents are common due to poor human-visibility in foggy-conditions, dim-lights, etc. Low-light object-detection with image enhancement aims at improving the visibility of images captured in poor-visibility. In the present work, the author have implemented a deep-learning model to detect the objects first, enhance the quality of the image understanding the object's dimension, and provide the measurement of safety distance to prevent accidents. The proposed-framework utilizes Faster R-CNN model using TensorFlow object-detection API and the ExDark dataset. We have used Protobufs to configure models and training parameters using COCO-API. The measurement of risk factors is highlighted in result section.

Keywords: Deep Learning, Faster R-CNN, Tensorflow, COCO-API, Object Detection, ExDark dataset, Night vision

Protein-Protein Interactions (PPIs): A comparative study using a number of Graph Neural Networks

***Arkaprava Das*[1]**, *Moupiya Ghosh*[2], *Sourajit Maity*[1*]

[1]*Department of Computer Science and Engineering, Sister Nivedita University, Kolkata-700156, India*
[2]*Department of Physics, Basic Science & Humanities, Institute of Engineering and Management (IEM), Kolkata, University of Engineering and Management, Newtown, Kolkata-700160, West Bengal, India *Corresponding author: sourajit.cse.ju@gmail.com*

Abstract

In this study, we compare a number of graph neural networks for predicting protein-protein interactions. The analysis and comparison of Graph neural networks include Graph Convolutional Networks (GCNs), Graph Attention Networks (GATs), GraphSAGE (Graph Sample and Aggregation, and Graph Isomorphism Networks (GIN). These models can all forecast how proteins will interact. We also discuss the strengths and limitations of each method and highlight recent advances in the field. Furthermore, we examine the challenges and opportunities in PPI prediction and suggest potential future directions.

Machine Learning for Anomaly Detection: A Review

Laboni Sarkar[1], Dr. Ranjan Kumar Mondal[2]

[1]Research Scholar, CSE, Swami Vivekananda University, Barrackpore, WB, India
[2]Assistant Professor, CSE, Swami Vivekananda University, Barrackpore, WB, India

labonisarkar.sona@gmail.com, ranjankm@svu.ac.in

Abstract: For many years, anomaly detection has been employed to locate and separate unusual elements from data. Anomalies have been found using a variety of methods. Machine Learning (ML) is one of the methods that is becoming more and more relevant in this field. We do a Systematic Literature Review (SLR) of ML models that identify abnormalities in their use in this research work. Our analysis examines the models from four angles: anomaly detection applications, machine learning methods, ML model performance measures, and anomaly detection categorization. After a study, we found 290 research publications covering machine learning algorithms for anomaly detection that were published between 2000 and 2020. Following our analysis of the chosen research papers, we provide 43 distinct anomaly detection applications we discovered among the selected research publications. Furthermore, we pinpoint 29 different machine learning models employed to detect abnormalities. In conclusion, we offer 22 distinct datasets, along with several other general datasets, that are utilized in anomaly detection investigations. Furthermore, researchers have embraced unsupervised anomaly detection more than classification anomaly detection methods. Researchers have put Several ML models into practice, and the field of study on anomaly detection using ML models shows great promise and potential for future breakthroughs. As a result, we offer guidance and recommendations to researchers based on this evaluation.

Key Words: Anomaly Detection, Machine Learning, Security and Privacy Protection.

Intrusion detection system: A comprehensive review

Laboni Sarkar[1], Dr. Ranjan Kumar Mondal[2]
[1]*Research Scholar, CSE, Swami Vivekananda University, Barrackpore, WB, India*
[2]*Assistant Professor, CSE, Swami Vivekananda University, Barrackpore, WB, India*
labonisarkar.sona@gmail.com, ranjankm@svu.ac.in

Abstract

The discipline of computer science has focused a lot of effort on investigating intrusion detection systems (IDSs) because of the rising network traffic and security risks. Present-day intrusion detection systems have difficulties with significant processing power and erratic incursion categories. Despite the abundance of current literature on IDS concerns, we try to offer a more detailed picture for a thorough analysis. Using a comprehensive survey and a well-organized structure, we suggest the taxonomy to describe contemporary IDSs. Furthermore, the tables and figures we compiled in the text help readers rapidly understand the big picture of IDSs.

Keywords: Intrusion detection, Anomaly Misuse

Spam Detection using a Naïve Bayes Classifier in the context of Social Media Big Data

Amitava Sarder[1], Dr. Ranjan Kumar Mondal[2]
[1] *Research Scholar, School of CS, Swami Vivekananda University, Barrackpore, WB, India*
[2] *Assistant Professor, Dept. of CSE, Swami Vivekananda University, Barrackpore, WB, India*
*sarder.amitava@gmail.com, ranjankm@svu.ac.in

Abstract

In today's extensive data landscape on social media, detecting spam is a significant challenge due to the large volume of user-generated content and the impact of spam on insights. This study explores using a Naïve Bayes classifier for efficient spam detection in social media datasets. Utilizing Naïve Bayes' probabilistic framework, it aims to separate spam from genuine content through tokenization, stop-word removal, TF-IDF extraction, hyperparameter tuning, and transforming text into meaningful numerical data. The classifier, trained on labeled data, identifies spam with high accuracy. Future work will enhance the model using additional features and hybrid methods for greater detection accuracy.

Spam Detection on Social Media Text

Amitava Sarder[1], Dr. Ranjan Kumar Mondal[2]
[1]Research Scholar, School of CS, Swami Vivekananda University, Barrackpore, WB, India
[2]Assistant Professor, CSE, Swami Vivekananda University, Barrackpore, WB, India
*sarder.amitava@gmail.com, *ranjankm@svu.ac.in*

Abstract

The use of social media has grown exponentially over the past several years, strengthening communication. Individuals use them to stay in touch with friends, make new ones, and keep each other informed about life's significant events, among other things. The two most important forms of social media are mobile networks and social networking sites. Because of their broad audience and rising popularity, these channels are heavily contaminated with spam content. This work has covered five conventional machine-learning methods for identifying spam in brief text messages using the Twitter and SMS Spam Collection datasets, both accessible from the UCI Repository. Twitter API crawls public live tweets, which compiles the Twitter dataset. The BoW with TF and TF-IDF weighting schemes are employed for feature selection. Metrics like precision, recall, accuracy, and F1 score are used to assess the performance of different classifiers. The outcomes demonstrate that, out of 100 estimators, Random Forest provided the highest accuracy.

Keywords: Spam Detection, Machine Learning, Traditional classifiers, Text Classification

Optimizing Prompt Engineering for Voice-Activated AI Systems

Sanu Hait*[1], Prabir Kumar Jana*[2], Ashim Raha*[3], Dipa Das*[4], Dr. B.Vasumathi*[5]

1. *PG Student, Department of Computational Sciences, Brainware University*
2. *PG Student, Department of Computational Sciences, Brainware University*
3. *PG Student, Department of Computational Sciences, Brainware University*
4. *PG Student, Department of Computational Sciences, Brainware University*
5. *Associate Professor, Department of Computational Sciences, Brainware University*

Sanu Hait: *bwumca23170@brainwareuniversity.ac.in*
Prabir Kumar Jana: bwumca23167@brainwareuniversity.ac.in
Ashim Raha: bwumca23180@brainwareuniversity.ac.in
Dipa Das: bwumca23168@brainwareuniversity.ac.in
Dr. B.Vasumathi: vasumathibaskar@gmail.com

Abstract

The growing prevalence of voice-activated AI systems in everyday applications underscores the need for optimizing prompt engineering to enhance user experience, efficiency, and system responsiveness. This paper investigates techniques for refining prompt design tailored to voice interactions, where challenges such as ambiguity, context sensitivity, and real-time processing emerge. We also examine the potential of adaptive learning in improving system accuracy and responsiveness over time. Through case studies and experiments, we highlight the enhanced user experience that voice-activated systems offer, paving the way for more seamless and efficient voice-based conversational AI applications across various industries.

Advanced Machine Learning Algorithms for Resolving Human-Animal Conflict in Hybrid Networks

Bhuvan Atul Savant, P.JayaRekha, **Deepa Naik*** and Tanmay De

Department of Information Science and Engineering
B.M.S.College Of Engineering,Bull Temple Road, Bangalore - 560 019
Karnataka, India.
Department of Information Science and Engineering
B.M.S.College Of Engineering,Bull Temple Road, Bangalore - 560 019
Karnataka, India.
Department of Computer Science and Engineering,
Dr.B.C.Roy Engineering College, Fulzore Mode, Durgapur, 713206
West Begal, India.
Department of Computer Science and Engineering,
National Institute of Technology, Gandhi Mode, Durgapur, 713204
West Bengal, India.
Corresponding author(s). E-mail(s):
naiksavantdeepa@gmail.com

Abstract

The human-wildlife interface refers to the range of direct and indirect interactions between wild animals and human communities coexisting in the same environment. These interactions can sometimes lead to conflicts, resulting in harm to either party. To address this, it is essential to understand the various aspects of these interactions in order to detect the presence of animals and send timely alerts to the appropriate authorities, ensuring that warnings are not broadcast to passing vehicles or pedestrians. To tackle the challenge of processing real-time images and dispatching alerts to forest authorities, we propose a hybrid network powered by Machine learning algorithms. The YOLO (You Only Look Once) V4 image detection and localization algorithm is employed to efficiently track objects in real-time. This algorithm is fast and effective for handling real-time images. Additionally, the Long Short-Term Memory (LSTM) network model, designed for time-series traffic prediction, aids in reducing the bandwidth blocking ratio of the given network.

A new efficient to approach to solve Multi Objective Transportation Problem

Utpal Majee
Department of Mathematics, Bidhan Chandra College, Asansol

Abstract

In this paper, we present a new method to solve Multi Objective Transportation problem. we have taken into consideration min-max arrangement rather than typical. When compared to the new row maximum approach, we obtain a better solution for two of the three objectives in this issue. In the real world, not all transportation issues have a single cause. Multi-objective transportation problems are those that involve several competing and incommensurable goal functions. *The method is illustrated by numerical examples. The result is compared with some other available methods in the literature.*

Key words: Multi-objective transportation problem, fuzzy membership function, Vogel's approximation method.

Conclusion:

In this paper, we propose a new approach name it with (product approach) to solve (MOTP). We use fuzzy programming to convert different penalty units (cost, time,distance etc) to membership value .It can solve (MOTP) with higher dimensions, It is an easy and uncomplicated method , As compared to other approaches, we see its results rather close to the optimum solution .

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Enhancing Pipeline Safety with Real Time Leak Detection via One Class SVM and Simulated Data

Koyndrik Bhattacharjee[1,2,*], Pronab Roy[1]

1. National Institute of Technology, Durgapur
2. Dr. B. C. Roy Engineering College, Durgapur
**Corresponding author: kb.19ce1502@phd.nitdgp.ac.in*

Abstract

In this work, an advanced machine learning based approach for the real time pipeline leakage detection using One Class Support Vector Machine (SVM) is presented. This study identifies leakage patterns from simulated data generated through COMSOL Multiphysics and MATLAB using pressure, temperature, and velocity anomalies. New techniques proposed here may improve precision in leak localization, and reduce risks from environment. We show how One-Class SVM can be practically applied to real time monitoring systems that improve safety and operational efficiency in distributed pipeline networks.

A Prototype Modeling of a Smart Agriculture Monitoring System using IOT Based Drones for Spraying Pesticides

[1*]Rahul Karmakar, [2]Tanaya Paul, and [3]**Aditi Mandal**

[1,2,3] Department of Computer Science, The University of Burdwan, Burdwan, West Bengal, India
[1*] rkarmakar@cs.buruniv.ac.in, [2]tanayasathipaul2002@gmail.com, and [3]aditimandal2506@gmail.com

Abstract

Due to the health complications arising from the use of pesticides and insecticides, a considerable number of farmers in the agricultural sector are facing significant health challenges. The conventional practice of manually applying pesticides to crop fields through traditional irrigation systems has adverse effects on health. An optimistic alternative to this manual approach involves the integration of drones for pesticide application. This substitution not only lessens the physical burden on farmers but also accelerates task completion, as drones can efficiently carry and spray insecticides across the entire farm. The two indispensable agricultural processes crucial for achieving optimal crop production include fertilizer application and pesticide use. Farmers can easily navigate the user-friendly design of this application, enhancing their ability to carry out agricultural tasks with efficiency.

A quadcopter, commonly known as a drone, is employed for agricultural purposes to uniformly distribute pesticides across a field, thereby significantly reducing the labor required by farmers. Through an Android app, the farmer gains control over the drone, establishing a seamless connection with the device via the drone's Wi-Fi module. The drone is capable of precisely navigating the farmer's land, efficiently spraying pesticides across the entire area, regardless of crop variety or field shape.

Addressing the need for a comprehensive model to enhance yields, especially in large irrigation areas with diverse crops, seasons, and influencing factors, a formal model of a drone-based smart irrigation system prototype is presented in this study. The developed model utilizes the Event-B methodology, and its validity is verified through the support of the RODIN tool. This approach ensures a robust and reliable foundation for the implementation of an advanced agricultural irrigation system, taking into account various parameters that contribute to successful and efficient crop management.

Keywords: Formal Methods · Event-B · Smart Irrigation · Smart Agriculture · IoT

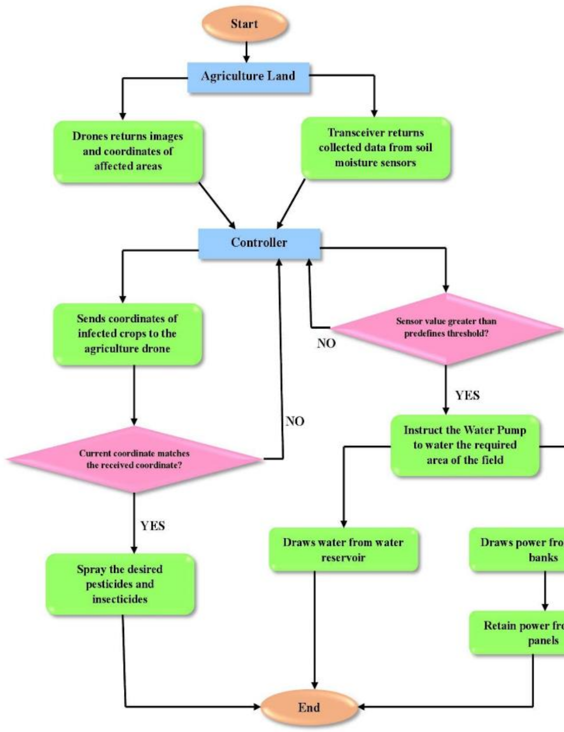

Fig 1: Flow chart of proposed system architecture

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One Optimal Convolution Neural Network for Differentiation among Coronavirus Pneumonia andNormal Chest

Dr. Goutam Sarker*,

1. National Institute of Technology, Durgapur

**Corresponding author: gsarker.cse@nitdgp.ac.in*

Abstract

In the preset work, we have proposed one Optimal Convolution Neural Network based methodology for the classification and differentiation of chest X Rays affected by corona and viral pneumonia and normal chest X Rays. The CNN during training learns the optimal number of filters with stratified data to exhibit the maximum performance evaluation of 99.24% accuracy at the optimal point of the conjunction of number of filters and training data size. Also the training and validation time of 30 minutes and 10 sec. respectively at the optimal point of 130 filters at each layer and data size of 150 is moderate and affordable.

Synthetic Data Generation and Regression Analysis of the generated data: A Comprehensive Study Using Machine Learning Techniques

Nagasreenivasarao P.[1,2*], Prof. Kaushik Parida[1]

Indian Institute of Technology, Roorkee[1],
Swami Rama Himalayan University[2]
**Corresponding author: nagasreenivasarao_p@pe.iitr.ac.in*

Abstract

Synthetic data generation is essential for many fields, as it facilitates the creation of realistic datasets for model training and testing, especially when real-world data is limited. This paper presents a comprehensive study on synthetic data generation and the performance ranking of five regression models using machine learning techniques. We generated a synthetic dataset to simulate real-world scenarios and applied five regression models. Performance metrics, including Mean Squared Error (MSE), Mean Absolute Error (MAE), and R^2 scores, were calculated. Polynomial Regression performed best, followed by Support Vector Regression, Random Forest, Decision Tree, and Linear Regression for the 1000 sample synthetic dataset.

Development of smart school id card system

SHALINI S
St. Joseph's Insititute of Technology

Abstract

The design of the Smart Id Card System was to create a robust and in trend solution for schools' attendance system. The proposed solution aims to remove the human error involved in taking manual attendance and also eliminates the sanitary issues and concerns when using biometric system. The system recognizes the faces of the students and stores their data in the respective databases and marks the present if the face is recognized and is done so well before the commencement of the class hours and marks absent otherwise. The system aims to improve the management of the attendance by employing the latest technologies. The Smart School ID Card system offers significant advantages over traditional ID cards by streamlining administrative processes, reducing manual errors, and improving the overall efficiency of school operations. Furthermore, this system fosters a safer school environment by ensuring that only authorized individuals can access specific areas, thus safeguarding students and staff. The proposed idea also addresses the implementation challenges such as data privacy concerns, infrastructure costs, and the need for stakeholder buy-in. Through a comprehensive analysis, this study underscores the potential of smart ID cards to revolutionize school management and enhance the educational experience for students and staff alike.

Enhancing Fraud Detection Accuracy through Hyperparameter Optimization of SMOTEENN and Random Forest

Gourango Ghosh[1*], Dr. Sunil Karforma[1], Dr. Amirul Islam[1], and Anirban Panja[1]

[1]*Department of Computer Science, The University of Burdwan, Rajbati, Burdwan, 713104, West Bengal, India*
***Corresponding author**: gourango.ghosh121@gmail.com*

Abstract

The reliance on online transactions has risen significantly post-COVID-19, increasing the risk of fraudulent activities. This problem can be considerably reduced by creating a system to identify fraudulent transactions. The imbalance in transaction datasets, where fraud cases are greatly outnumbered, is a major obstacle in this effort and causes biased model results. In order to rectify this imbalance, we provide a machine learning-based method in this paper that generates samples for the minority class utilizing SMOTEENN. Through feature engineering and hyper-parameter experimentation, we were able to attain optimal outcomes. The usefulness of our SMOTEENN-enhanced Random Forest algorithm in detecting fraud is demonstrated by its superior performance over the conventional Random Forest model.

Technical Track V: Sustainable Composites Technology

From Rainfall to Resilience: Understanding Drought Effects in Bangladesh's North-Western Agriculture

1. ***Sumaya Binta Ashraf****, *Department of Earth and Environmental Studies, NIT Durgapur, India*
2. *Ruhul Ashraf Khan, Department of Civil Engineering, Bangladesh Army University of Engineering and Technology, Bangladesh*

Corresponding author: ashraf.sumayab@gmail.com

Abstract

This study examines the effects of drought in the northwestern region of Bangladesh, with a focus on its impact on agriculture and local communities. Over the past decade, drought intensity has increased significantly, resulting in reduced rainfall and frequent crop failures. Through surveys and data analysis, the research reveals that farmers are struggling to adapt to these changing conditions. Findings highlight the urgent need for sustainable water management practices and the cultivation of less water-intensive crops. By analyzing local perceptions of drought, this study aims to provide recommendations for enhancing resilience and ensuring food security in the face of climate change.

Electrical Impedance Spectroscopy (EIS) Based Carbon Fibre Reinforced Polymer (CFRP) Characterization: A Short Review

Tushar Kanti Bera[1]

[1]*Department of Electrical Engineering, NIT Durgapur (NITDgp), M G Avenue, Durgapur, WB 713209, INDIA*
Corresponding Author's Email: tkbera77@gmail.com

Abstract

Electrical impedance of a material is an electrical property which depends on the material composition, structure and the health conditions. Also, the material impedance depends on the frequency of the alternating electrical signal which is applied for the impedance measurement process. Therefore, probing the electrical impedance of any material one can characterize the materials to extract a lot of information regarding material composition, structure and health condition either offline or online. Using a suitable electrical instrumentation and surface electrodes, the impedance of the materials under test can be probed noninvasively from the material surface. Utilizing the microelectrodes electrical impedance studies such as electrical impedance spectroscopy (EIS) and electrical impedance tomography (EIT) are found possible to be successfully applied in microstructure or MEMS systems to extract the information as the signature of material health or material properties. As the material properties are deeply related to its health conditions and material compositions, the EIS and EIT are being applied for material characterization either in macro or micro scale. Carbon fibre reinforced polymer (CFRP) is a material which has an extremely high strength to weight ratio and hence is used in mechanical structure development. The CFRP characterization is required for identifying structural defects, damages and other deformations either after manufacturing or during the application. Electrical impedance techniques are found efficient to study the CFRP properties noninvasively and hence EIS and EIT are found suitable for impedance-based NDT methods for CFRP structural health monitoring. As the conductivity of the resin layers of CFRP is low, by applying Nanomaterials win the CFRP layers the conductivity can be enhanced and sometimes electrical impedance methods are found more effective. In this paper the fundamentals electrical impedance spectroscopy (EIS) based carbon fibre reinforced polymer (CFRP) Characterization has been reviewed. The CFRP structures, electrical impedance spectroscopy, CFRP-impedance and the impedance-based NDT techniques such as EIS have been discussed. The instrumentation, data acquisition and measurement process of the CFRP-impedance are also discussed in detail. The applications and possibilities of impedance based CFRP-monitoring with nanomaterials embedded into the CFRP layers are also summarized. The limitation, challenges and future direction of impedance based CFRP monitoring system are presented.

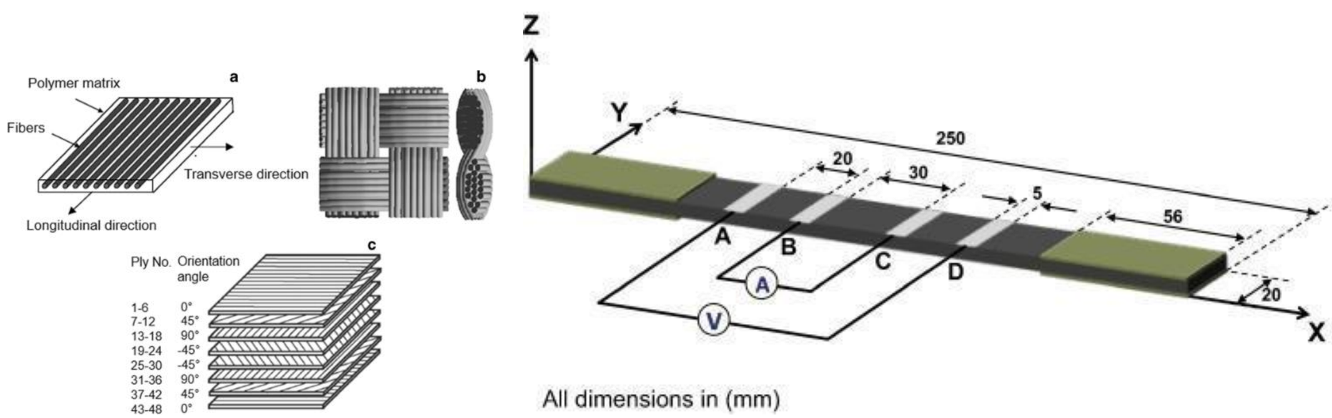


Fig. Electrical Impedance Spectroscopy (EIS) Based Carbon Fibre Reinforced Polymer (CFRP) Characterization (a) Structure of a CFRP, (b) electrode placement and impedance measurement on a CFRP laminate.

Optimizing the process of extraction of a polysaccharide from *Zizyphus mauritiana* fruit pulp

Baisnab Das Pathak[a], Saptarshi Samajdar[a], Nirmal Chandra Nath[a], Gautam Mishra[b], Bimal Das[b], Deepshikha Datta[c,d]

[b]*Department of Pharmaceutical Technology, Brainware University, Barasat, Kolkata, West Bengal 700125, India*
[b]*Department of Chemical Engineering, National Institute of Technology Durgapur-713209*
[c]*Department of Chemistry, Brainware University, Barasat, Kolkata, West Bengal 700125, India*
[d]*Center for Interdisciplinary Research & Innovations (CMRI), Brainware University, Barasat, Kolkata, West Bengal 700125, India*

Abstract

The increasing demand for novel drug carriers has driven the exploration of new biopolymers in pharmaceutical research. Among these, polysaccharides stand out due to their abundance in nature and their biocompatible and biodegradable properties as well as in industries they are generally regarded as safe. This study aims to extract and characterize a novel polysaccharide suitable for drug delivery. The polysaccharide will be extracted from Ziziphus mauritiana and characterized for compatibility using FTIR, thermal behaviour using DSC, and structural analysis using HPLC, GC-MS, and NMR. Propranolol hydrochloride will serve as a model drug, and the efficacy of the Z. mauritiana polysaccharide in tablet formulation as a binder and release retardant will be evaluated. Results will be compared with those of starch and HPMC K 15M, standard binders, and release retardants, respectively. The binding effect of Z. mauritiana-derived polysaccharide will be compared with that of starch, and the release retardant efficacy will be compared with that of HPMC K 15M at similar concentrations. Depending on the drug release data, the release mechanism will be established. Accelerated Stability studies will be conducted for six months to determine the stability of the selected formulations. Through this study, we aim to elucidate the biocompatible and biodegradable characteristics of Z. mauritiana polysaccharides, while also unveiling their diverse phytopharmaceutical properties. Consequently, this research paves the way for the development of a multifacility, industry-grade adjuvant tailored for pharmaceutical applications. Polysaccharides play diverse roles in biological processes and offer immense potential in healthcare, food, and cosmetic industries due to their therapeutic benefits and low toxicity. In this study, a water-soluble polysaccharide was extracted from the fruit pulp of Ziziphus mauritiana (commonly known as jujube or ber) using water as the extraction solvent, followed by ethanol precipitation. The extraction process was optimized by varying two key parameters: the ratio of water to plant material (ranging from 1:3 to 1:9) and the extraction temperature (30°C to 75°C). Employing a central composite design, the percentage yield of polysaccharide was found to vary with these parameters. The optimal extraction conditions were determined to be a 1:5 ratio of jujube pulp to water and an extraction temperature of 60°C, yielding the highest polysaccharide content of 9.4% ± 0.21. After the RSM study the R-sq value is 99.97% and R-sq(adj) is 99.94% and R-sq(pred) is 93.96% and the F-value is large compared to P-value and P-value.

***Keywords**:* Ziziphus mauritiana fruit pulp, polysaccharide, extraction, optimization, phytopharmaceutical properties

Effect of change in quantity and layers of chopped jute strand mat on the structure and properties of egg shell filled polyester reinforced laminates

Dhriti Barman[a], **Priyasi Bhangar[a]**, Sayanton Mazumder[b], Bimal Das[b], Deepshikha Datta[c,d]*

[a]*Department of Biotechnology, Brainware University, Barasat, Kolkata, West Bengal 700125*
[b]*Department of Chemical Engineering, National Institute of Technology, Durgapur-713209, India*
[c]*Department of Chemistry, Brainware University, Barasat, Kolkata, West Bengal 700125*
[d]*Center for Multidisciplinary Research and Innovation, Brainware University, Barasat, Kolkata, West Bengal 700125*
Corresponding author: ded.chem@brainwareuniversity.ac.in

Abstract

The increase in growth in automobile sector has paved importance in the inclusion of smart sustainable eco-friendly materials for the development of automobile parts. The use of natural fiber has paved a major role in this context. This study investigates the mechanical and microstructural properties of chopped jute fiber reinforced unsaturated polyester laminates reinforced with microsized egg shell impact modifier. Number of jute chopped strand mats were varied inorder to study the effect of fiber content and thickness on the mechanical properties of the laminate.The microsized eggshell fillers effectively reduced voids, improved homogeneity, and enhanced the microstructure and crystallinity.

Sustainable Superalloy Machining in a near dry Lubrication Environment: A GEP-PSO Hybrid Optimization Approach

Shantanu Debnath
SRKR Engineering College, Bhimavaram

Abstract

This research establishes a sustainable manufacturing model to optimize machining parameters under minimum quantity lubrication for Inconel 690. Key variables—cutting speed, feed, and depth of cut—were investigated, with sustainability assessed through five indicators: energy consumption, carbon emissions, cost, surface roughness, and tool wear. Gene Expression Programming (GEP) was paired with Particle Swarm Optimization (PSO) to model and optimize parameters, achieving less than 3% deviation from experimental results. Machining with near dry Electric discharge machining reduced energy by 15%, carbon emissions by 16.68%, cost by 7.76%, surface roughness by 18.21%, and tool wear by 25.71%, presenting an eco-friendly alternative to dry machining.

Characterizations of some types of solitons in general relativistic spacetime

Santu Dey

Department of Mathematics, Bidhan Chandra College, Asansol-4, West Bengal-713304, India
e-mail: santu.mathju@gmail.com

Abstract

The aim of this paper is to study geometrical and physical applications of certain types of metrics such as conformal η-Einstein soliton and quasi-Yamabe soliton in general relativistic spacetime. Here, we have shown the characterization of the metrics when the spacetime with semisymmetric energy-momentum tensor admits conformal η-Einstein soliton, whose potential vector field is torse-forming. We have studied certain curvature conditions on the spacetime that admits conformal η-Einstein soliton. Also, we have enhanced the importance of the Laplace equation on the spacetime, admitting conformal η-Einstein soliton. Next, we have given some physical applications with the connection of dust fluid, dark fluid and radiation era in general relativistic spacetime admitting conformal η-Einstein soliton and quasi-Yamabe soliton.

Effect of change in quantity and layers of chopped jute strand mat on the structure and properties of egg shell filled polyester reinforced laminates

Dhriti Barman[a], **Priyasi Bhangar[a]**, Sayanton Mazumder[b], Bimal Das[b], Deepshikha Datta[c,d]*

[a]Department of Biotechnology, Brainware University, Barasat, Kolkata, West Bengal 700125
[b]Department of Chemical Engineering, National Institute of Technology, Durgapur-713209, India
[c]Department of Chemistry, Brainware University, Barasat, Kolkata, West Bengal 700125
[d]Center for Multidisciplinary Research and Innovation, Brainware University, Barasat, Kolkata, West Bengal 700125
**Corresponding author: ded.chem@brainwareuniversity.ac.in*

Abstract

The increase in growth in automobile sector has paved importance in the inclusion of smart sustainable eco-friendly materials for the development of automobile parts. The use of natural fiber has paved a major role in this context. This study investigates the mechanical and microstructural properties of chopped jute fiber reinforced unsaturated polyester laminates reinforced with microsized egg shell impact modifier. Number of jute chopped strand mats were varied inorder to study the effect of fiber content and thickness on the mechanical properties of the laminate.The microsized eggshell fillers effectively reduced voids, improved homogeneity, and enhanced the microstructure and crystallinity.

Fabrication of efficient packaging substitute by blending of recycled Polypropylene with surface functionalized rice husk extracted nanosilica and phthalated starch

Anirban Bhar[a,e], **Aditi Roy[b]**, Divakar Pamanji[c], Priyasi Bhangar[d], Oliva Roy[d], ***Bimal Das[b]**, ***Biswajit Kamila[e]**, ***Deepshikha Datta[a,f]**

[a]*Department of Chemistry, Brainware University, Barasat, Kolkata, West Bengal*
[b]*Department of Chemical Engineering, National Institute of Technology Durgapur, West Bengal* [c]*Department of Civil Engineering, Mother Theresa Institute of Engineering and Technology, Melumoi, Palamaner, India*
[d]*Department of Biotechnology, Brainware University, Barasat, Kolkata, West Bengal*
[e]*Department of Chemical Engineering, Calcutta University,West Bengal*
[f]*Center for Multidisciplinary Research & Innovations (CMRI), Brainware University, Barasat, Kolkata, West Bengal 700125, India*

Corresponding authors email : deepa.datta81@gmail.com and bkchemengg@caluniv.ac.in

Abstract

Polypropylene is extensively used in packaging industry which is creating a huge environmental pollution. This work highlights on the conversion of recycled polypropylene with phthalated starch and modified nanosilica into environmental friendly biodegradable polymer blend. Starch is modified to starch phthalate in order to undergo a good dispersion in Polypropylene matrix. The surface functionalization of nano silica is done by salinization process using aminopropyl trimethoxy silane. The surface area of produced starch phthalate (2.87m^2/gm) is much higher than that of starch (1.91 m^2/gm), whereas the particle size of produced starch phthalate (9.87µm) is much lower than that of starch (40.28 µm). Different composition of starch/modified starch with silinized nanosilica and recycled PP are blended at different compositions at about 160℃ and then sheets are produced using compression moulder. The best ratio of starch/starch phthalate, modified nanosilica, recycled PP was found to be 8:0.6:32. The produced blended sheet were extensively characterised by FTIR, SEM, XRD and TGA analysis. SEM study investigates that on replacement of starch by starch phthalate, the surface texture gets highly improved leading to less susceptibility to mechanical deformation. Due to better binding property, the interfacial tension gets reduced which ultimately reduces the phase separation. XRD study reveals major peaks at 14.225°, 17.025°, 18.725° and 21.875° for the unmodified starch blended sheet however the starch phthalate blended recycled PP has a very sharp peak at 17.075° which justifies the crystalline nature of starch phthalate blended PP. The starch phthalate blended recycled PP was much more biodegradable than that of starch blended PP which was justified by its mechanical properties (tensile strength and tear strength). The initial tensile strength and tear strength for best composition of starch phthalate blended recycled PP (38.12 MPa, 88.24 N) is greater than that of starch blended recycled PP (37.012 MPa, 82.01N) which justifies the interfacial adhesion between starch phthalate and recycled PP. The produced blend can act as a superior packaging alternative for maintaining sustainable environmental.

Keywords: Recycled Polypropylene, Biodegradable sheet, Starch phthalate, Nanosilica, Amino propyl trimethoxysilane

Numerical analysis and optimization of different process parameters in AZ31B magnesium plates during friction stir welding process

Sayon Dey[1,2*], Rayapati Subbarao[3]

[1]Department of Mechanical Engineering, Kolkata, Brainware University
[2]Department of Mechanical Engineering, Nadia, Maulana Abul Kalam Azad University of Technology
[3]Department of Mechanical Engineering, Kolkata, NITTTR
**Corresponding author: dey.sayon@gmail.com*

Abstract

The transient temperature distribution of magnesium alloy AZ31B during FSW was estimated in this work using finite element modelling. The impact of process variables on heat generation across the plates, including tool rotational speed, tool travel speed, shoulder diameter, and pin diameter, was investigated using a factorial design. To control the production of brittle intermetallic compounds (IMCs), this study intends to use Response Surface Methodology to optimise the process parameters. Tool traverse speed and tool shoulder diameter were shown to be negatively correlated with peak temperature. The pin diameter and tool rotation speed were directly proportional to the peak temperature.

Application of Biopolymer based flocculants in re-refining of waste lubricating oil using environmental-friendly method: An optimization study

Sayantan Sarkar[a], **Deep Laha[a]**, Chhandam Chakraborty[b], Deepshikha Datta[*c,d], Bimal Das[*a]

[a]*Department of Chemical Engineering, National Institute of Technology Durgapur, West Bengal, India*
[b]*Department of Biotechnology, Brainware University, Barasat, Kolkata, West Bengal*
[c]*Department of Chemistry, Brainware University, Barasat, Kolkata, West Bengal*
[d]*Center for Interdisciplinary Research & Innovations (CMRI), Brainware University, Barasat, Kolkata, West Bengal 700125, India*

**Corresponding author: Tel.:+91-9434789023,*
E-mail: bimal.das@che.nitdgp.ac.in
deepa.datta81@gmail.com

Abstract

Long-term use of lubricating oil generates waste that threatens environmental safety, public health, and economic stability. Proper treatment and disposal are crucial for sustainability. This study explores the extraction-flocculation method for recovering used engine oil using sodium alginate and corn starch as biopolymeric flocculants. Optimal conditions were determined for maximizing recovery, with 1-butanol and sodium alginate yielding the highest recovery rate of 91.81%. This environmentally friendly method demonstrates the potential for reusing refined oil, addressing the oil crisis, and promoting a greener ecosystem.

DEVELOPMENT OF SILVER-THERMOCOL NANOCOMPOSITE FOR ANTI-MICROBIAL ACTIVITY

Kushagra Bhargava, Arpita Bhattacharya*, Ranu Nayak*
Amity Institute of Nanotechnology, Amity University, Noida, Uttar Pradesh- 201301
*abhattacharya@amity.edu
*rnayak@amity.edu

Abstract

This study presents the synthesis of an innovative silver-incorporated “Thermocol” nanocomposite film utilizing recycled commercial “Thermocol” as the polystyrene source and biologically synthesized silver nanoparticles. The nanocomposite exhibits significant antimicrobial properties, leveraging silver’s well-documented bactericidal and fungicidal capabilities. The approach addresses multiple waste management challenges by repurposing waste “Thermocol” and integrating biologically produced nanoparticles while promoting sustainable material development. Preliminary results highlight its potential in antimicrobial coatings and packaging applications, offering a dual advantage of environmental remediation and functional innovation. This work underscores the role of nanocomposites in achieving sustainability goals while tackling critical global challenges in waste and health management.

Stress distribution and heat transfer of steel alloys insights into gas turbine compressor stator blade performance and failure mechanisms

Nityanando Mahato[*1,2], Rayapati Subbarao[3]

[1*] *Department of Mechanical Engineering, Brainware University, India, West Bengal, Kolkata*
[2*] *Department of Mechanical Engineering, MAKAUT, West Bengal - 741249, India*
[3] *Department of Mechanical Engineering NITTTR, Kolkata.*
**Corresponding author: nityanandomahato@gmail.com*

Abstract

During gas turbine operations compressor blades play a crucial role in power generation. Here we address the issue of high pressure, rotational speed and temperatures which can lead to material deterioration in compressor stator blades. Alloys and AISI403+Nb, COMSOL Multiphasic software have been used to evaluate heat transfer, deformation and thermal stresses in a compressor stator blade. The effects are contrasted with the alloy AISI403 compared to AISI403+Nb. It has been observed that alloyAISI403+Nb has a more uniform temperature distribution because of its smaller thermal gradient. The total displacement of AISI403 was somewhat greater than that of AISI403+Nb.

Jute fibre reinforced unsaturated polyesters laminate preparation using egg shell filler

Deepshikha Datta[a], K S Deepak[b], Bimal Das[b] , Sayanton Mazumder

[a]Department of Chemistry, Brainware University, Barasat, Kolkata, West Bengal 700125
[b]Department of Chemical Engineering, National Institute of Technology, Durgapur-713209, India

Abstract

The current work aims to evaluate the properties of unsaturated polyester laminates reinforced with discontinuous randomly oriented chopped jute fibre matrix filled with microsized (57.8 µm) eggshell filler. Laminates with 2 and 3 layers of jute fibres were prepared by hand lay-up process. The mechanical properties like tensile strength, impact strength, and flexural strength was enhanced from 20.16 to 25.8 MPa, 1.42 to 3.98 KJ/m^2 and 35.54 to 57.84 MPa, respectively, when the eggshell filler (surface area - 72.64 m^2/g, pore volume - 0.297 cc/g) content was increased from 0 to 2.5 % in the matrix for the three-layered laminate. The increase in filler content to 5% enhanced the hardness from 21.95 to 90.35 Rockwell L-scale (2-layered laminate); however, there was a declination of the other mechanical properties at a high filler content. The microsized filler has significantly decreased the voids and improvised the homogeneity, microstructure, crystallinity and contact angle [from 70.98 (unfilled) to 74.72 (filled)] of the produced filled laminates, as substantiated by SEM, AFM, XRD and Contact angle measurements.As continuation to the previous work done, the result obtained from the recent studies shows that the R-sq value is 94.46%, R-sq(adj) value is 75.91%,R-sq (pred) is 74.1%, P-Value for filler content is 0.048 and the F-vale is increasing. Thus, the fabricated laminates can be efficiently utilised as an eco-friendly, high-strength, low-cost, light material for fabricating automobile dashboards.

Keywords: *Laminates; jute fibre; unsaturated polyester; eggshell; hydrophobic; hardness*

Assessment the potential impact of Green space planning for climate change mitigation In Indian cities: An integrated approach in Operation Research

[1]Bhaskar Chatterjee, Department of Mathematics, Bidhan Chandra College, Asansol -713304, West Bengal, India
[2]Bhawna Agrawal, Department of Physical Science, Rabindranath Tagore University, Bhopal - 400 098, Madhya Pradesh, India
[3]Gaurav Sharma, Department of Mathematics, Sagar Institute of Research and Technology Bhopal - 400 098, Madhya Pradesh, India

Abstract

The principles of operational research (OR) and related mathematical methods have been applied to environmental issues for the long times. However, the increasing pressures experienced by industry over the last decade, pertaining to sustainable development performances, have renewed interests and intensified the potential application of OR techniques in environmental. Capacity decisions establish a set of conditions within which operations will be required to function. Hence, it is extremely important to include input from operations management people in making capacity decisions. There is need to develop a balance between modernization and environmental. To find possibilities of including environmental issues in existing Operational Research models and methods and to find possibilities to use Operational Research models and methods in solving environmental problems. In metropolitan cities of India currently facing high challenges due to growing urbanization and impact of climate changing, also lack of using urban green space for climate adaptation and mitigation. The intensity of transportation activities significantly contributes to the escalation of carbon emissions. This study aims to Proposes that there should be guideline for urban planners on green space planning by using integrated approaches that meets the social and ecological needs for the cities. The requisite green spaces in Indian metropolitan areas, predicated on the climate changes generated. After reviewed many paper of global literature it recommends the best practices in green space for conversation of urban biodiversity.

Keywords: **-** Carbon emission, Green space, Operation Research.

Technical Track VI: Environment and Water

Conceptualizing an Idea of Seed and Pesticide Sprinkling Machine Powered by Solar Energy for Indian Agriculture Sector

Ratnesh Kumar[1*], Kundan Kumar[2], Ranit Das[2], Navlesh Kumar[2], Tamminent Rajesh[2] and Minukuri Nishanth Reddy[2]

*[1]*Assistant Professor, Mechanical Engineering Department, National Institute of Technology, Durgapur-713209.*
[2]*B. Tech. Student, Mechanical Engineering Department, National Institute of Technology, Durgapur-713209.*
**Corresponding author: rkumar.me@nitdgp.ac.in*

Abstract

The seed and pesticide sprinkling machine is an important part of the agricultural industry. In India, many seed sowing and fertilizer placement techniques are employed, including human, animal, and tractor operators. The manual operator techniques are time-consuming and result in low production. Tractor runs on fossil fuels, emitting carbon dioxide and other pollutants every second. In order to make the development of our farmers and nation sustainable while causing less harm to our environment, the project's current strategy is to construct a seed spraying equipment that will save labour costs while also operating on sustainable energy.

A nanosensor for detecting ethephon toxicity in ensuring food chemical safety

Shrodha Mondal[a] and Prithidipa Sahoo*[a]

[a]*Department of Chemistry, Visva-Bharati University, Santiniketan-731235, India*
**Corresponding author: prithidipa.sahoo@visva-bharati.ac.in*

Abstract

Food toxicity is a significant global concern for consumers, resulting from the widespread use of pesticides, insecticides, ripening agents, and food colorants. Recently, ethephon, or 2-chloroethylphosphonic acid, has become a common substance in agriculture. This compound is a widely recognized chemical used for artificial ripening in fruits and vegetables and plays a key role in plant growth regulation. However, it inhibits plasma cholinesterase and reduces the metabolic activity of hepatocytes, leading to various health issues such as liver and heart problems, dizziness, weakness, and the formation of skin ulcers, among other concerns. In our research, we have developed an innovative technique for detecting ethephon using Nitrogen-doped Carbon Quantum Dots (N-CQDs). This method leverages a quenching mechanism to facilitate fluorometric detection of ethephon, even in minute quantities within fruits and vegetables. We employed confocal microscopy to confirm and visually illustrate the interaction between ethephon and N-CQDs in the fruit cells. Additionally, ethephon toxicity has been effectively demonstrated through in vitro analysis using human cell lines (HeLa). This innovative technique has clearly shown the binding process, representing a major step forward in detecting and monitoring ethephon toxicity in living organisms.

Effect of Residual Ammonia on Zebrafish Physiological Tolerance and Behaviour in Aquatic Environment

Nabajit Mondal[1#], Jaspreet Kaur[2], Anulekha Bal[3], Anirban Ghosh[1*]

1. *Cell Development and Immunobiology Laboratory (CDIL), Department of Zoology, School of Sciences, Kalyani Regional Centre – Netaji Subhas Open University (NSOU), Kalyani, WB*
2. *Post-graduate Zoology Study Centre – NSOU, Durgapur Government College, Durgapur, WB*
3. *Post-graduate Zoology Study Centre – NSOU, RPM College, Uttarpara, Hoogly, WB*

#**Presenting author:** nabajitmondal1308@gmail.com
*Corresponding author: anirbanghosh@wbnsou.ac.in

Abstract

Ammonia is present in an equilibrium of ionic and non-ionic forms depending on pH level in aquatic environment and have significant impact on aquatic organisms but non-ionic form is more permeable to create 0-abnormalities in fish. Presence of ammonia in intensive and semi-intensive fish culture is a common problem causing serious quality and production loss in aquaculture. Present study investigates the ammonia tolerance level and responsive behavioural changes under ammoniacal toxicant-induced stress in zebrafish.

Untangling the Effects of Microplastics on Microalgae Growth for Sustainable Bioremediation

Payal Das[1*], Manisha Bal[1**]

[1]*Department of Chemical Engineering, National Institute of Technology Durgapur, Durgapur, West Bengal – 713209*

Email id: daspayal274@gmail.com, mbal.che@nitdgp.ac.in***

Abstract

The increasing rate of water contamination, brought on by the presence of microplastics (MPs), has shown the necessity to find solutions to remediate this issue. To investigate this problem, freshwater microalgae *Chroococcidiopsis cubana* was exposed to polystyrene (PS) MPs at three different concentrations over time, and the cell density, growth inhibition, extracellular polymeric substances (EPS), chlorophyll production, and settlement rate were measured accordingly. According to the results, the cell density of microalgae declined as PS microplastics concentrations increased, and the maximum inhibition rate (IR) was 31.7% under PS microplastics concentrations of 120000 number/mL. Our research will enhance the understanding of the impacts of MPs on freshwater microalgae and assist in evaluating their potential role in the removal of MPs from aquatic ecosystems.

Keywords: Microplastics, Microalgae, Growth Inhibition, Extracellular polymeric substances (EPS), Microplastics removal

Adsorption-regeneration simulation for lead removal from simulated wastewater

Utsav Raj, Bikash Kumar Mondal*

National Institute of Technology, Durgapur
**Corresponding author: bkmondal.che@nitdgp.ac.in*

Abstract

This study investigates the removal of lead (Pb) from wastewater using activated carbon WG-12, focusing on adsorption efficiency and regeneration. Experimental results confirm the adsorption process follows the Langmuir isotherm and the Linear Driving Force (LDF) models, achieving effective lead removal under optimal flow rate, initial concentration, and bed height conditions. Regeneration of WG-12 demonstrated economic and environmental viability for sustainable reuse. Breakthrough curves and parametric analyses highlighted WG-12's potential as a cost-effective adsorbent. These findings provide insights into optimizing adsorption processes for wastewater treatment, addressing the critical issue of lead contamination in an efficient and sustainable manner.

From Water to Brain: Understanding Nitrate Toxicity in Fish

***Dr. Mohammed Moniruzzaman, Sayani Dhara, Shalmoli Bandopadhyay**

1. Bidhan Chandra College,Asansol
2. Bethune College
3. Asutosh College
**Dr. Mohammad Moniruzzaman: moniruzzaman@bccollegeasansol.ac.in*

Abstract

Nitrate toxicity is increasingly recognized as a significant environmental concern, particularly regarding its effects on brain inflammation in aquatic organisms. Elevated nitrate levels, often due to agricultural runoff and industrial waste, can lead to neuroinflammatory responses that adversely affect fish and other aquatic species often leading to lower reproductive success. Current research explores the mechanisms by which nitrate exposure triggers inflammation in the central nervous system in fish, focusing on the instigation of oxidative stress and the subsequent release of pro-inflammatory cytokines like IL-1, IL-6, IL-17. Key pathways, including oxidative stress and disruption of neurotransmitter (AChE) balance, are examined for their roles in mediating these effects. The implications of brain inflammation extend beyond immediate neurotoxicity, potentially impacting behavior, cognitive function, and overall fitness of affected species. Therefore, we aimed at highlighting the role of reactive oxygen species and pro-inflammatory cytokines in modulating stress responses. Physiological stress markers, including cortisol levels and respiratory patterns, are examined in relation to nitrate exposure. The cumulative effects of chronic nitrate toxicity were noted to disrupt homeostasis, leading to increased susceptibility to diseases and diminished overall fitness. Given the ecological significance of fish populations, understanding the impact of nitrate toxicity on brain health is crucial for developing strategies to mitigate pollution and protect aquatic biodiversity. Further research is needed to fully elucidate these mechanisms and their long-term consequences for both individual organisms and ecosystems.

Rapid Cleavage of Lignin-Carbohydrate Complexes for the Extraction of Pristine Lignin and Fermentable Carbohydrates from Pineapple leaf Biomass

Baby Salini J R & Raghuram Chetty

Electrochemical Engineering Laboratory, Department of Chemical Engineering, Indian Institute of Technology Madras, Chennai-600036

Efficient extraction of lignin from biomass is essential for enhancing bioethanol production and unlocking lignin's versatile properties for sustainable applications. This study presents an innovative and eco-friendly method utilizing a natural deep eutectic solvent (NADES) composed of lactic acid and choline chloride in a 5:1 molar ratio, combined with low-energy microwave technology. The extraction process is rapid, completing in just 5 minutes at 450 W, and achieving a remarkable 95% yield of high-purity lignin while preserving its aromatic integrity. This efficient approach effectively cleaves lignin-carbohydrate complex (LCC) linkages while maintaining crucial β-O-4, β-β, and β-5 linkages within the lignin structure. Comprehensive characterization of the extracted lignin was performed using FTIR, HRMS, GPC, XPS, and an array of NMR techniques, including ^{13}C-NMR, ^{1}H NMR, HSQC, HMBC, COSY, and ROESY, confirming its structural preservation. Additionally, the process leaves behind fermentable carbohydrates as residue, providing an ideal feedstock for bioethanol production. This eco-friendly extraction method represents a significant advancement in green chemistry and sustainable biorefinery practices, enhancing biomass valorisation and paving the way for lignin's multifunctional applications across diverse sectors, from materials science to renewable energy.

Keywords: Lignin extraction; Natural deep eutectic solvents; Microwave technology; Sustainable biorefinery; Biomass valorisation.

Computational Insights into Isonicotinic Acid Derivatives: Unraveling Their Therapeutic Potential Against Tuberculosis

Dr. Aniket Kundu[1], Prof. Sonaali borkar[1], Dr. Saumik Sen [2] *

[1]*Vidyalankar Institute of Technology, Mumbai*
[2]*Paul Scherrer Institute, Switzerland*

**Corresponding author:* aniket.kundu@vit.edu.in

Abstract

This paper focuses on the computational analysis of isonicotinic acid and its derivatives, which are critical in the development of antituberculosis medications, particularly Isoniazid. Utilizing advanced molecular modeling techniques, we explore the pharmacokinetic and pharmacodynamic properties of these compounds to better understand their biological activities and therapeutic potential. Geometric optimization techniques, such as semi-empirical calculations, were used to refine molecular geometries and predict stability. The results of this computational study provide valuable insights into the interactions between isonicotinic acid derivatives and their targets, highlighting their potential efficacy against multidrug-resistant strains of Mycobacterium tuberculosis. This research underscores the importance of computational approaches in drug discovery, offering a pathway for identifying novel therapeutic agents that can address significant public health challenges.

GEOPOLYMER CONCRETE USING SOLID WASTE MATERIALS: A REVIEW

Sourav Sarkhel[1*], Radhikesh Prasad Nanda[2]

[1]PhD Research Scholar, Civil Engineering Department, NIT Durgapur, Durgapur 713209, India (Corresponding Author)
E-mail: ss.23ce1102@phd.nitdgp.ac.in
[2]Associate Professor, Civil Engineering Department, NIT Durgapur, Durgapur 713209, India
rpnanda.ce@nitdgp.ac.in

Abstract

The rapid growth in solid waste generation significantly affects environment, including land degradation, water pollution, greenhouse gas emissions, and poses threats to ecosystems and human health. Additionally, the construction industry heavily depends on cement, increasing greenhouse gasses. This study reviews existing literature on geopolymer concrete (GPC) as an alternative to Portland cement concrete by reusing industrial waste. Further, the use of solid waste in the form of agricultural, municipal, biomedical, construction and demolished, organic, plastic and e-waste has also been discussed. It is observed that waste-based GPC offers superior mechanical, physical, and durability properties, making it a sustainable construction material.

Keywords: Solid Waste, Sustainable Construction, Geopolymer Concrete, Greenhouse Gas, Waste Management.

Comprehensive Approaches to Cancer Prevention: Integrating Lifestyle Modifications, Early Detection, and Cellular Oxygen Management

∗ **Corresponding author:** liza.22@nshm.edu.in

(B.Tech CSE 3rd Year)

Angshu Kumar Sinha[1], Liza[2], Rohit Mondal[3], Amit Kumar[4], Amisha Gupta[5], Anujit Chatterjee[6]

[1]angshu.sinha@nshm.com, Department of Mathematics, NSHM Knowledge Campus, Durgapur, West Bengal, India
[2]liza.22@nshm.edu.in, B. Tech, 3rd year, Computer Science, NSHM Knowledge Campus, Durgapur, West Bengal, India
[3]rohitmondal.22@nshm.edu.in, B. Tech, 3rd year, Computer Science, NSHM Knowledge Campus, Durgapur, West Bengal, India
[4]amitkumar2.22@nshm.edu.com, B. Tech, 3rd year, Computer Science, NSHM Knowledge Campus, Durgapur, West Bengal, India
[5]amishagupta.22@nshm.edu.in, B. Tech, 3rd year, Computer Science, NSHM Knowledge Campus, Durgapur, West Bengal, India
[6]anujit.chatterjee@nshm.com, BDS, MHA, NSHM Knowledge Campus, Durgapur, West Bengal, India

ABSTRACT

This study explores the potential of manipulating oxygen levels to enhance cancer treatment efficacy. In low-oxygen (hypoxic) environments, cancer cells often enter a dormant state, which makes them resistant to conventional therapies like chemotherapy. We hypothesize that reducing oxygen availability decreases the production of viral oncoproteins E6 and E7 in HPV-related cancers, leading to a temporary halt in cell growth without inducing cell death. Upon reoxygenation, these dormant "sleeper cells" are predicted to resume rapid division, exhibiting increased resistance to treatment and potential evasion from immune detection. We propose that hyperbaric oxygen therapy, by enriching oxygen levels in the bloodstream, could reverse this resistance by sensitizing cancer cells to chemotherapy and radiation. This approach may also activate natural healing processes, providing additional therapeutic benefits. Our hypothesis opens new avenues for understanding the adaptability of cancer cells to fluctuating oxygen levels, suggesting innovative strategies for enhancing treatment outcomes in resistant cancers.

Monitoring Water Quality, Distribution Pattern and Planktonic Diversity in Durgapur Barrage on the River Damodar from Pre to Post-Monsoon Period (2022-2023)

Swornojit Bol [1, 2], Kuntal Bhattacharyya [2], Anirban Ghosh [1]*

1. Department of Zoology, School of Sciences, Netaji Subhas Open University (NSOU), WB
2. Post-graduate Zoology Study Centre – NSOU, Durgapur Government College, Durgapur, WB

Presenting author: Swornojit Bol, Email: swornojitbol88@gmail.com
*Corresponding author: Dr. Anirban Ghosh, Email: anirbanghosh@wbnsou.ac.in

Abstract

River Damodar is one of the major water source of eastern India mainly in Chotanagpur Plateau. It has many Dams constructed across and Durgapur Barrage is one of them constructed with 34 spillways situated at Durgapur in between Paschim Bardhhaman and Bankura with an elevation of 12 meters and length 692.2 meters to control flood in the region and distribute water for agriculture.

Objectives: The study was planned to assess different hydrological parameters of water quality monitoring in connection with the available planktonic diversity and water distribution scenario of Durgapur Barrage during pre to post monsoon period of 2022-2023.

Methodology: Periodic water samples were collected for the month of May-December for the consecutive year from 5 different spots marked with GPS locator to analyze the water quality parameters like pH, Silica, Conductivity, Hardness, Methyl Alkalinity, Chloride content and DO. Samples were also analyzed for planktonic diversity of the main reservoir and outlet canals as well. Periodic data on water distribution and discharge for the same period was collected from DVC regional office of Durgapur.

Results: From this cross-sectional study, data shows distinct characteristics of different parameters from 5 sampling spots with appropriate variation in the result on main reservoir as well as distributary canals/outlets. Data on pH shows distinct variation of main reservoir, connected main irrigation canal, industrial supply outlet and other connected waterbodies. We also found such variations in conductivity, silica and chloride conc., calcium and total hardness etc. Variations of this parameters are more site specific than seasonal due to anthropogenic activities and industrially treated water shows completely distinctive quality. Data on planktonic diversity and DO shows seasonal variations as well as site specific inherent differences showing both site and season have effects in compositions of planktonic community. The water distribution scenario clearly showed the maintained water level of the barrage which is 180-220 feet during the study period and excess water was mainly discharged through left bank canal and right downstream to maintain an optimum water level. The discharge varied in between 325-8500 hectometers/day to minimize the load over the dam and found excess and maximum discharge during monsoon.

Inference: Present work focuses on how different hydrological parameters and planktonic community compositions are interconnected with seasons and spot specific human activities. This work also highlighted the limitation of the barrage to contain the monsoon water where heavy rain leads to excessive release of water defying the primary purpose of the dam, which is observed in the 2024 flood occurred downstream of Durgapur barrage.

Key Words: Durgapur Barrage, Damodar River, DVC, Hydrological Parameters, Planktonic Diversity

Tuning Ti^{3+}-states in TiO_2 Thin Films by RF Magnetron Sputtering for Applications in Photocatalytic Dye Degradation and p-Si/TiO_2 Heterojunction Photodetectors

Sukalyan Shyam and Debajyoti Das*

Energy Research Unit, School of Materials Sciences
Indian Association for the Cultivation of Science, Jadavpur, Kolkata – 700 032, India.
*Corresponding author: erdd@iacs.res.in

Abstract

Ti^{3+} states in TiO_2 thin films are manipulated by controlling plasma pressure in RF magnetron sputtering. The low pressure (~20 mTorr) film, rich in Ti^{3+} states, possesses reduced work function, enhanced carrier lifetime, and accomplishes superior photocatalytic dye-degradation efficiency ~82.7%. Increased precursor collisions at higher pressures reduce the Ti^{3+} states in the matrix and photocatalytic efficiency. Reduced Ti^{3+} states generate lower positive fixed oxide charges and higher interface traps. Optimal p-Si/TiO_2 devices at 30 mTorr showed efficient minority carrier transport and photoresponsivity (~0.158 A W^{-1}) due to low interface traps, narrow conduction band offset, and moderate positive fixed oxide charges.

Production of Hydrogen-rich gaseous product from Pyrolysis of polypropylene wastes using Bauxite Ore catalyst: yield analysis of various products

Ravindra Kumar [a], Anup Kumar Sadhukhan [a*], Biswajit Ruj [b]

[a] *Department of Chemical Engineering, NIT Durgapur, West Bengal, India -713209.*
[b] *Environmental Engineering Group, CSIR-CMERI, Durgapur, India – 713209*
* *Corresponding author: aksadhukhan.che@nitdgp.ac.in*
Mob. No.- +91 9434788048

Abstract

The study investigates the catalytic role of bauxite ore in the pyrolysis of polypropylene wastes (PPW) for producing hydrogen-rich gaseous mixtures. Thermogravimetric analysis (TGA) was conducted to examine the thermal degradation behavior of PPW without and with catalysts. A batch reactor study was conducted with different proportions of bauxite at varying temperatures (525 °C to 600 °C) and heating rates to evaluate the temperature and heating rate effect on product yields and compositions. The result showed that bauxite ore's presence significantly enhanced hydrogen generation compared to thermal pyrolysis alone. At 575 °C, with 18 ^{0}C/min, the hydrogen content in the gaseous product reached up to 8.8%. The corresponding yields of pyrolytic oil (PO), gaseous products, and solid (residual char) were 75.04%, 17.06 %, and 7.9 %, respectively. The analysis of PO by FTIR and GC-MS showed higher concentrations of aromatics, namely toluene, ethyl-benzene, xylene, and methyl-naphthalene in addition to aliphatic components. The PO thus obtained resembles gasoline range fuel with high calorific value. So bauxite ore has a promising catalytic activity, making the process sustainable for hydrogen-rich syngas and aromatics-rich PO.

Keywords: Polypropylene waste; Pyrolysis; Bauxite; GCMS.

Melatonin regulated activation of PI3K/PDE signaling in BPA induced deleterious testicular functions in catfish, Clarias batrachus

[1]**Akash Acharyya**, [1]Sayan Mukherjee and [1]Kazi Nurul Hasan*

[1]*Department of Zoology, Sidho Kanho Birsha University, Purulia, West Bengal, India*

**Corresponding author: kazihasan5@gmail.com*

Abstract

Present ex vivo study explores the effects of melatonin hormone on a major water contaminant, bisphenol-A (BPA) induced impairments in testicular germ cell maturation in Clarias batrachus during spawning phase. Melatonin (100 pg/mL) significantly enhanced haploid cell percentage in BPA-primed testicular fragments, effect abrogated by MT1, PI3K, or PDE inhibitors, underscoring the necessity of MT1-dependent signaling. Furthermore, melatonin mitigated oxidative stress by activating antioxidant and anti-apoptotic responses via MT1 receptor. It also up-regulated StAR, 3β-hsd, 17β-hsd genes, potent markers of testicular maturation. In conclusion, results identify signaling cascades through which melatonin counteracts BPA-induced disruptions in spermatogenesis, oxidative balance and apoptotic regulation.

Dump-Yard Leachate Spreading Detection With Electrical Impedance Spectroscopy (EIS): A simulation Study Using COMSOL Multiphysics

Tushar Kanti Bera[1,2,*], Tanisha Roy[1], Anushka Mandal[1], Dibyaduti Layek[1],

[1]*Department of Electrical Engineering, NIT Durgapur (NITDgp), Durgapur, WB 713209, INDIA*
[2]*Centre for Research on Environment and Water (CREW), NIT Durgapur (NITDgp), WB 713209, INDIA*

[*]Corresponding Author's Email: tkbera77@gmail.com

Abstract

Materials are produced during our daily life and these are discarded to a place called dump yard. Overtime few of the materials are degraded and decomposed but in most of the cases a leachate is produced. Leachate is a highly contaminated liquid which is produced from waste materials in the disposal sites is found as a hazardous liquid to the environment if not properly identified and managed. The leachate, generated in landfills and dump-yards can flow into the soil layers contaminating the soils with the organic and inorganic contaminants which can pose a significant risk to the environment and public health. Moreover, due to rain the leachate can spread further and even can contaminate other water resources. To prevent soil and water contamination with leachate, effective and reliable detection and monitoring techniques are essential in dump-yard areas. Electrical Impedance based methods such as electrical impedance spectroscopy (EIS) can provide the information about the leachate formation and flow. EIS is an multifrequency impedance measurement technique that offers a non-invasive method to analyze the material composition, structure and health in terms of its electrical properties like electrical impedance.

EIS injects a small amplitude and low frequency electrical signals and measures the electrical impedance which provide the insights of the materials chemical composition changes. This paper explores the applicability of EIS as a new method for leachate detection and analysis in a dump-yard. The dump-yard with leachate formation model is simulated and the impedance measurement is studied in COMSOL Multiphysics. The Impedance spectroscopy analysis is also conducted by simulating the 100 mA electrical current applied in different frequencies. Electrical properties of the dump-yard are studied for different geometry, different composition and leachate at different depth and different amount of current amplitude and electrical properties of the leachate are studied to be correlate with the levels of contamination. Simulation study demonstrate that, the EIS can be used as a low-cost, fast, and reliable method for the leachate detection process to ensure water contamination prevention from leachate contributing to environmental sustainability and improved public health protection.

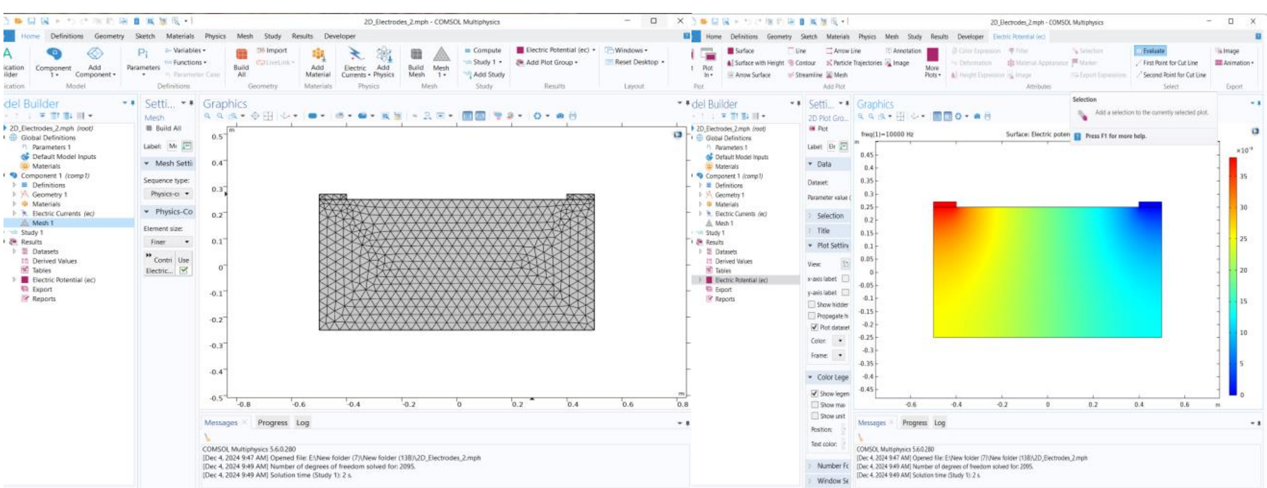


Fig. 1: Electrical Impedance Spectroscopy (EIS) based Dump-Yard Leachate detection using COMSOL Multiphysics (a) 2D domain with FEM mesh, (b) potential distribution plot for 500 mA current injection.

Nanobiocatalysis: a sustainable approach to biocatalysis

Dr. Sujit Kumar Bera

Department of Chemistry
Bidhan Chandra College
Asansol – 713304 (W.B)
E.mail: sujit@bccollegeasansol.ac.in

Abstract

With the rapid growth of nanobiotechnology, nanobiocatalysis (NBC) has emerged as an important innovation that synergistically integrates advanced nanotechnology with biotechnology. As enzymes have several limitations, NBC has exciting benefits regarding stability and activity of enzyme under harsh situation. The NBC not only improve the stability and efficiency of the system, but they also facilitate the purification and reuse for various bioprocessing cycles. Thus, the synthesis of NBC with specific physicochemical characteristics are of immense importance to the different industries like food, agriculture etc. NBC has also shown extensive applications in various fields such as biomedicine, biotherapy, biocatalysis, biosensing, biodiesel. So, the development of NBC will be a benchmark for sustainable society and the environment.

A Comparative Study on Diatom Extraction from Local Water Bodies and Clothing Materials in Haringhata, Nadia District, West Bengal, and Its Forensic Significance

Mayukh Chatterjee, Sandip Karmakar*, Gaurab Som, Subhashis Samanta*

Department of Forensic Science and Technology
Maulana Abul Kalam Azad University of Technology, West Bengal
**Corresponding authors: subhashis.samanta@makautwb.ac.in (Dr. Subhashis Samanta)*
: sandip.karmakar@makautwb.ac.in (Dr. Sandip Karmakar)

Abstract

Diatom analysis is a crucial forensic tool for investigating drowning cases, as it detects waterborne diatoms in victims' bodies or clothing. These microorganisms can link individuals to specific aquatic environments, aiding in the differentiation between ante-mortem and post-mortem drowning. By confirming contact with a particular water source, diatom analysis enhances forensic investigations. This manuscript presents a comparative study of diatom samples collected from two distinct water bodies within Haringhata Municipality. Utilizing microscopy, UV-VIS spectroscopy etc., we examine diatoms found on clothing material to assess potential contact between victim or suspect and water sources. The significance of diatom analysis linking individuals and aquatic environments in forensic science is also explored.

Health risk assessment due to the presence of antibiotics in groundwater of India's Damodar River basin

Rajalaxmi Nath[1*], Hirok Chaudhuri[1,2]

1. Department of Physics, National Institute of Technology Durgapur, Durgapur, India
2. Center for Research on Environment and Water, National Institute of Technology Durgapur, Durgapur, India

***Rajalaxmi Nath:** rn.21ph1105@phd.nitdgp.ac.in

Abstract

In the present study, antibiotic contamination profile and health risk assessment are examined. Twelve different types of antibiotics, including macrolide, fluoroquinolone, sulfonamide, and tetracycline groups, are found in 735 groundwater samples collected from 49 locations during different seasons in the Damodar river basin of India. The sum of total erythromycin, sulfadiazine and doxycycline are seen as 646.08, 323.76, and 547.81 ng/L with comparatively higher average concentrations among other detected antibiotics. The health risk of human beings results in negligible impact except for infants. The Durgapur-Asansol industrial zone is identified as a targeted pollution region on the spatial distribution map.

In-depth insights into anticorrosion behavior of azanylylidene derivatives: A symphony of green defense unveiling the 4E synergy

Sanjukta Zamindar[1,2], Priyabrata Banerjee[1,2*]

[1]*Electric Mobility and Tribology Research Group, CSIR-Central Mechanical Engineering Research Institute, Mahatma Gandhi Avenue, Durgapur 713209, India.*
[2]*Academy of Scientific and Innovative Research (AcSIR), AcSIR Headquarters CSIR-HRDC Campus, Sector-19, Kamla Nehru Nagar, Ghaziabad 201002, India.*
**Corresponding author: pr_banerjee@cmeri.res.in*

Abstract

In alignment with the principles of Green Chemistry as well as environmental sustainability, herein two green corrosion inhibitors (CIs) *namely*, PAMM-1 and PAMM-2 were synthesized through energy-efficient pathway. Greenness analysis revealed their excellent atom economy, carbon efficiency, and environmental factor. Both of the CIs exhibited excellent corrosion inhibition efficiency (IE) toward the protection of mild steel in HCl medium with IE>90%. Electrochemical investigation combined with morphological analysis and advanced *in-silico* investigations were carried out in a perceptive way. This research elucidates the impact of positional substituents on inhibition efficiency, leading to the ultimate achievement of '4E factors': energy, economy, environment, and efficiency.

Evaluation of Catalytic and Electrocatalytic Activity in Hydrothermally Prepared 2D $MoSe_2$ Nanosheets

Rashbihari Layek*, *Pathik Kumbhakar*
Nanoscience Laboratory, Department of Physics, National Institute of Technology Durgapur, Durgapur-713209, West Bengal, India
**E-mail: rl.22ph1104@phd.nitdgp.ac.in*

Abstract

Herein, we have focused on an easy hydrothermal process of syntheses of $MoSe_2$ nanosheets (NSs) and its applications towards MB (methylene blue) dye degradation and hydrogen energy generation. Synthesized samples exhibited pronounced adsorption properties. The kinetic study revealed that the adsorption process follows the pseudo-second-order model. Furthermore, adherence to the Freundlich isotherm indicates that adsorption occurred on the heterogeneous surfaces. The $MoSe_2$ NSs exhibit a low Tafel slope of 74 mV dec^{-1}, revealing that the hydrogen evolution reaction mechanism involves a combination of the Volmer–Heyrovsky stages.

Smartphone Enabled Machine Learning Approach Assisted Copper (II) Quantification and Opto-electrochemical Explosive Recognition by Aldazine-functionalized Chemobiosensor

Mohit Kumar Chattopadhyay [1,2], Priyabrata Banerjee[1,2]*

1. Electric mobility and tribology research group, CSIR-Central, Mechanical Engineering Research Institute, M. G. Avenue, Durgapur 713209, India.
2. Academy of Scientific and Innovative Research (AcSIR), AcSIR Headquarters CSIR-HRDC Campus, Postal Staff College Area, Sector 19, Kamla Nehru Nagar, Ghaziabad-201002, Uttar Pradesh, India.
**Corresponding author: pr_banerjee@cmeri.res.in*

Abstract

An novel optoelectrochemical sensor, BMH (1-(quinolin-4-ylmethylene)hydrazono)methyl)naphthalen-2-ol), enables selective detection of copper (Cu^{2+}) and 2, 4, 6-Trinitrophenol (TNP) at ultra-low levels (0.09 ppm for Cu^{2+} and 0.019 ppm for TNP). Its multichannel recognition capability allows detection in various samples, including water, fetal bovine serum, and human urine for Cu^{2+}, and water, soil, and matches powder for TNP. The sensor's effectiveness was tested in human lung cancer cells (A459). A smartphone machine learning method for Cu^{2+} quantification enhances water quality analysis. Moreover, ethylenediaminetetraacetic acid (EDTA)-mediated reversibility mimics electrical circuitry logic gates.

Exploitation of a 1D coordination polymer as a portable kit for an eye-catching fluorometric response towards sensing of trivalent cations

Sourav Datta[1,2], Priyabrata Banerjee[2,3*], Mohammad Hedayetullah Mir[1*]

1. Department of Chemistry, Aliah University, New Town, Kolkata 700 160, India.
2. Electric Mobility and Tribology Research Group, CSIR-Central Mechanical Engineering Research Institute, M. G. Avenue, Durgapur 713209, India.
3. Academy of Scientific and Innovative Research (AcSIR), AcSIR Headquarters CSIR-HRDC Campus, Postal Staff College Area, Sector 19, Kamla Nehru Nagar, Ghaziabad-201002, Uttar Pradesh, India.
**Corresponding author:* pr_banerjee@cmeri.res.in and chmmir@gmail.com

Abstract

The development and utilization of coordination polymers (CPs) have drawn interest for potential applications detection of metal ions in efficient and selective manners is an important field of research. It paves the way to protect human health by balancing toxic metal ions and biologically active metal ions in atmosphere. In this regard, a new one-dimensional 4-(1-naphthylvinyl)pyridine (4-nvp) based CP $[Cd(NCS)_2(4\text{-nvp})_2]n$ (1) was synthesized and characterized. Supramolecular aggregation through $\pi\cdots\pi$ stacking enabled this CP to selectively detect Fe^{3+}, Al^{3+}, and Cr^{3+} ions with high sensitivity in the nanomolar range in pure water, leading to develop of a portable, hands-on cotton swab kit.

Next-Generation Piezo-Responsive Membranes for Comprehensive Wastewater Treatment

Indrajit Mondal, Pabitra Kumar Paul, Sukhen Das*

Department of Physics, Jadavpur University, Kolkata-32
**Corresponding author: sdasphysics@gmail.com*

Abstract

This study presents a sustainable piezo-responsive membrane for water treatment, incorporating cobalt chromate quantum dots (CCOQDs) into a poly (vinylidene fluoride) (PVDF) matrix. Among membranes with varying CCOQD concentrations (0%, 10%, 20%), the 10% (PCCO 10) demonstrated exceptional performance, achieving 98.7% Congo red degradation under ultrasonic stimulation. PCCO 10 also exhibited a β-phase content of 75.93% and retained 97.2% activity after four reuse cycles. Effective pollutant removal was observed in real-world tests, and byproduct analysis confirmed non-toxic compounds. This scalable and eco-friendly membrane offers an innovative solution for sustainable water purification.

Fluorescent Detection of Copper Ions Using Functionalized ZIF-8 with Catalytic Efficiency in Benzyl Alcohol Oxidation

Dudekula Khasim Vali, Pallav Mondal, Bhaskar Kumar Brahma, Utpal Adhikari*****, Sourav Laha*****
National Institute of Technology Durgapur
**Corresponding author: slaha.ch@nitdgp.ac.in*

Abstract

In this work, we present a modified ZIF-8 framework, functionalized with a fluorescent probe for the detection and removal of copper ions from water, and its catalytic application in benzyl alcohol oxidation. The structure features a multilayer coating with a copper (Cu) layer sandwiched between Zn-based ZIF-8, enhancing its function as an oxidation catalyst. A key innovation is the substitution of zinc with low-cost copper for effective environmental remediation, targeting copper ion-laden wastewater. The Cu-Zn oxide composite demonstrates strong catalytic performance, showcasing the potential of Cu-based modifications in water purification and catalytic application.

Optimized Adsorption of Toxic Ions Using Modified Rice Husk in Aqueous Solutions

1. ***Sumaya Binta Ashraf***, *Department of Earth and Environmental Studies, NIT Durgapur, India*
2. *Anibrata Das, Department of Earth and Environmental Studies, NIT Durgapur, India*
3. *Sandip Mondal*, Department of Earth and Environmental Studies, NIT Durgapur, India*

Corresponding author: san.modal@gmail.com, ashraf.sumayab@gmail.com

Abstract

India produces vast amounts of underutilized rice husk, rich in silica, hemicellulose, cellulose, and lignin. This study investigates the use of rice husk as a cost-effective adsorbent for removing cyanide and hexavalent chromium from water. The rice husk underwent sodium hydroxide alkali treatment to remove silica and was compared with ferric chloride-impregnated rice husk. Batch adsorption experiments optimized various parameters. Results showed that ferric chloride-impregnated rice husk significantly enhanced removal efficiency. The adsorption followed pseudo-second-order kinetics and the Langmuir isotherm model, indicating effective water treatment potential.

Delayed carrying capacity induced intricate dynamics in single-species evolution in ecology

N. C. Pati

Department of Mathematics,
Bidhan Chandra College,
Asansol-713304, West Bengal, India
Email: naresh@bccollegeasansol.ac.in

Abstract

The past activities of a species can significantly influence its sustainable density (the maximum number of population in a given area that can sustain in the environment). The essence of this presentation is to explore the intricate dynamics of a species' temporal evolution within the framework of nonlinear dynamics, considering the influence of the past activities of the species. We will introduce a carrying capacity, effectively capturing the dual impact of both constructive and destructive past actions. Through rigorous analytical and numerical explorations, we will discuss a range of complex dynamical scenarios arising from the delayed carrying capacity, taking into account both intra-specific competition and cooperation.

Extraction and characterization of fiber from pineapple leaf by different treatment techniques for its application in bioleather

Md Saifi Reza[a] ,Dipendu Maji[a], Bimal Das[b], Deepshikha Datta[c,d]

[a]*Department of Biotechnology, Brainware University, Barasat, Kolkata, West Bengal 700125*
[b]*Department of Chemical Engineering, National Institute of Technology, Durgapur-713209, India*
[c]*Department of Chemistry, Brainware University, Barasat, Kolkata, West Bengal 700125*
[d]*Center for Multidisciplinary Research and Innovation, Brainware University, Barasat, Kolkata, West Bengal 700125*
Corresponding author: deepa.datta81@gmail.com

Abstract

Natural fiber extraction from sources such as pineapple leaves has gained popularity due to the growing demand for sustainable materials. In order to effectively extract pineapple leaf fiber (PALF), this study investigates chemical treatments such as urea, sodium hydroxide (NaOH), and their combination. When compared to retting and NaOH-only techniques, the dual treatment (NaOH+Urea) produced soft, superior fibers in less time. The dual-treated fibers' excellent mechanical qualities, including tensile strength and elongation at break, were revealed by thorough analysis utilizing SEM, XRD, FTIR, and TGA. When combined with natural latex, these environmentally friendly fibers show great promise for manufacturing biodegradable leather.

Marigold (*Calendula officinalis*) leaves powder as a cost-effective and eco-friendly biosorbent in removing methylene blue from aqueous solution

Aditi Koley[1], Sukanya Dutta[1], Rhitbina Roy[1], Sreyosee Chabri[1], Sarandeep Mondal[1], Souvik Sutradhar[2], Deepjyoti Maji[1], Krishnendu Maji[3], Sagarika Chakraborty[4], Animesh Naskar[1*]

[1]Department of Food Science, Maulana Abul Kalam Azad University of Technology, Haringhata, Nadia 741249, West Bengal, India
[2]Department of Biotechnology, Maulana Abul Kalam Azad University of Technology, Haringhata, Nadia - 741249, West Bengal, India
[3]Department of Applied Chemistry, Maulana Abul Kalam Azad University of Technology, Haringhata, Nadia 741249, West Bengal, India
[4]Department of Food and Beverage, Jaiprakash Hospital & Research center Pvt. Ltd., Rourkela-769004, Odisha, India.
Corresponding author: animesh.ftbe@gmail.com

Abstract

In this study, locally sourced agricultural waste, marigold (*Calendula officinalis*) leaves was utilized as an alternative and cost-effective adsorbent to remove methylene blue (MB) from aqueous solution. The marigold leaves powder (MLP) was characterized using zeta potential analyzer, FTIR, and FESEM. The optimal conditions for MB adsorption using MLP were determined at pH 6.0, biosorbent dosage 2.5 gL^{-1}, and contact time 110 min. The pseudo-second-order kinetic, film diffusion and Langmuir isotherm model were the most suitable for describing the sorption phenomenon, suggesting chemisorption and monolayer dye adsorption. Thermodynamically, dye adsorption process was spontaneous and endothermic under studied experimental conditions.

Green synthesis of Titanium Dioxide nanoparticles and its adsorptive studies on removal of Crystal Violet dye

Modhalavalasa Venkatesh [1], **Kolluru Sree Manaswini [2*],** N. Chitti Babu[3]

Department of Chemical Engineering, Andhra University, Visakhapatnam-3, India
[*] kolluru sree manaswini, chandana280418@gmail.com, ph. 9030832697

Abstract

The present study aims to exploit the experimental determination of biosorptive capacity and characteristics of Titanium dioxide nanoparticles with Citrus Limon leaf extract. TiO_2-Np's were characterized by XRD, SEM and FTIR analysis. The process variables studied in batch biosorption are Agitation time, Initial concentration of “Crystal Violet” dye, pH, Dosage of TiO_2-Np's and Temperature and optimum conditions were compared by using Response Surface Methodology (RSM). At the optimized parameter conditions, the dye adsorption studies were examined using different Isotherms, Kinetics and Thermodynamics models respectively. It was found that the Freundlich isotherm, pseudo second order kinetics were fitted well as compared to other isotherm and kinetic models. The results of thermodynamic studies exhibit exothermic nature, thermodynamically feasible nature of adsorption.

***Keywords**: Citrus Limon; Crystal Violet; TiO_2-Np's; Isotherms; Kinetics; Response Surface Methodology*

Adsorption-regeneration simulation for flouride removal from simulated wastewater

SHIVAM VERMA, Bikash Kumar Mondal*

National Institute of Technology, Durgapur
**Corresponding author: bkmondal.che@nitdgp.ac.in*

Abstract

Fluoride contamination in water is a major concern due to its harmful effects, such as dental and skeletal fluorosis. Developing cost-effective and environmentally friendly solutions for fluoride removal is essential. This study explores the use of aluminum hydroxide-modified diatomaceous earth (diatomite) as an adsorbent for fluoride removal. The removal of fluoride (F^-) from wastewater using aluminum hydroxide as an adsorbent was investigated, focusing on adsorption efficiency and regeneration. The adsorption process follows the Langmuir isotherm and Linear Driving Force (LDF) models, achieving effective fluoride removal under optimal flow rate, initial concentration, and bed height conditions.

Effect of Wall Corrugation on Entropy Generation for Mixed Convective Flows Over a Backward Facing Step

Debayan Bhowmick *[*1,2]; Subir Sardar[1]*
1. Department of Mechanical Engineering, Brainware University
2. Centre for Multidisciplinary Research and Innovations, Brainware University
**Corresponding author: db.me@brainwareuniversity.ac.in*

Abstract

The present study investigates thermo-hydraulic characteristics of fluid flow over a backward-facing step with a corrugated bottom wall. Laminar incompressible flow with mixed convection has been considered using air as a working fluid. Sinusoidal walls of different amplitudes are considered for better analysis. Effects of amplitude of corrugated wall and Richardson number on heat transfer and fluid flow characteristics have been studied. Close attention was paid to the distribution of average Nusselt number, pressure drop, performance, and total entropy generation. It has been found that the average Nusselt number increases with the Richardson number and wall amplitude. A similar trend was observed in the case of entropy generation. It is seen that thermal entropy generation is predominant over frictional entropy generation owing to high thermal irreversibility. Performance was evaluated based on each configuration's Nusselt number and pressure drop. It was found that peak performance was obtained for a wall with high amplitude and Richardson number.

Impact of Sponge Iron Contamination on Soil Microbial Communities: A Metagenomic Investigation

Kajari Roy[1], Nandan Bhattacharyya[2*], RP Singh 'Ratan'

[1]*Department of Agriculture, Jharkhand Rai University, Raja Ullatu, Namkum, Ranchi, Ulatu, Jharkhand 834010*
[2]*Department of Biotechnology, Panskura Banamali College (Autonomous), Panskura R.S., Purba Medinipur, West Bengal-721152, India*
[*]*Corresponding Author: rpsinghratan@gmail.com*
[1]*Presenting author: roykajari@gail.com*

Abstract

Soil biodiversity, particularly microbial life, is vital for ecosystem health. While bacteria, fungi, and viruses maintain soil functionality, the relationship between their diversity and biomass across biomes remains unclear. Metagenomic analysis of sponge iron-contaminated soil revealed a dominance of Proteobacteria (58.73%) and Actinobacteria (32.12%) among bacteria, with Ascomycota (87.48%) and Basidiomycota (12.32%) dominating fungi. Viral populations were led by Insthoviricetes (94.40%). Bacterial diversity stabilizes, fungal diversity fluctuates, and viral diversity increases over time. The ABC transporter protein family was most abundant. Future studies will focus on isolating microorganisms for bioremediation efforts in contaminated environments.

Optimization of arsenic detection in water using electrochemical sensors fabricated from nano silica derived from waste rice straw

Deepshikha Datta[a,b], Sunny Saurabh[c] Sampurna Santra[d], Alok Pratap Singh[e], Susanta Ghosh[e], Sayantan[e] Chaubey[f], Bimal Das[c]

[a]*Department of Chemistry, Brainware University, Barasat, Kolkata, West Bengal*
[b]*Center for Interdisciplinary Research & Innovations (CMRI), Brainware University, Barasat, Kolkata, West Bengal 700125, India*
[c]*Department of Chemical Engineering, National Institute of Technology Durgapur, West Bengal*
[d]*Department of Electronics and Communication Engineering, Murshidabad College of Engineering & Technology, Berhampore*
[e]*Integrated Science Education and Research Centre, Siksha Bhavana, Visva-Bharati*
[f]*Department of Electronics and Communication Engineering, Brainware University, Barasat, Kolkata, West Bengal*

Abstract

Arsenic poses a major threat to ecological systems considering a hazardous heavy metal, and can have adverse impacts on human health if exposed over an extended period of time. The presence of arsenic in water and the food chain must be addressed, and prompt identification of traces of active arsenic (As^{3+}) is critical. Furthermore, the development of low-cost, straightforward procedures is essential. Here a comprehensive investigation on the detection of different concentrations of As^{3+} (2.5mM to 10mM) solution using chemical-free nano silica electrodes. A novel composite based on nano silica particles and carbon was utilized for the preparation of NS-carbon paste electrode where nano silica was synthesized from rice straw, a readily available agricultural waste. The Nano silica after extraction was characterized using XRD, SEM and BET analysis. Additionally, FE-SEM of nano silica and Carbon composite material before electrolysis, after electrolysis and Energy dispersive X-ray (EDX) spectroscopy and elemental mapping is also analyzed. It came to light that the resulting nano silica had a high surface area of 189.64 m2/g and a three-dimensional structure consisting of highly open spaces coupled to each other, supporting its potential for application in electrode construction. Chemical processing was used to create Nano silica (200 nm), which was then further reduced in size using a cryomill. By utilizing a modified glassy carbon electrode in several variation of Nano silica and Carbon as well as comparing it to a bare glassy carbon electrode Cyclic Voltammetery (CV) and DPV (Differential Pulse Voltammetry) methods were employed to find harmful arsenic ions in ground water. Amongst various modified electrodes with differing silica concentrations, the Si-30% exhibits the best sensing properties. Additionally, the effect of variations in scan rate was investigated in order to calculate certain physiochemical properties. When compared to the bare electrode, the modified glassy carbon electrode performs better, exhibiting distinct oxidation/reduction peaks. The LOD of the electrode was derived to be 8.141454246 mM as well as LOQ was 24.67107347mM. These findings show that the graph had a linear regression coefficient R^2 = 0.9151 and was linear up to 10mM (where n = 4) concentration of arsenic solution. Additionally, for a sensitive and selective study, the electrochemical nano silica electrode can be used to detect arsenic in a complex system that includes other heavy metal ions like Ni^{2+}, Cd^{2+} and Zn^{2+} ions. Central Composite Design approach of Response Surface Methodology was used to optimize the content of nanosilica for optimal detection of arsenic ion in water. ANOVA (Analysis of variance) study suggested a strong correlation between experimental data and model predictions at an optimum concentration of 30% silica in electrode.

Keywords**:** Nano silica particles, Electrodes, Arsenic ions, Cyclic Voltammetry, Differential Pulse Voltammetry, ANOVA analysis

Preparation of an Ultrathin Graphitic Carbon Nitride (g-C_3N_4) for Visible-Light-Driven Photocatalysis

Freddy Solomon S, Abinash Das *****

Solar Fuel Research Group (SFRG), PSG Institute of Advanced Studies, Coimbatore, Tamil Nadu-641004, India
**Abinash Das: abinashnitsmsc@gmail.com*

Abstract

g-C_3N_4 is an emerging photocatalyst with 2D layered structure. However, the bulk g-C_3N_4 has limited photocatalytic performance due to low surface area and exposed sites. Therefore, photocatalytic activity of g-C_3N_4 can be enhanced by exfoliation into ultrathin nanosheets. In this work, we report the preparation of bulk g-C_3N_4 from melamine and followed by the exfoliation using sonication assisted method. Different physicochemical characterization has been carried out to evaluate its modified properties. Photocatalytic activity test is conducted using Rhodamine B as a probe pollutant and as expected exfoliated g-C_3N_4 has shown significantly improved visible-light-driven photocatalytic performance than the bulk g-C_3N_4.

Technical Track VII: Biotechnology and Healthcare

Pan-cancer study of Interferon-Stimulated gene 15 computationally

Shrabonti Chatterjee [1], Joydeep Mahata [1], Shrabonti Chatterjee*

1.Integrated Science Education and Research Centre (ISERC), Visva-Bharati University
**Corresponding author: shrabon12386@gmail.com*

Abstract

In the present work, we highlight ISG15 mRNA and protein regulation in all cancer types employing cancer databases- GTEx, TCGA and CPTAC. ISG15, a 15 kDa ubiquitin-like protein, plays a key role in ISGylation, a post-translational modification process, and shares structural similarities with ubiquitin. It is crucial for antiviral responses and cancer, influencing proteins like STAT1, JAK-1, and RIG-1, ISG15 regulation study in cancer stages and subtypes further helps to gain insights in tumor biology. To find probable potential drugs targeting ISG15 mediated tumorogenesis we constructed PPI interactions of ISG15 correlated and similar genes to obtain hub genes and their pathways.

Understanding the gene-regulatory network for Alzheimer's disease

Ranu Kundu[1], Priya Chakraborty[2,*], Sayantari Ghosh[1,*]

[1] *Department of Physics, NIT Durgapur*
[2] *Department of Physics, IIT Bombay*
**Corresponding author:* sayantari.ghosh@phy.nitdgp.ac.in

Abstract

Alzheimer's disease (AD) disrupts neurocognitive function and progressively worsens over time. Despite extensive research and numerous therapeutic strategies, effective treatments remain elusive due to challenges such as blood brain barrier restrictions and low drug availability. Therefore, understanding the underlying gene regulatory network associated with AD progression is crucial to identify therapeutic targets. Here we identify a feedback-loop model of key proteins involved in AD progression and analyze its dynamics which further provides insights into the development of medical therapies as well as slowing AD progression. The inherent nonlinear dynamics of this motif give rise to bistability, indicating possible strategies to address this disease.

A Tale of Two Pandemics and the Human Immunity: Covid 19 and HIV AIDS

Dr. Udita Mukhopadhyay

MBBS(Hons), MD (General Medicine, JR1),
Senior Scholar at Jagadish Bose National Science Talent Search

Abstract

The emergence of SARS-CoV-2 in 2019 has led to a juxtaposition of two pandemics: COVID-19 and HIV/AIDS. The peculiarity in people living with HIV is the compromised immune system from chronic HIV infection and the use of antiretroviral therapy, which increases the risk of SARS-CoV-2 infection and mortality from COVID-19.

On analysis, it was found that the risk of developing severe fatal COVID-19 was 38% greater in this population when compared to people without HIV infection. PLHIV frequently face adverse social determinants of health and structural factors that may lead to higher SARS-CoV-2 exposure. They also have a high prevalence of some comorbidities associated with poorer COVID-19 outcomes, such as cardiovascular disease, diabetes, chronic respiratory disease and hypertension. Additionally, lower CD4 T-cell counts are associated with advanced HIV disease and several epidemiological studies are suggesting that this HIV subpopulation is at greater risk for hospitalization due to COVID-19 and mortality.

Timely diagnosis plays an essential role in the disease progression in either of these viral infections. Personal protection measures are to be mandatorily adopted for prevention. Vaccination also plays a vital role in strengthening the acquired immune system.

Harnessing the power of Assorted Datasets for Bladder Segmentation in Gynaecological Brachytherapy

Suresh Das[1,*], Sayantari Ghosh[2]

[1] *Department of Radiotherapy, Narayana Superspeciality Hospital,*
[2] *Department of Physics, NIT Durgapur*
**Corresponding author: dassureshster@gmail.com*

Abstract

In order to ensure safe and accurate dosimetry, bladder segmentation is essential during gynecological brachytherapy. However, labeled datasets for DL-based organ auto-segmentation in brachytherapy are rarely available, due to huge manual efforts involved. The usefulness of hybrid datasets—where with applicators (WA) and without applicators (NA) labeled datasets are used in varying amounts for bladder auto-segmentation using UNet—was examined in our study. We discover that bladder segmentation in WA scans requires more than just NA datasets. With assorted dataset, we attain an extraordinary 10% improvement, with an average IOU of 85%.

Viscous fingering studies in paper membrane/Pads using Hydrogel towards Point of Care (POC) Healthcare Application

Chandra Bhushan, Debayan Das*

Department of Chemical Engineering, NIT Durgapur, Mahatma Gandhi Rd, A-Zone, Durgapur, West Bengal 713209, India

**Corresponding author: ddas.che@nitdgp.ac.in*
Mob. No- +91 9884684201

Abstract

Viscous fingering, or hydrodynamic instability, occurs when a less viscous fluid displaces a more viscous fluid at its interface in a porous medium, such as paper membranes. This phenomenon impacts fluid flow and mixing in paper-based diagnostics, potentially reducing sensitivity due to unstable "finger" behaviour and understanding this flow behaviour in cellulose-based membranes, widely used in diagnostics. Paper strips (5 cm × 0.5 cm) were soaked in hydrogels (6.45–12.9 mg/ml), dried, treated with 50 ppm phenolphthalein, and reacted with 10 ppm NaOH to observe flow behaviour. High-resolution images captured the flow instability of varying hydrogel concentrations, mixing speeds (100–400 rpm), and membrane types. Viscous fingering was characterized by length and width variations of the instabilities caused by the viscosity difference. When the mixing speed increased, the number of fingering increased. Higher hydrogel concentrations reduce dispersion and improve flow stability. These findings enhance understanding of fluid behaviour in porous media, with implications for POC testing, oil recovery, and microfluidics.

Keywords: Viscous fingering, Paper Membranes, Hydrogel, Flow behaviour

Practical Denoising of Electroencephalography (EEG) Signal using High Precision Low-cost Active Filter

Sunil Kumar Choudhary[1, 2] and Tushar Kanti Bera[1, 3]

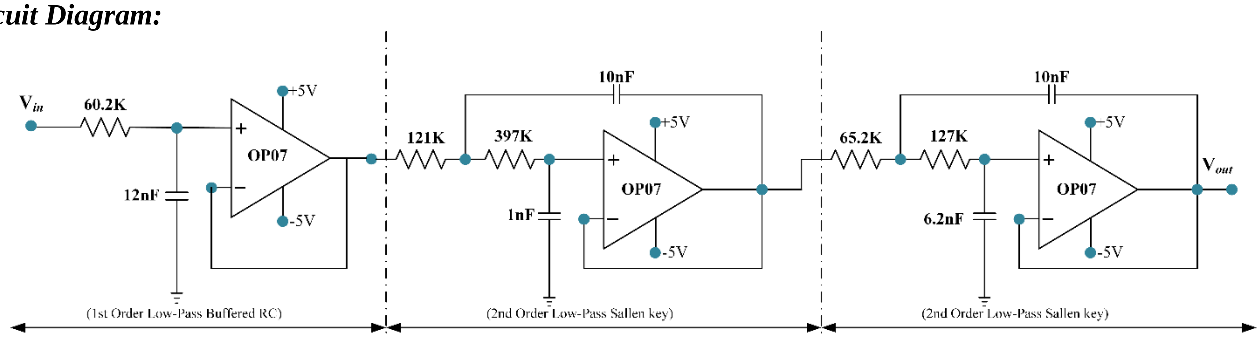
[1]*Dept. of Electrical Engineering, National Institute of Technology Durgapur (NIT, Dgp), Durgapur, WB 713209, INDIA*
[2]*Dept. of Electrical Engineering, Dr. B. C. Roy Engineering College, Durgapur, WB 713206, INDIA*
[3]*Centre for Biomedical Engineering and Assistive Technology (BEAT), National Institute of Technology Durgapur (NIT, Dgp), Durgapur, WB 713209, INDIA*
Corresponding Author's Email: tkbera77@gmail.com

Abstract

Despite their importance, electroencephalography (EEG) signals are often contaminated with all sorts of noise generated by environmental, physiological, and equipment sources. The preservation of the accuracy and reliability of these signals requires effective denoising methods. This work presents the practical application of a highly precise fifth-order active filter, suitable for denoising EEG signals, and examines how the filter translates into noise attenuation with minimal or no compromise of the neural information desired. While the fifth-order design has sharper cut-off characteristics and higher attenuation in rejected frequency bands compared to the lower-order filter. The EEG signals we use cover the range of 0.2 to 50 Hz and this filter is tuned to a particular frequency range, including the power line interference (50/60 Hz), ocular artifacts, and muscle activity. The active filter is adaptive, allowing the parameters to be changed dynamically in response to the signal's characteristics, and thus ensures robust denoising in real-time and in portable applications. Results from experiments show a substantial increase in the signal-to-noise ratios (SNRs), with minimal distortion of the neural features, such as event-related potentials (ERPs) and oscillatory rhythms. Filters' superior ability to handle different noise profiles is demonstrated through comparative evaluations with conventional methods such as wavelet transforms and independent component analysis (ICA). The simplicity, precision, and ease of implementation of the fifth-order active filter make it highly suitable for several applications, including brain-computer interfaces (BCI) and clinical diagnostics. This work establishes a practical pathway to improve the quality of EEG signals, which will consequently improve the accuracy of diagnosis and research in neuroscience.

Keywords: Brain health, brain diseases, electroencephalography (EEG), EEG signal, neuroscience, neuroengineering, EEG amplifier, low-pass filter, EEG signal acquisition system (ESAS).

Circuit Diagram:



Development of A 32-Electrode Practical Chest Phantom for Electrical Impedance Tomography (EIT)

Tushar Kanti Bera[1,2,*], Subhrajit Mahanti[1], Sandeep Sahoo[1]

[1]Department of Electrical Engineering, NIT Durgapur (NITDgp), Durgapur, WB 713209, INDIA
[2]Centre of Biomedical Engg. & Assistive Tech. (BEAT), NIT Durgapur (NITDgp), WB 713209, INDIA

[*]Corresponding Author's Email: tkbera77@gmail.com

Abstract

With the invention of X-Ray and X-Ray planar radiography (XRPR) revolutionized the field of medical imaging. The limitation of viewing the cross-sectional images in XRPR inspired and motivated the scientist to invent the X-Ray computed tomography (XRCT). The XRPR and XRCT are used in the modern healthcare domain as the gold methods for obtaining the planar impression of the issues and the tomographic visualization of the tissue property distribution respectively. Moreover, the application of X-Ray in XRPR and in XRCT again motivated the researchers to think about other noninvasive CT-imaging modalities without using the ionizing radiation. In this direction a number of CT-imaging modalities have been proposed to obtain the tomographic images using signal safer for the human subjects. Electrical Impedance Tomography (EIT) has been proposed as a promising non-invasive radiation-free CT-imaging technique which have been successfully applied for material characterization, non-destructive testing (NDT) and structural health monitoring (SHM). Due to several unique advantages of EIT, the EIT-technology has been applied to solve a number of inverse problems in several fields of science, engineering and technology such as biomedical engineering, medical science, healthcare technology, clinical engineering, material engineering, mechanical engineering, manufacturing technology, civil engineering, chemical engineering, biotechnology, and a number of other applied sciences. An EIT-system is generally developed with an electronic instrumentation interfaced with the PC through a graphical user interface. The object under test is interfaced with the instrumentation through the surface electrode array. The EIT instrumentation injects a low amplitude low frequency alternating current signal and measures the developed voltage signal through the surface electrodes. The boundary voltage-current data are collected and are supplied to a computer algorithm called image reconstruction program (IRP) which reconstructs the conductivity (or resistivity) distribution profile of the object domain under test in the form of tomographic images. Any developed medical instrument are not applied directly to the patient. Similarly, any EIT system is not applied to human subject rather it is tested, analyzed and calibrated with human body mimicking subjects called practical phantoms. The practical phantoms are developed with organic or inorganic objects and used for boundary data generation and image reconstruction for the instrument testing process. In this direction a 32-electrode practical chest phantom for electrical impedance tomography (EIT) has been developed and studied for EIT system analysis. The chest phantom is developed with a chest mimicking geometry having a waterproof tank like containing saline solution. 32 electrodes made up of stainless steel bolts are used and placed on the internal surface wall of the tank. The tank is filled with saline solution having the conductivity of 0.9 S/m and the insulating objects are placed within the saline solution as the model of lungs and heart. A low amplitude (1mA) and low frequency (50 kHz) sinusoidal alternating current (constant amplitude) is applied and the boundary voltage data are collected. The impedance of each electrode are also measured and found identical. The 2D and 3D chest phantom model is also developed in computer using COMSOL Multiphysics modelling software and boundary data are simulated. Boundary data generated with computer simulation and the data generated from practical phantom are compared. The date are found showing the variation in the voltages for the inclusion of the inhomogeneities and hence found suitable for EIT reconstruction.

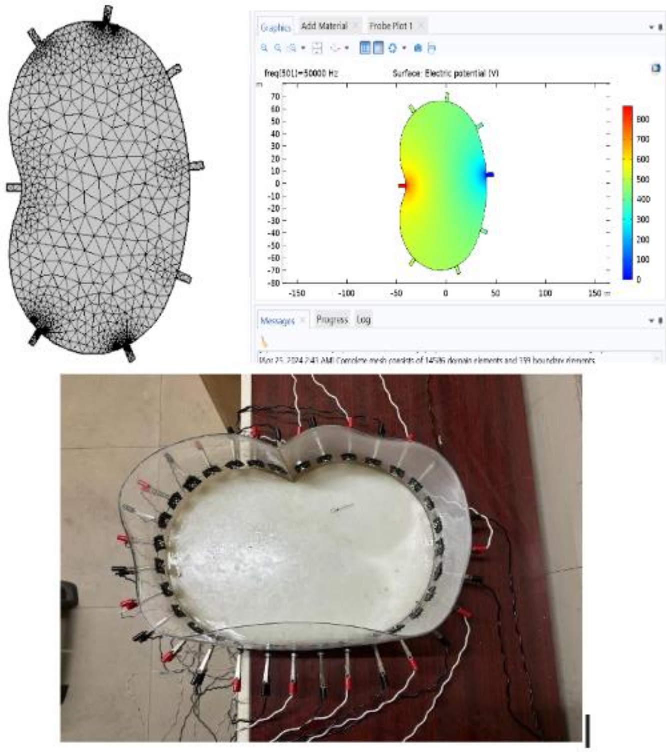


Fig. 1: Development of A 32-Electrode Practical Chest Phantom for Electrical Impedance Tomography (EIT) (a) Simulated Chest Phantom developed in COMSOL Multiphysics, (b) Voltage distribution within the Simulate Chest Phantom model developed in COMSOL Multiphysics, (c) 32-electrode practical Chest Phantom for EIT.

The Applications of Electrical Impedance Tomography (EIT) for Respiratory Disease Diagnosis: Prospects and Challenges

Tushar Kanti Bera[1,2,*], Priyanka Bawali[1], Sujato Ganguli[1]

[1]*Department of Electrical Engineering, NIT Durgapur (NITDgp), Durgapur, WB 713209, INDIA*
[2]*Centre of Biomedical Engg. & Assistive Tech. (BEAT), NIT Durgapur (NITDgp), WB 713209, INDIA*

[*]Corresponding Author's Email: tkbera77@gmail.com

Abstract

Computed tomography is essential for obtaining the cross-sectional images noninvasively in medical imaging domain. Electrical impedance tomography. Medical imaging process introduced in 1895 by Roentgen. There are various types of imaging process called X-Ray, Ultra Sonography (USG), Computed Tomography (CT), Positron Emission Tomography (PET), Single Photon Emission Tomography (SPECT), Magnetic Resonance Imaging (MRI), Gamma Camera etc. X-Ray planar radiography and the X-Ray CT uses X-Rays which are the ionizing radiation. MRI is a costlier technique and imposes a lot of limitations and restrictions during the imaging procedures. PET and SPECT are emission computed tomography (ECT) methods which applies radioisotopes into the body to produce the Gamma Ray emission required for the imaging procedure. nuclear medicine imaging. In contrast, the Electrical Impedance Tomography (EIT) is a promising CT technique which can be utilized to solve a number of practical problems in biomedical and medical engineering, healthcare technology, material engineering, mechanical engineering, manufacturing technology, chemical engineering, civil engineering, biotechnology, and a number of other applied sciences. In medical science, the EIT techniques has been applied for a number of diagnostic procedures such as arm anatomy imaging, lung imaging, brain tumour studies, breast cancer screening, cardiac and transthoracic imaging, and many other clinical investigations. EIT imaging system consists of an electronic instrumentation which injects a low amplitude low frequency alternating current signal and measures the developed voltage signal using an array of surface electrodes. The boundary voltage-current data collection is conducted through an array of surface electrodes attached to the domain boundary. The boundary data collected are supplied to a computer program called image reconstruction program (IRP) to reconstruct the conductivity distribution profile of the object domain under test in the form of tomographic images. In recent time, the EIT procedure have been applied for lung imaging and respiratory disease diagnosis, analysis and treatment. In this paper the applicability of EIT technique for respiratory disease detection has been reviewed. The advantage and limitations of static and dynamic EIT have been detailed. Lung-EIT instrumentation, instrumentation circuit, instrumentation cost and its commercial scenario have been summarized. The advantages, limitation and challenges are discussed. The recent research trends have been highlighted.

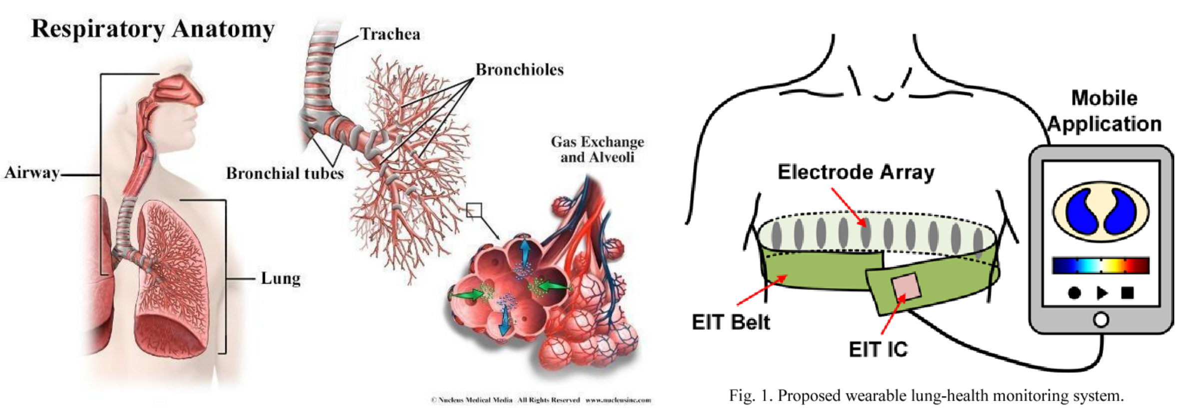


Fig. 1: Electrical Impedance Tomography (EIT) for respiratory disease detection (a) lung anatomy of a human subject, (b) EIT based respiratory imaging schematic.

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A DIP-Switch Based Electrode Switching Module (ESM) for Boundary Data Collection for 32-Electrode Electrical Impedance Tomography (EIT) System

Tushar Kanti Bera[1,2]

[1]*Department of Electrical Engineering, NIT Durgapur (NITDgp), Durgapur, WB 713209, INDIA*
[2]*Centre of Biomedical Engg. & Assistive Tech. (BEAT), NIT Durgapur (NITDgp), WB 713209, INDIA*

**Corresponding Author's Email: tkbera77@gmail.com*

Abstract

Electrical Impedance Tomography (EIT) produces 2D or 3D spatial distribution of electrical conductivity or resistivity within a domain under tests. As the electrical impedance of a biological tissue is found influenced by the tissue structure, composition and health, EIT has been applied as a biomedical computed tomography (CT) to study the anatomy, physiology and health status of human body. In recent time in medical and healthcare domain, the EIT techniques has been applied for arm anatomy imaging, lung imaging, brain tumour studies, breast cancer screening, cardiac and transthoracic imaging, and other clinical investigations. EIT is also found efficient not only in respiratory function studies but also found promising in pulmonary disease detection, analysis and treatment. An EIT system is developed with an electronic instrumentation and computer with image reconstruction algorithm. EIT electronic hardware applies a low amplitude low frequency alternating current (or voltage) signal and measures the surface voltage (or current) signal using an array of electrodes attached to the boundary of the object under test. Boundary data are collected from the surface electrode by switching the electrodes in a particular fashion to obtain a set of independent data set for image reconstruction. The boundary voltage-current data collected from the object surface are used to reconstruct the tomographic in terms of the electrical conductivity or resistivity. An EIT system is tested, analysed and calibrated with practical phantoms before we apply it to the human body imaging. In this paper a DIP-Switch-based Electrode Switching Module (ESM) is developed for boundary data collection for 32-Electrode Electrical Impedance Tomography (EIT) System. The impedance of individual DIP switch points, DIP switch assembly are tested. Boundary data are collected from practical phantoms with 16-electrode and 32-electrode systems using the DIP-switch-based ESM. The voltage data collected are found suitable for image reconstruction. The impedance of the DIP switches produces negligible voltage drop for 1 mA, 50 kHz constant current injection.

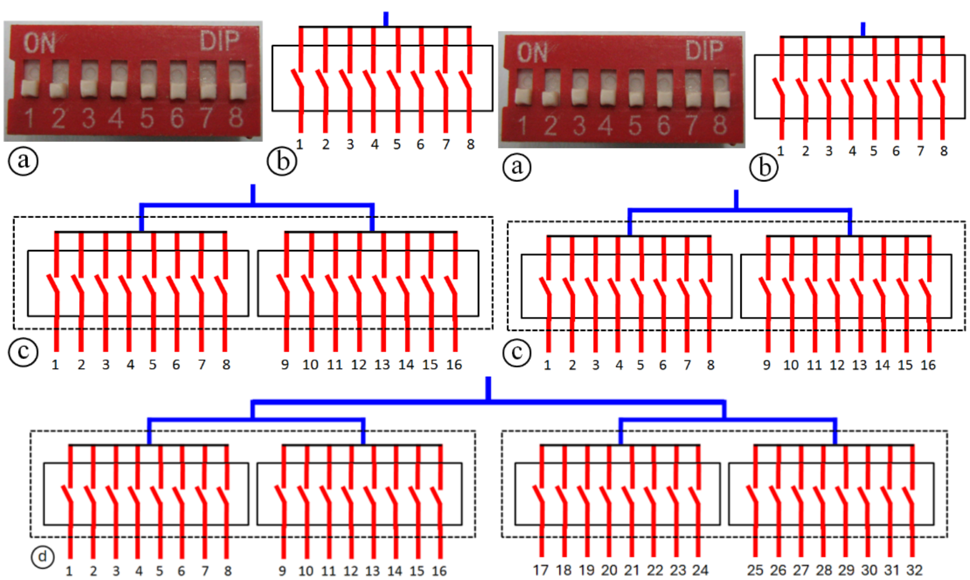


Figure-1: Electrode switching module Electrical Impedance Tomography (EIT) data generation using (a) A DIP switch, (b) A 8:1 DIP Switch Based Multiplexer, (c) A 16:1 DIP Switch Based Multiplexer, (c) A 32:1 DIP Switch Based Multiplexer.

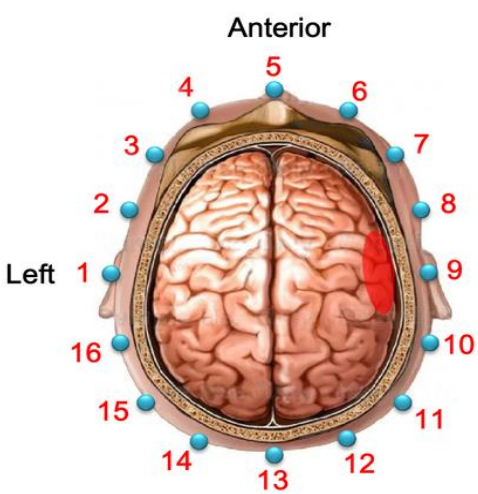
Electrical Impedance Tomography (EIT) Based Brain Tumour Detection: A Short Review

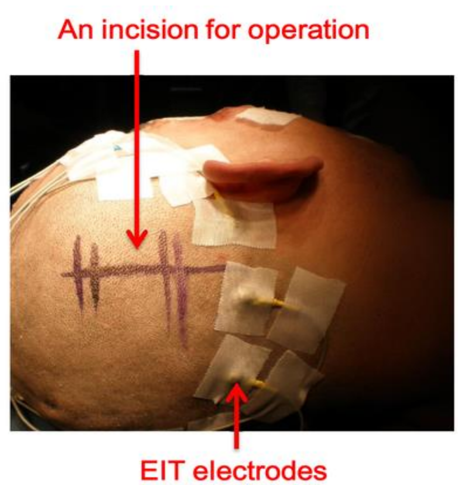
Tushar Kanti Bera[1,2,*], Sujato Ganguli[1], Priyanka Bawali[1],
[1]*Department of Electrical Engineering, NIT Durgapur (NITDgp), Durgapur, WB 713209, INDIA*
[2]*Centre of Biomedical Engg. & Assistive Tech. (BEAT), NIT Durgapur (NITDgp), WB 713209, INDIA*

[*]*Corresponding Author's Email: tkbera77@gmail.com*

Abstract

Electrical impedance tomography (EIT) has been applied as a promising computed tomography (CT) technique has been applied in medical and biomedical applications. Due to its unique advantages, it has been also used to solve several practical problems in mechanical engineering, material engineering, manufacturing technology, chemical engineering, civil engineering, biotechnology, and a number of other applied sciences. In medical and healthcare domain, the EIT techniques has been applied for lung imaging, arm imaging, brain imaging studies, breast tumour imaging, cardiac and transthoracic imaging, and other clinical investigations. EIT imaging system is generally consisting of an electronic instrumentation and a PC with image reconstruction software. The EIT electronic circuit applies a low amplitude, low frequency alternating current signal and measures the developed voltage data using an array of surface electrodes attached to the object-boundary. The boundary voltage-current data are fed to the reconstruction software which runs an image reconstruction algorithm (IRA) to reconstruct the tomographic image which are found as the spatial distribution of electrical conductivity of the domain under test. The brain is extremely sensitive and essential organ and works as the central processing unit. Brain monitoring is very important to study the brain anatomy and functions but also to detect, analysis and treat the brain diseases and disorders. Non-invasive brain monitoring is always found preferable by the patients under diagnosis. EEG is a non-invasive brain monitoring process but provides only the time varying brain potential signals and hence, the information extraction and brain anatomy reconstruction found difficult. X-Ray CT uses ionizing radiation, and long-term monitoring is not possible. MRI is a costlier experiment and could not be applied for long term and frequently. Moreover, the patient preparation in MRI experiment is long and it imposes a lot of limitations to the patients especially the patients with metal implants. On the contrary, the EIT is found as low cost, portable, user friendly, radiation free, fast and non-invasive CT imaging procedure. Due to the several advantages the EIT procedure is being studied for brain imaging and brain monitoring. In this paper the applicability of Eit in brain imaging is studied. The EIT technology and the brain EIT procedure have been discussed in detail. Brain EIT instrumentation and its cost-effectiveness have been discussed in detail. The advantages and reliability have been summarised. The limitation, challenges and recent trends of EIT based brain imaging and brain monitoring have been studied.





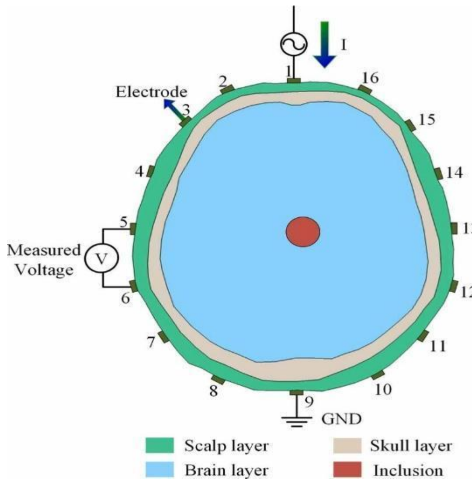


Fig. 1: Electrical Impedance Tomography (EIT) applied for brain imaging and brain monitoring (a) electrode placement in human brain EIT, (b) boundary data collection in EIT-based brain imaging.

A Case Study On Reducing Student Motorbike CO2 Emissions To Meet SDG 13

Murali Korikana, Nikhil Raj Kumar, Pavan Kalyan, Sai Teja, Varun, Suresh
Members IGEN SDG13 Research Group
Dr. M. G. R. Educational and Research Institute
Chennai, India
igen.murali@gmail.com

L. Ramesh, N.S. Subhashree, N. Ethiraj, E.Kavitha, Preetha George, Manoj Babu
Professors
Dr. M. G. R. Educational and Research Institute
Chennai, India
igen.ramesh@gmail.com

APJMJ Sheik Dawood[1],Balamurugan J[2]
Member SDG research form
The Institution Of Green Engineers

Abstract

Environmental degradation caused by indiscriminate CO2 emissions into the atmosphere has recently been a major concern for many developing countries. Reducing CO2 emissions is crucial for combating anthropogenic climate change, which is mostly caused by human activities such as transportation, industrial processes, and deforestation.

Climate change's effects are threatening ecosystems, human health, and global stability, making it more important than ever to protect the world. Sustainable Development Goal 13 underlines the need for immediate action to prevent climate change and its consequences. We must put in efforts to protect our planet by focusing on reducing emissions. Not only this, but we also need to develop strategies to tackle emissions and other factors contributing to anthropogenic climate change.

The paper examines the role of youth motorbike usage in meeting Sustainable Development Goal 13 on climate action and it presents a review on CO2 emission impact on climate change, emphasizing the critical need for targeted solutions. The paper includes current studies on climate change and SDG 13, with particular focus on carbon emissions in the transportation sector. The survey reveals a severe lack of awareness among youth about Sustainable Development Goal 13 (SDG 13) and its importance in tackling climate change. The findings highlight the necessity of including youth in sustainable practices to reduce climate change and to contribute Sustainable Development Goals.

***Keywords*—** Carbon neutrality, Urban transportation, Co2 Emission, Youth, SDG 13, Motor Bike, Sustainable.

Functional modification of polysaccharides for enhanced industrial and pharmacological applications

Dr. Sutapa Adhikari (Mazumder)[a]

[a]Department of Chemistry, Bidhan Chandra College, Asansol- 713304 West Bengal.

Email – sutapashuchi1@gmail.com

Abstract

Polysaccharides are of importance not only as primary components in foods, like cereal-based products, but also as additives in relatively low proportions, acting as thickening, stabilizing, and emulsifying agents. Due to the unique molecular structures some naturally occurring polysaccharides also exhibit valuable biological activities, including antitussive, antiviral, and anti-tumor effects. Given their diverse applications, there is a growing need to explore alternative polysaccharide sources and to modify them physically or chemically. Also tailoring these modifications to achieve specific quality attributes can expand their usability and enhance their functionality across various industries in a broader aspect and meet industrial demands. The present paper emphasizes the need for further exploration to maximize the potential of these polysaccharides.

Keywords: polysaccharides, industrial application, pharmacological activity, chemical modifications.

Nanoparticle- Based Blood-Brain-Barrier (BBB) Permeable Strategies for the Treatment of Central Nervous System (CNS) Diseases: A Review

Tapan Kumar Si[1], Nibedita Pradhan[2]*

[1]Department of Chemistry, Bidhan Chandra College, Asansol-713304, West Bengal, India.
Email: tapan@bccollegeasansol.ac.in

[2]Department of Biotechnology, RAMAIAH College of Arts, Science & Commerce-Autonomous, MSR Nagar, MSRIT Post, Bangalore-560054, India
*Corresponding author's Email: pnibedita11@gmail.com

Abstract

Nanotechnology has amplified the progress of therapeutics development for the treatment of neurodegenerative diseases (Alzheimer's diseases, Parkinson's diseases, Huntington's diseases, brain cancer etc). The blood-brain barrier is one of the major hurdles for the clinical application of drugs for any neurodegenerative disease. Thus, nanomaterials with blood brain barrier (BBB) permeability with its advantageous features (e.g. relatively high drug loading content, controllable drug release, excellent passive and active targeting, good stability, biodegradability, biocompatibility, and low toxicity) nanomedicines research have been extensively developed for the treatment of central nervous system (CNS) diseases. In this chapter, the advancement of nanoparticle-based therapeutics for ameliorating CNS disease in terms of design, approach, mechanism of action, and limitations associated with their clinical availability will be discussed. Here, the current state-of-art of nanoparticles-based therapeutics for crossing blood-brain-barrier will also be focused.

Sanitary Napkins Recycling: A Sustainable Approach

Institute names 1. Vidyalankar Institute Of Technology, Wadala, Mumbai.
0. Vidyalankar Institute Of Technology, Wadala, Mumbai.
3.Vidyalankar Institute Of Technology, Wadala, Mumbai.
***SHRAVANI BHAMARE**: shravani.bhamare@vit.edu.in*
***MANASVI GHADGE**: manasvi.ghadge@vit.edu.in*
HARSHA JADHAV: harsha.jadhav@vit.edu.in

Abstract

Sanitary waste disposal in India poses a significant environmental and public health challenge, exacerbated by inadequate municipal waste management systems. Disposable sanitary napkins, primarily composed of non-biodegradable plastics, contribute to this crisis, with an estimated 12 billion pads generated annually. Misclassification of sanitary waste under Solid Waste Management (SWM) Rules, 2016, and Biomedical Waste Management Rules, 2016, complicates effective disposal practices. The incineration of these materials can release dioxins and furans, potent carcinogens that bioaccumulate and disrupt ecosystems. To address this issue, we propose a comprehensive solution involving the recycling of this waste into reusable products, which is elaborated upon further in the paper. Urgent implementation of robust waste management protocols and public awareness initiatives is imperative to mitigate these risks and protect community health.

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Pt (II) based anticancer agents with (N, N) bidentate σ-donor and π-acceptor ligands: their synthesis, cytotoxic property, DNA binding and DFT study

Chandrika Das, Ishani Maitra, S. C. Moi*

Department of Chemistry, National Institute of Technology Durgapur, Durgapur- 713209, West Bengal, India.
Corresponding author Email: sankar.moi@ch.nitdgp.ac.in

Abstract

The exploration of the mechanism of interaction of cytotoxic Pt(II) complexes with Sulfur containing biomolecules are relevant in biological aspect in order to understand their drug-reservoir activity. [Pt(AMBIM)Cl_2] and [Pt(MAMP)Cl_2] and their thiol substituted derivatives were synthesised and characterised spectroscopically. At pH 4 the reactions took place in two distinct consecutive steps. The rate constant and values were calculated. DNA binding constant were evaluated for all the complexes through absorption titration, competitive binding and gel electrophoresis. Theoretical investigation was considered through DFT study. MTT assay and ROS generation study displayed comparable cancer cell growth inhibition as cis-platin.

Anticancer activity of Pt (II) Complexes with bidentate (N, N) carrier ligand and ancillary labile groups: Their DNA/BSA Binding, Molecular Docking, and Cytotoxic Property

Sharmistha Chatterjee, Saikat Mandal, Swarup Kumar Tarai, Sankar Chandra Moi*

Department of Chemistry, National Institute of Technology Durgapur
**Corresponding author: sankar.moi@ch.nitdgp.ac.in*

Abstract

The potent bidentate carrier ligand 2-picolylamine (pic) has been used to synthesize Pt(II) complexes to know their bioactivity and anticancer property. The dichloro Pt(II) complex [Pt(pic)Cl_2] and its hydrolysed diaqua complex [Pt(pic)$(OH_2)_2]^{2+}$ and two thiol-containing Pt(II) complexes $[Pt(pic)(Lcys)]^+$ and $[Pt(pic)(NAL)]^+$ were synthesized. Their biomolecular interactions with BSA and DNA by spectroscopic methods, theoretical approach on optimization structures, HOMO-LUMO energy, DFT, and molecular docking were executed. In vitro cytotoxic profiles of the complexes like the anticancer activity were brought under consideration on A549 cancer cells and normal HEK-293 cells. Cytotoxic property was compared with that of the recognized anticancer drug cisplatin.

Antibiofilm and antimicrobial potential of choi jhal (*Piper chaba* Hunter) extract against drug resistant pathogens

Rameswar Mukhopadhyay[1], Anushma Biswas[2], Rajib Majumder[1], Krishnendu Maji[3], Sagarika Chakraborty[4], Subhashis Samanta[5], Animesh Naskar[2*]

[1]Department of Biotechnology, ADAMAS University, Kolkata-700126, West Bengal, India
[2]Department of Food Science, Maulana Abul Kalam Azad University of Technology, Haringhata, Nadia 741249, West Bengal, India
[3]Department of Applied Chemistry, Maulana Abul Kalam Azad University of Technology, Haringhata, Nadia 741249, West Bengal, India
[4]Department of Food and Beverage, Jaiprakash Hospital & Research center Pvt. Ltd., Rourkela-769004, Odisha, India
[5]Department of Forensic Science & Technology, Maulana Abul Kalam Azad University of Technology, Haringhata, Nadia 741249, West Bengal, India
**Corresponding author: animesh.ftbe@gmail.com*

Abstract

Traditional medicine has derived from herbs has recently employed for potent therapeutic and curative agents as contemporary medicine. Choi jhal (*Piper chaba* Hunter) is commonly used as traditional herb in Bangladesh and India. However, a microbial biofilm refers to a group of microorganisms that can develop drug resistance, enhancing their ability to spread diseases. In our research, choi jhal exhibited considerable antimicrobial activity against the test organisms like *Bacillus subtilis*, *Salmonella typhi*, *Staphylococcus aureus*, and *Escherichia coli*. Moreover, the antibiofilm potential of such herb (50-70%) was contemplated against the biofilm formation by *Staphylococcus aureus*.

Skin Disease Classification: A Feature Fusion-based Custom Deep Learning Model

Sourajit Maity[1] *and Moupiya Ghosh*[2]*

[1]*Department of Computer Science and Engineering, Sister Nivedita University,*
Kolkata-700156, India
[2]*Department of Physics, Basic Science & Humanities, Institute of Engineering and Management (IEM), Kolkata,*
University of Engineering and Management, Newtown, Kolkata-700160, West Bengal, India

**Corresponding author: moupiyaghosh29091994@gmail.com*

Abstract

To prevent, diagnose, and treat diseases, timely identification is essential. Several convolutional neural networks (CNNs) have demonstrated efficacy in recognizing various diseases in images, and automated systems that employ deep learning and machine learning (ML) can address this issue. To improve the robustness and accuracy of skin disease classification systems, we employed a modified Convolutional Block Attention Module (CBAM) added with two baseline models namely Xception and DenseNet201 on the MSLDV2, MSIC, and ISIC datasets.

Enhanced antibacterial activity of a novel drug-conjugated magnetic nanoparticles

Moupiya Ghosh*

Department of Physics, Basic Science & Humanities, Institute of Engineering and Management (IEM), Kolkata, University of Engineering and Management, Newtown, Kolkata-700160, West Bengal, India

Corresponding author: moupiyaghosh29091994@gmail.com

Abstract

$MgFe_2O_4$ nanoparticles have been synthesized by sol-gel method and applied to target the antibiotic Azithromycin (10 mol% drug has been conjugated). The samples have been well characterized by the analysis of the XRD, EDS pattern, FESEM and TEM images analysis. The enhanced activity of the drug-conjugated sample against Gram-positive bacteria has been confirmed by Agar – cup assay and MIC study. It has been revealed that the drug-conjugated nanoparticles (with 10 mol% azithromycin) and the pure 100% azithromycin have almost similar efficacy against bacteria. This confirms the enhanced activity of azithromycin after its conjugation with the nanoparticles.

Design of a Multiband FSS Absorber

S. Das[*1,2], R. C. Tiwari[1], L. L. K. Singh[3], P.P. Sarkar[4]

1. Deprtment of Physics, Mizoram University, Mizoram, India.
2. Department of Electronics, Rishi Bankim Chandra College, Naihati, West Bengal, India.
3. Department of Electronics and Communication Engineering, Mizoram University, Mizoram, India.
4. Department of Engineering and Technological Studies, University of Kalyani, West Bengal, India.
**Corresponding author: saptarsika@gmail.com*

Abstract

The development of a cost effective FSS absorber has been set forth by simulation. Three layers of conventional bandstop FSS are united together to obtain multiband absorption in the frequency range of 8.5 GHz to 11 GHz. The absorption frequency bands obtained are 8.82 GHz to 8.86 GHz, 9.17 GHz to 9.28 GHz and 10.35 GHz to 10.77 GHz. The bandwidths are 40 MHz, 110 MHz and 420 MHz.The designed FSS absorber is capable to reduce the health hazards that causes due to the prolong exposure to microwave radiation.

High Throughput Fabrication of Cost-Effective SERS Substrate with Remarkable Sensitivity

Debichhanda De, Sajal Biring *

Ming Chi University of Technology, New Taipei City 243303, *Taiwan*
*biring@mail.mcut.edu.tw

Abstract

In this research, I developed a novel SERS substrate using anodic aluminum oxide (AAO) membranes, chosen for their unique nanostructured, highly ordered pores. To enhance SERS signals, a 13 nm silver (Ag) layer was deposited onto the AAO surface via electron gun (E-gun) evaporation, leveraging Ag's strong Raman amplification properties, particularly in the visible spectrum. This substrate was used to detect adenine—a purine nucleobase found in DNA and RNA—at low concentrations, demonstrating the substrate's sensitivity and potential in biomolecular detection applications.

Stochastic gene transcription with non-competitive transcription regulatory architecture

Amit Kumar Das*

Bankura University, Purandarpur, Bankura -722146, West Bengal, India.
**Corresponding author: mr.das201718@yahoo.com*

Abstract

In this paper, we construct a stochastic model where the transcription factors (activators and repressors), interact with the gene promoter in a non-competitive fashion. We also develop an analytical theory supported by stochastic simulation that re-establishes the experimental results [3] with improved data fitting. The theory allows us to determine the mechanisms and parameters that govern the noisiness and regulation of gene expression for that architecture. We notice that the Fano factor (FF_m) varies from sub-Poissonian to super-Poissonian regime. In addition, we observe some anomalous characteristics of FF_m and the variance of protein at lower activator concentrations.