SMART MATERIALS CONFERENCE 2025

UNIVERSITY *of the* WESTERN CAPE

3 - 5 December 2025

University of the Western Cape

Cape Town, SOUTH AFRICA

Conference programme
Abstract booklet

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Message from the Vice-Chancellor

Smart Materials Conference 2025 (SMC 2025)
3–5 December 2025 | University of the Western Cape, Cape Town, South Africa

It gives me great pleasure to welcome all participants to the *Smart Materials Conference 2025 (SMC 2025)*, proudly hosted by the University of the Western Cape (UWC) in collaboration with the American Chemical Society (ACS). This international gathering marks an important milestone in our continued commitment to advancing science, technology, and innovation for a sustainable and inclusive future.

The *Smart Materials Conference 2025* brings together leading researchers, academicians, students, and industry experts from around the world to share their discoveries and perspectives in the rapidly growing fields of smart materials, nanotechnology, energy, electronics, medicine, and environmental sustainability. Such exchanges are vital for shaping the next generation of technologies and for nurturing global partnerships that transcend disciplinary and geographical boundaries.

At UWC, we take pride in being a hub of cutting-edge research that addresses real-world challenges through collaboration and creativity. This conference embodies our mission to empower knowledge creation that serves the public good, fostering innovation that is both impactful and humane.

I am delighted that *SMC 2025* features many distinguished speakers and hundreds of participants from international institutions, representing the strength and diversity of our scientific community. I am also pleased to acknowledge the unwavering support of our partners and sponsors—whose contributions have made this event possible and meaningful.

On behalf of the University of the Western Cape, I extend my warmest wishes to all delegates for a stimulating, productive, and memorable conference. May your discussions, discoveries, and connections make here in Cape Town continue to inspire collaborative innovation long after the sessions conclude.

With best wishes and regards,

Prof. Robert John Balfour
Rector and Vice-Chancellor
University of the Western Cape, South Africa

Message from the Dean: Faculty of Natural Sciences

Smart Materials Conference 2025 (SMC 2025)
3–5 December 2025 | University of the Western Cape, Cape Town, South Africa

It is my great pleasure and honour to warmly welcome all delegates, speakers, and participants attending the *Smart Materials Conference 2025 (SMC 2025)*, hosted by the University of the Western Cape in collaboration with the American Chemical Society. We are glad to host you on our campus and to provide the space for conversations and collaborations within your community of researchers, innovators, and industry leaders committed to shaping a future for smart materials and nanotechnology.

At UWC, we value research that is not only of the highest quality but also collaborative and socially responsive. Our Science can only have impact if it is at the frontier of knowledge and developed in relationship with colleagues and with broader society. This conference reflects those values well. Over the next few days, you will hear from colleagues working across a wide range of areas—energy, health, water, electronics, environmental systems, and more. What brings everyone together is a shared commitment to the future of smart materials, excellent science and the belief that good ideas often arise when people from different backgrounds and disciplines have the chance to learn from one another.

In this spirit it is wonderful to welcome speakers and participants from institutions across South Africa and from international partners in India, the United Kingdom, China, Germany and elsewhere. Your presence here enriches the discussions and helps build the wider network of researchers working in this space. I am especially glad that students and early-career researchers are part of the programme; their involvement brings zeal and fresh insight and is essential for the long-term development of the field, and indeed Science in general.

My thanks go to the Organizing and Scientific Committees for the considerable work that goes into arranging a meeting of this kind, and to our sponsors and partners for their support of *SMC 2025*. I hope that the sessions, discussions, and informal exchanges over the coming days strengthen existing partnerships and open doors to new ones.

On behalf of the Faculty of Natural Sciences, and the broader UWC community, I wish you a productive and enjoyable conference and trust that your time on our campus—and in Cape Town—will be worthwhile and memorable. Hopefully by the end of the conference you will already be planning when to return for the next meeting.

With warm regards,

Prof. David Holgate
Dean: Faculty of Natural Sciences
University of the Western Cape, South Africa

Message from the General Chair

Smart Materials Conference 2025 (SMC 2025)
3–5 December 2025 | University of the Western Cape, Cape Town, South Africa

It is a profound honour and privilege to welcome you all to the *Smart Materials Conference 2025 (SMC 2025)*—a global convergence of minds dedicated to the pursuit of innovation, collaboration, and sustainability in the realm of smart materials and nanotechnology. Hosted by the University of the Western Cape (UWC) in association with the American Chemical Society (ACS), this event represents an extraordinary synergy between academia, industry, and research communities across continents.

Over the next three days, *SMC 2025* will evolve into a dynamic arena of ideas and discovery, where leading scientists, researchers, and innovators converge to share insights, challenge boundaries, and inspire new directions in smart materials research. The diversity of participants and perspectives enriches every session, embodying the true spirit of collaboration and scientific progress that defines this conference.

As we stand at the crossroads of global challenges—climate change, energy transition, sustainable materials, and human health—the role of smart materials research has never been more critical. *SMC 2025* invites us to rethink conventional boundaries, to collaborate beyond borders, and to envision technologies that advance both science and society.

I extend my deepest gratitude to our Organizing and Scientific Committees, sponsors, and academic partners for their tireless efforts and unwavering support. A special word of appreciation goes to our young researchers and students, whose curiosity and creativity form the heartbeat of this conference.

I hope that the interactions, ideas, and partnerships forged during *SMC 2025* will continue to grow long after the sessions conclude—driving new discoveries, shared learning, and global cooperation.

Welcome to *SMC 2025*, and welcome to Cape Town—a city where science, culture, and natural beauty come together in perfect harmony.

With warm regards,

Prof. Ajay Kumar Mishra
General Chair, Smart Materials Conference 2025
University of the Western Cape, South Africa

Message from the Convener

Smart Materials Conference 2025 (SMC 2025)
3–5 December 2025 | University of the Western Cape, Cape Town, South Africa

It is my great privilege and pleasure to welcome you all to the *Smart Materials Conference 2025 (SMC 2025)*, being held from 3rd to 5th December 2025 at the University of the Western Cape (UWC), Cape Town, South Africa, in association with the American Chemical Society (ACS). This international conference aims to bring together a vibrant community of scientists, academicians, engineers, and industry professionals to share their recent innovations, experiences, and emerging ideas in the rapidly evolving domain of smart materials and nanotechnology.

This year's conference has received an overwhelming response, almost 200 registered participants representing almost 50 academic institutions worldwide, research centres, and industries from South Africa, India, the United Kingdom, USA, Denmark, Germany and several other countries. We are deeply honoured to host 29 keynote speakers who are leaders in their respective fields that cover the latest developments in energy, environment, medicine, electronics, water, and sustainable technologies. Besides, the conference is hosting three academic workshops by delegates representing Institute of electrical and electronics engineers (IEEE), American Chemical Society (ACS) and South African Nanotechnology initiative (SANi). We are in process of registering two UWC student chapters namely IEEE and ACS.

The *SMC 2025* scientific program reflects the diversity and dynamism of modern materials research. Across three days, the conference will feature plenary sessions, parallel technical discussions, and poster presentations designed to promote cross-disciplinary collaboration and dialogue. Special emphasis has been placed on nurturing young researchers—offering them a platform to present their ideas, engage in meaningful discussions, and connect with global experts.

As the Convenor of the conference, I take this opportunity to extend my sincere appreciation to the Scientific and Organizing Committees, our academic and industrial partners, and all sponsors for their invaluable support in realizing this global platform. I am equally grateful to the team of coordinators, student volunteers, and technical staff whose dedication and teamwork have made this event possible.

The *Smart Materials Conference 2025* is more than a scientific meeting—it is a celebration of collaboration, curiosity, and creativity. I invite all participants to engage deeply, share generously, and build partnerships that transcend borders and disciplines. May the discussions here ignite ideas that shape the next generation of smart materials and sustainable technologies.

On behalf of the University of the Western Cape and the Organizing Committee, I warmly welcome you once again to *SMC 2025* and wish you an intellectually stimulating and memorable stay in the beautiful city of Cape Town.

With warm regards,

Prof. Ajay Kumar Mishra
Convener, Smart Materials Conference 2025
University of the Western Cape, South Africa

Keynote Speakers

AI for Environmental Monitoring & Protection to Enhance Sustainability Decision-Making

Abstract

Environmental monitoring has become an essential pillar for safeguarding ecosystems, mitigating climate risks, and ensuring compliance with sustainability goals. However, traditional monitoring approaches often struggle with fragmented datasets, delayed reporting, and limited predictive capacity. This review explores how artificial intelligence (AI) and machine learning (ML) can help transform environmental indicators into predictive modelling frameworks for long-term forecasting[1]. We examine state-of-the-art AI and machine learning techniques, including Random Forest, XGBoost, Prophet, LSTM, and NLP, for predicting environmental indicators such as carbon emissions[2], water usage, and waste generation. We evaluate case studies[3][4] where AI-enhanced sustainability data tracking has enhanced environmental protection, and guided strategic sustainability decisions across corporate, governmental, and research domains. By demonstrating how AI-powered analytics can bridge the gap between environmental data collection and actionable decision-making[5], this review highlights the urgent need for intelligent, data-driven monitoring systems to accelerate measurable progress towards environmental protection.

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Dr Mritunjay Chaubey

Dr Mritunjay Chaubey is sustainability, environment and water expert of international repute. He has done Ph.D. in environmental engineering from Indian Institute of Technology (IIT) Delhi. He has nearly 27- years of professional working experience in renowned MNCs Pentair, Shell, Unilever & UPL. Recently Dr Chaubey elected as Governing Council Member of United Nations Global Compact Network India. Dr Chaubey has made an unique position in corporate world by embedding sustainability & reducing the environmental footprint of big corporates such as Pentair, Shell, Unilever & UPL. Currently more than 100 environmental protection sustainable technologies are successfully working in Europe, Asia, Africa, North America & South America designed by him. Under his leadership UPL has reduced 40% water consumption, 21% carbon emission & 57% waste disposal in last 3-years. UPL is also known for its pioneering University of Sustainable Technology. Dr Chaubey is Editorial Board member of renowned international journal "Research Journal of Chemistry and Environment" as well as "Arab Water World". He is also member of Bureau of Indian Standards for making BIS Standards for water & wastewater treatment and environmental protection. More than 50 technical papers has been published in renowned international journals & conferences with his name. Dr Chaubey is author of a renowned book "Wastewater Treatment Technologies Design Considerations" published by Wiley publisher USA. Dr. Chaubey is currently working as Global Vice President & Head – Sustainability & Environment with UPL. Recently Dr. Chaubey is awarded with "Most Influential Sustainability Leader Award", "Chief Sustainability Officer of the Year Award" and "Asian Sustainable Leadership Award". In March 2023, Dr Chaubey delivered lecture in UN Water Conference New York.

Magnetic characterisation of catalysts for energy applications

D. de Oliveira[1], M. Claeys[1*]

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The University of Cape Town, in collaboration with Sasol Technology, has developed an *operando* magnetometer, which allows to study ferromagnetic catalysts at industrial conditions of high temperature (>800°C) and high pressure (>50 bar) [1]. This unique set-up can be used to study phase changes (such as reduction, oxidation and carburization) as well as crystallites size changes. In certain cases even crystallite size distributions of the magnetic phase can be obtained. Importantly, while studying these changes, fully relevant kinetic data can be measured on this flow through fixed bed reactor system so that the catalyst performance can be directly linked to its current state. Examples of investigations on energy materials conducted with the set-up, which inform catalyst and process design, will be presented and these include, *inter alia*:

- Crystallite size dependent oxidation of cobalt, iron and nickel CO hydrogenation catalysts.
- Sintering of a cobalt and nickel CO hydrogenation catalyst as function of process conditions.
- Role of carbides in cobalt based Fischer-Tropsch synthesis.
- Leaching of cobalt from Pt-Co fuel cell catalysts.

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Professor Michael Claeys

Professor Claeys obtained his PhD (with distinction) in Fischer-Tropsch catalysis at the University of Karlsruhe, Germany, in 1997 and then joined the Catalysis Institute at the University of Cape Town. Here he was instrumental in establishing a large research activity with focus on Fischer-Tropsch catalysis, a technology, which lies at the heart of South Africa's synthetic fuels and chemicals industry and which is playing an increasingly important role in the production of green future fuels via Power-to-X processes. Other research interests include the preparation and characterisation of nano materials and their use in catalytic applications, as well as the development of catalysts and novel instrumentation for characterisation of catalysts at working conditions. Professor Claeys has published extensively on these topics, he holds a number of patents and he has been awarded an A-rating ('leading international researcher') by the National Research Foundation of South Africa. A large portion of his research is conducted in conjunction with industrial partners, in particular a longstanding industrial collaboration with Sasol R&D. Professor Claeys directed the Director of the DSI-NRF Centre of Excellence in Catalysis, c*change, a large virtual and multidisciplinary Centre, where he also acted as the Manager of the Scientific Synthesis Gas Programme, which includes processes of catalytic valorization of CO2. He is currently involved in various large PTL projects including the BMBF-funded CARE-O-SENE consortium and the South African national Coal CO2-to-X flagship programme. Moreover, he is the co-founder and director of three spin-off companies and the founding Chairperson of the Syngas Convention, a triennial international meeting on synthesis gas technologies held in Cape Town.

KEY-03

Title: Nanomedicine for the treatment of tuberculosis

Abstract:

Tuberculosis (TB) caused by *Mycobacterium tuberculosis* is the leading cause of death from an infectious disease. Each year about 1.2 million people die from TB worldwide. While antibiotics exist, challenges faced by the treatment regimens, including drug absorption challenges, lengthy treatment durations and associated adherence challenges, and toxicity, are barriers to successful treatment of this disease. In addition, increasing resistance of *M.tb* limits the effectiveness of the antibiotics. To achieve effective treatment, there is need for application of innovative approaches to develop new treatment modalities. This talk will give an overview of work in application of nanoparticles to address challenges in the treatment of this disease. Particular focus will be on work to develop and investigate a nanoparticle based host directed therapy for this disease.

Professor Admire Dube

Admire is a Professor in Nanomedicine in the School of Pharmacy, at the University of the Western Cape. He is also the Deputy Dean for Learning and Teaching. He is a pharmacist by training, holds an MSc in Pharmaceutical Sciences from UWC, a PhD from Monash University Australia, and post-doctoral training from University at Buffalo, USA. His research group at UWC focuses on the application of nanoparticles towards the treatment of tuberculosis, especially to achieve immunotherapy, targeted drug delivery and/or access across biological barriers.

Innovative Biomaterials for Implants: Engineering the Future of Medical Devices

Ioanna Giouroudi[1], Thomas Czerny[2], Margit Gföhler[1], Sabine Gruber[2], Andreas Otto[1], Aleksandr Ovsianikov[1], Marianne Raith[2], Elisabeth Riegel[3], Philipp Schlossgangl[1], Jürgen Stampfl[1], Ines Swoboda[2], Veronica Viola[1], Peter Andras Viragh[1], Christina Winter[2]

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Advances in biomaterials and implant technologies are transforming modern healthcare, enabling treatments that were unimaginable a few decades ago. This keynote will present recent developments in functional and responsive biomaterials engineered to interact seamlessly with the human body. Topics will include bioactive surface modifications to enhance tissue integration and additive manufacturing approaches for personalized implants. Emphasis will be placed on how these innovations address challenges such as implant rejection, infection, and mechanical failure. Drawing on examples from interdisciplinary collaborations between materials scientists, biomedical engineers, biologists, chemists, physicists, and clinicians, the talk will illustrate how fundamental research is driving the development of innovative medical devices [1–5]. The session will also cover regulatory considerations, sustainability in biomaterials, and the future potential of emerging technologies. Attendees will gain insights into how scientific breakthroughs can be translated into real-world solutions that improve patient outcomes.

Acknowledgements

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Dr Ioanna Giouroudi

Dr. Ioanna Giouroudi is Head of the Doctoral Center and Senior Scientist at TU Wien, where she leads the implementation and advancement of structured doctoral education across the university.

She has extensive experience in research training, student supervision, and academic program development, and is dedicated to empowering early-stage researchers to achieve excellence and drive innovation.

With more than 20 years of expertise in biomedical engineering and nanotechnology, her research spans the development of biomaterials for implants, portable diagnostic systems, smart materials for energy applications, and targeted drug delivery systems using magnetic methods.

Wastewater treatment and water recovery at the industrial sector: Lessons learned and innovative approaches in the EU

Dr. S. Saeid Hosseini; Industry Manager - Water Treatment

Caldic BV, Terlochtweg 1, 2620 Hemiksem, Belgium

Aligned with the EU Green Deal, Circular Economy Action Plan, and Zero Pollution targets, industrial water management is shifting toward circular, low-impact operation models aimed at closing the water loop and optimizing resource via innovative means. This presentation shares lessons from recent pilot and full-scale implementations that integrate next-generation coagulants, flocculants, and bio/plant-based chemicals to improve water quality while minimizing sludge generation. Emphasis is placed on operational strategies that enhance operations. Case studies demonstrate how advanced process control and hybrid treatment configurations support higher water recovery rates, internal reuse, and consistent compliance with stringent discharge permits. The presentation highlights key parameters influencing chemical performance, process stability, and energy efficiency, alongside the role of monitoring and data analytics in performance optimization. These experiences provide a technical framework for industries seeking to implement sustainable, circular water management solutions that reduce costs, environmental impact, and dependence on freshwater resources.

Dr Saeid Hosseini

Dr Saeid Hosseini is a techno-commercial expert in the domains of environmental and water technologies and knowledge-based solutions. He has vast experience in academia, research and industrial sectors, by which he combines science, technology and business together in order to address the challenges in the industrial operations. He has served more than a decade as university professor and three years as extraordinary professor at iNanoWS (UNISA). After taking several distinct roles over the years, Dr Hosseini is currently Industry Manager at Caldic, one of the leading companies in the environmental solutions, and is responsible for handling several projects relevant to water and wastewater treatment and promoting sustainability in collaboration with the clients across the EU.

KEY-06

Electrochemical Sensing of Microplastic in Point-of-Care Settings.

Ajeet Kaushik

NanoBioTech Laboratory, Department of Chemistry, Florida Polytechnic University, Lakeland, FL-USA

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Presently, smart materials-based sensing technology, interfaced with other tools like the Internet-of-Things (IoT, 5^{th} generation sensing) and artificial intelligence (AI, 6^{th} generation sensing), emerges as useful for efficient sensing for point-of-care (POC) applications. Such systems have transformative aspects to contribute to sustainability, as defined by the United Nations. To achieve such tasks, we are exploring electrochemical sensing of a targeted analyte in POC settings. Our approach consists of customized electrodes interfaced with the smart electrochemical analyzer that can be operated using a smartphone. Recently, we have developed a Molecularly Imprinted Polymers (MIPs)-based electrochemical sensing of microplastics and PFAS in water samples at a low concentration. Such developed smartphone-EA@MIP-based microplastic and PFAS sensing systems can detect microplastics in the field to analyze the situation and make decisions in a timely manner.

Keywords: *IoT, Sensing technology, nanoscience, AI, health wellness, environmental surveillance*

Ajeet Kaushik

Ajeet Kaushik, Fellow-ICS, is an Associate Professor of Chemistry at the Department of Environmental Engineering, Florida Polytechnic University, USA. He is exploring nano-enabled technologies for health and environmental monitoring, involving efficient sensing and nanomedicine. He is an accomplished scholar (supported by over 300 publications, editorial roles, 12 edited books, 3 patents, and international collaborations) and the recipient of several international awards in support of his credentials. His research interests include green chemistry, electrochemistry, chemical sensors, biosensors, nanomedicine, targeted drug delivery, point-of-care sensing, and personalized health wellness. To achieve goals, Dr. Kaushik is focused on cutting-edge research and seeking collaborations.

Advancing Multifunctional Nano-Hybrid Materials: From Design Principles to Applications in Nanobiotechnology

Jin-Woo Kim, *Distinguished Professor, Fellow, IEEE*

Bio/Nano Technology Group, Institute for Nanoscience & Engineering, University of Arkansas, Fayetteville, AR 72701, USA; Dept. of Bio. & Ag. Engineering, University of Arkansas, Fayetteville, AR 72701, USA; Materials Science & Engineering Program, University of Arkansas, Fayetteville, AR 72701, USA

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Abstract

Nanotechnology continues to expand the frontiers of material innovation, giving rise to bio/nanomaterials of extraordinary structural, chemical, and functional diversity. Both hard and soft systems display unique physicochemical properties that have already transformed areas such as molecular sensing, biosecurity, nanomedicine, optoelectronics, and nanophotonics. Yet the field is moving beyond discovery – toward the intentional design of multifunctional nano-hybrids that unite biological and synthetic components into purpose-built materials. These engineered hybrids offer a powerful platform for creating adaptable, high-performance nanoagents tailored to specific challenges in nanobiotechnology. In this keynote, I will present our latest progress in the design, assembly, and functionalization of advanced bio-hybrid nanocomposites, with a focus on their translational potential across biomedical and biotechnological domains. Special attention will be given to strategies for controlling nanoparticle organization into well-defined, functional architectures, as well as approaches to improve scalability, precision, and reliability. Together, these advances point toward the next generation of smart, application-driven nano-hybrid systems that bridge design and real-world impact.

This work was supported in part by the Arkansas Biosciences Institute (ABI) and the Arkansas Research Alliance (ARA) Impact Grant.

Professor Jin-Woo Kim

Jin-Woo Kim is Director of the Bio/Nano Technology Group and a Distinguished Professor of Biological Engineering and Materials Science & Engineering at the University of Arkansas, as well as an Adjunct Professor of Electrical Engineering at Pohang University of Science & Technology (POSTECH). He earned dual B.S. degrees in Chemical Technology (now Chemical & Biological Engineering) from Seoul National University and in Microbiology from the University of Iowa, followed by an M.S. in Biology from the University of Wisconsin and a Ph.D. in Biological Engineering from Texas A&M University. He has held visiting appointments at Harvard University's School of Engineering and Applied Sciences and at Brookhaven National Laboratory's Center for Functional Nanomaterials. Dr. Kim's research centers on biologically inspired nanotechnology, bridging biological/biomedical engineering, biology, chemistry, and nanotechnology. By learning from natural systems, his group develops innovative approaches for "panoscale" system integration – constructing multifunctional, hierarchical structures for advanced biomimetic materials and devices. He has published over 150 peer-reviewed papers, delivered more than 280 presentations (including over 100 invited talks), and holds six patents (granted or pending). He has received multiple awards for teaching and research, serves as Editor-in-Chief of the IEEE Open Journal of Nanotechnology, and is on the editorial boards of several leading journals. He has also reviewed for Science, PNAS, Nature Nanotechnology, and other top-tier publications. In professional leadership, Dr. Kim is President of the IEEE Nanotechnology Council (2024–2025) after serving as President-Elect (2023), Vice President for Conferences (2021–2022), and Vice President for Publications (2017–2019). He chairs the steering committees of IEEE-NANOMED and IEEE-LANANO and has organized numerous international conferences, including general chair or co-chair roles for IEEE-NANOMED (2011, 2015, 2017, 2019), IEEE-NANO (2019, 2023), IEEE-NEMS (2020), and IEEE-NMDC (2025). He was an IEEE Nanotechnology Distinguished Lecturer (2017–2018) and is an elected Fellow of both IEEE and the American Institute of Medical and Biological Engineering (AIMBE).

A simulation-based study on bio-thermochemical conversion of potato waste for sustainable biohydrogen production

Emmanuel Kweinor Tetteh*, Ahmed Mohammed Inuwa, Victor Oluwafemi Fatokun, Sudesh Rathilal,

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Abstract

The increasing demand for clean and renewable energy has boosted interest in producing biohydrogen from agro-industrial residues. This study introduces an integrated bio-thermochemical process for sustainable hydrogen production from waste potatoes, combining anaerobic digestion (AD) and steam gasification, and models it in Aspen Plus for process performance assessment. Optimal conditions for anaerobic digestion were identified at 37 °C (mesophilic) and 55 °C (thermophilic), with a 48-hour retention time, leading to maximum substrate conversion and hydrogen output of 7.8×10^{-4} kg H_2 per kg of feedstock per hour. For steam gasification, optimal conditions were 850 °C and a steam-to-biomass ratio of 0.6, yielding the highest hydrogen production of 9.92×10^{-3} kg H_2 per kg of feedstock per hour. Under these conditions, combining AD and gasification increased overall hydrogen recovery by 43% and overall energy efficiency to 68.7%. Additionally, CO_2 emissions decreased by 27% compared to single-path gasification. Pinch analysis showed 25% internal heat recovery, improving process self-sufficiency. By-products included biochar (12.6 wt%) and organic acids (7.8 wt%), supporting circular economy practices. A preliminary techno-economic analysis estimated a minimum hydrogen selling price (MHSP) of 2.84 USD per kg of H_2, with a payback period of 4.6 years under South African energy market conditions. These findings demonstrate that Aspen Plus–based integration of biological and thermochemical pathways offers a viable, low-carbon, energy-efficient approach for hydrogen production from potato waste.

Keywords: Biohydrogen; Potato waste; Bio-thermochemical conversion; Sustainable energy; Aspen plus simulation

Dr Emmanuel Kweinor Tetteh

Dr. Emmanuel Kweinor Tetteh is an NRF Y2-rated researcher, a Research Fellow and Senior Researcher with the Green Engineering Research Group (GERG), and an academic in the Faculty of Engineering and the Built Environment at the Durban University of Technology (DUT), South Africa. A highly driven and visionary scholar, Dr. Tetteh holds a Doctor of Engineering in Chemical Engineering and brings over a decade of multidisciplinary experience spanning academia, research, and industry.

With a strong commitment to scientific innovation and environmental sustainability, his expertise encompasses green hydrogen production, wastewater treatment, membrane and catalytic systems, magnetic nanotechnology, waste valorisation, renewable energy systems, and computational process optimisation. His research delivers cutting-edge solutions to global challenges by integrating AI, machine learning, life cycle assessment, and circular economy frameworks.

As Principal Investigator of GERG, Dr. Tetteh leads transformative, externally funded projects supported by NRF, SANEDI, and the Water Research Commission (WRC)—aligned with DUT's ENVISION2030 pillars of innovation, sustainability, and societal impact. His work includes developing pilot-scale smart systems for waste-to-energy conversion, solar-powered water technologies, and advanced electrocatalysis for hydrogen production.

Dr. Tetteh is the proud recipient of several prestigious accolades, including:

- Eni Award for Young Talent from Africa (2019) – presented by the President of Italy at the Quirinal Palace
- Winner, TW Kambule-NSTF Emerging Researcher Award (2024) – South Africa's "Science Oscars"
- Finalist, IChemE Global Renewable Energy Award (2025)

He has authored over 70 peer-reviewed articles, holds an H-index of 25, and has accumulated over 2,500 citations. His work has fostered strong global collaborations with partners in Germany, Ghana, Nigeria, Spain, Kenya, China, and the USA, bridging academia, policy, and industry.

Beyond research, Dr. Tetteh is passionate about empowering future generations. He has supervised and mentored over 50 postgraduate students, reviewed NRF rating applications, and examined numerous theses. He is a certified postgraduate supervision facilitator, trained at Rhodes University, and currently serves as Editor-in-Chief of the African Journal of Green Engineering and Energy Research.

Dr. Tetteh's visionary goal is to establish a multidisciplinary green innovation institute focusing on green hydrogen, AI-powered water-energy systems, green catalysis, and low-carbon technologies. His work exemplifies the fusion of scientific excellence, inclusive leadership, and societal relevance, inspiring the next generation of African scientists and engineers.

An overview of Sol Gel Technology: Nanoscale methodology for industrial and environmental applications

Shivani Bhardwaj Mishra [1]
[1]*Academy of Nanotechnology and Wastewater Innovations*

Sol gel technology is a wet chemical technique converting liquid colloidal suspension (Sol) to solid (Gels) for developing ceramics, thin films, glassy materials, nanomaterials for reinforcement in nanoscale. A simple and easy to handle technique provides a wide platform for different types of nanomaterials and nanocomposites. With different precursor materials and reaction conditions, sol gel methodology give rise new materials with tailor made material properties as shown in Fig 1. These reaction conditions deliver high surface area with tunable porosity and mixing of precursors in liquid phase provide the homogeneity. Some precurosrs being biocompatible are good sources for biomedical applications such as sensors, implants, drug delivery systems, sensors and photonic devices, efficient catalysts for engineering applications, thin films and coating. This talk will unfold the fundamental of sol gel technology leading to its potential for developing nanomaterials and nanocomposites for environmental and industrial applications.

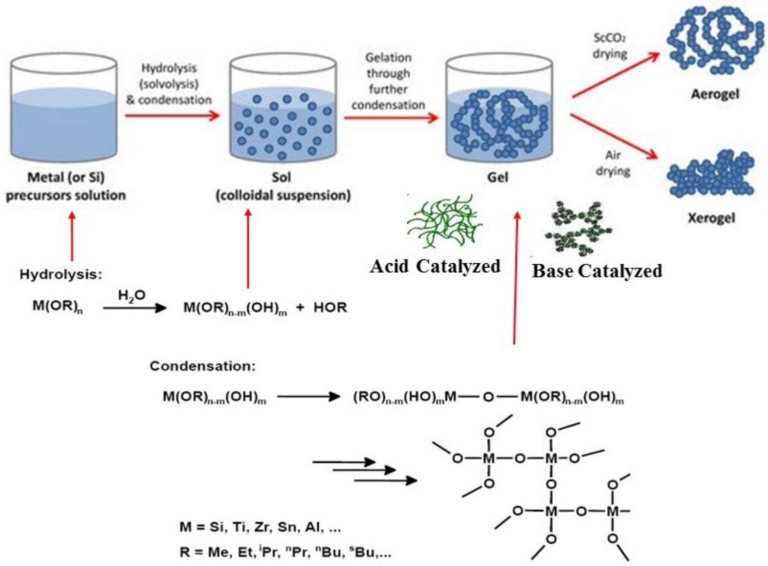

Fig 1. Schematic presentation of Sol-Gel Technology

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Professor Shivani Bhardwaj Mishra

Prof Shivani Bhardwaj Mishra is working as an Associate Editor, RSC Advances, journal published by Royal Society of Chemistry, UK. Besides, she is Founder and Director of Academy of Nanotechnology and Waste Water Innovations as her entrepreneurship venture engaging with academicians and researchers in order to promote translational research. As an International Advisory Board member, serving at Technical University Vienna, Austria. She is also an Adjunct Professor at Vaal University of Technology as well as at Hebei University of Science and Technology, China. Alongside Prior to this, she was appointed as Full Professor at University of South Africa and served at University of Johannesburg as an Associate Professor She holds experience of Postdoctoral fellow at various academic institutions in South Africa.Her research expertise is material development using nanotechnology, waste water treatment and waste valorization and has accumulated research funding for her projects and has supervised many Doctoral and Master's student. Over and above 120 research articles, 45 book chapters and five edited books goes to her research credentials and output. She has been Fellow of royal Society of Chemistry and has received many recognitions for her performances including Distinguished Woman in Science by Department of Science and Technology, South Africa and Woman in Research leadership by University of South Africa.

Tetrapods based Advanced Materials for Advanced Technologies

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Considering the size dependent utilization complexities of nanoscopic dimensions tin real technologies, the focus of nanomaterials community is converging to three-dimensional (3D) smart nanomaterials which are built out of interconnected nanostructures building blocks. This talk will briefly introduce the importance of tetrapod nanostructures towards smart 3D ceramic nanostructuring via a simple and single step flame-based approach for synthesis of zinc oxide tetrapods. These ceramic tetrapods have already demonstrated their potential roles in many different technologies. These zinc oxide tetrapods can be used as solid backbone or sacrificial templates to design hybrid or new tetrapods as smart materials. These smart 3D nanomaterials offer many applications in engineering and advanced technologies. Application examples of 3D ceramic tetrapods in nanosensing, optical sensing, whispering gallery mode resonances, light trapping and guiding, composite engineering, antiviral candidates, water purification, piezotronics, agriculture, and in several other applications will be demonstrated [1-10]. The integration of tetrapods in electrospun fibers offer many advantages in biomedical engineering and few examples about nano-engineered electrospun fibers will be presented as recent developments.

Keywords: *Tetrapods, Flexible Ceramics, Smart Materials, Advanced Technologies*

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Professor Yogendra Kumar Mishra

Yogendra Kumar Mishra, Fellow of Royal Society of Chemistry (FRSC), UK, is currently working as professor and the Leader of the Smart Materials group at Mads Clausen Institute, University of Southern Denmark (SDU), Sønderborg, Denmark. Before SDU, he was leading an independent research group on 3D Nanomaterials at Functional Nanomaterials Chair, Kiel University. At SDU, NanoSYD, the Smart Materials group's main focus is to develop a new class of 'Functional Materials for Advanced and Sustainable Technologies'. He is an Editorial Board Member/Associate Editor for many prestigious magazines (Advanced Functional Materials, Materials Today Family, Nano Energy, etc.). He has received many notable awards, like Alexander von Humboldt Fellowship (2008) and the Young Investigator Award (under 40) from BHJ Fonden-Denmark and has won several successful grants.

Sensor-Integrated Process Optimization and Structural Evaluation of Thermoplastic Composite Pipes for High Performance Oil and Gas Applications

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Abstract:

This study investigates the mechanical performance, failure mechanisms, and process optimization of thermoplastic composite pipes (TCPs) for offshore applications. TCPs offer high strength-to-weight ratios but are prone to delamination, matrix cracking, and fibre–matrix separation under complex loading. Flexural and compressive testing, combined with X-ray computed tomography and ultrasonic inspection, revealed that tensile cracks initiate flexural failure, while compression causes progressive matrix degradation, fibre buckling, and delamination. The evaluated pipe properties results highlighted the role of laminate design and polymer fracture toughness.

To improve manufacturability, thermocouples and strain gauges were embedded in polyethylene/glass fibre laminates to monitor consolidation. Optimized processing at 200°C and post-treatment heating reduced voids, enhanced inter-laminar bond strength by up to 74%, and ensured consistent mechanical properties. Statistical modelling and Particle Swarm Optimization study defined stable high-performance consolidation windows. This integrated approach provided insights into TCP failure, sensor-guided processing, and durable, defect-mitigated pipe manufacture for demanding offshore environments.

Professor James Njuguna

Professor Njuguna is the Director of Research and Innovation at the National Subsea Centre (NSC) at Robert Gordon University (RGU). Professor Njuguna is an internationally recognized expert in composite materials, with a particular focus on their application in high-performance and extreme environments, including the oil and gas, aerospace, automotive, renewable energy, and construction sectors. His research addresses the durability and safety of advanced materials and structures under operational conditions, with significant contributions to understanding failure mechanisms in polymer fibre-reinforced nanocomposites, especially the emission and diffusion behaviours of nanofillers. He is a Fellow of both the Royal Society of Edinburgh (FRSE) and the Institute of Materials, Minerals and Mining (FIMMM), and currently serves as Vice-President (International) of the Royal Society of Edinburgh.

Ambient vibrational energy into electrical energy: Thermally stable nanogenerators

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Abstract: Triboelectric nanogenerators (TENGs) are a rapidly advancing technology for converting ambient vibrational energy into electrical energy. Traditional polymer-based TENGs are widely used in wearable and flexible devices, but their performance is often restricted in high-temperature industrial environments or harsh conditions. To overcome this challenge, layered double hydroxide nanocomposite-based TENGs were developed to study their output efficiency at high temperature conditions. The designed and fabricated device exhibits strong thermal stability, allowing reliable operation under elevated temperatures, making it suitable for harvesting waste energy from industrial equipment. In addition to energy harvesting, the TENG demonstrates potential in structural health monitoring, as it produces distinct electrical responses under different vibrational patterns, enabling vibration analysis of machines. The device adaptability for wearable applications is also highlighted through human motion detection integrated with machine learning approaches. By combining robustness, multifunctionality, and environmental adaptability, the designed TENGs offer a versatile platform for sustainable energy harvesting and monitoring.

Keywords: Triboelectric nanogenerators (TENGs), Layered double hydroxide nanocomposite, Green and sustainable energy, Thermal stability.

Dr Manoj K. Patel

Dr. Manoj K. Patel received his B.Tech degree from NIT Jamshedpur and completed his PhD from the Academy of Scientific and Innovative Research (AcSIR). He is a Senior Principal Scientist at CSIR-CSIO, Chandigarh, and an Honorary Professor at AcSIR. His research interests include food safety and nutrition, 3D food printing, green energy, electrostatic liquid atomization, airborne charged particulate technology, surface decontamination, precision agriculture, UAVs and aerial electrostatic spraying, and social innovations.

Dr. Patel has completed numerous projects funded by CSIR, USISTEF, SERB, TDB, NIF, DST, the Govt. of India, research foundations, and industries. He is a project leader of various national and international projects funded by the CSIR HRDG, DST, Govt. of India. He has transferred eight (08) technology know-how to various industries for commercial production. Dr. Patel has received several awards; the most prominent are: Young Achiever Alumnus Award 2024, BRICS Young Scientist Award 2022, CSIR Young Scientist Award 2020, IEI Young Engineers Award 2019, NRDC National Societal Innovation Award 2017, and Gandhian Young Technological Innovation (GYTI) Award 2016. He is a recipient of the CSIR Raman Research Fellowship from CSIR (2024-2025), the Post Graduate Research Program for Engineers (PGRPE) Fellowship from CSIR (2010-2012), and the TATA Cummins Meritorious Scholarship from

Functionalized Track-Etched Membranes: Composite and Hybrid Nano-Materials

Leslie F. Petrik[2], Arnoux Rossouw[1], Alexander N. Nechaev[1], Pavel Yu Apel[1].

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Track-etched polymer membranes (TMs) have emerged as precision porous materials with tunable pore geometry and surface chemistry, enabling advanced applications in filtration, catalysis, and sensing. Innovative modifications, such as metal coatings, nanoparticle immobilization, and functionalized nanofiber composites, impart diverse opportunities for selective gas separation, metal recovery, improved hydrophilicity, fouling resistance, photocatalytic properties, and sensing capabilities. Overall, our research has produced hybrid membranes that for example, self-clean via photocatalysis, serve as platforms to detect pollutants via surface enhanced raman spectroscopy (SERS), recover metals of value, or filter organic contaminants with high kinetics – demonstrating a successful model of international collaboration in membrane science. Future directions include upscale manufacturing (e.g. roll-to-roll processing) to translate these laboratory innovations into practical water purification and sensing solutions.

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Professor Leslie Petrik

Leslie Petrik is Emeritus Professor, Department of Chemistry, University of the Western Cape (UWC), Bellville, Cape Town, South Africa, and Adjunct Professor, Department of Chemical Engineering, Cape Peninsula University of Technology, Bellville, Cape Town, South Africa. After obtaining her PhD in Chemistry in 2008 at the University of the Western Cape, she independently developed and led the Environmental and Nano Sciences research group, being principle investigator and grant holder of numerous local and international research agency projects with a focus on material science, nanotechnology, catalysis, and on environmental remediation, including beneficiation of industrial wastes and water treatment. Moreover, her scientific output, includes 5 granted patents; 11 book chapters; 248 international peer reviewed papers; numerous technical reports to industry and research agencies, and many conference presentations. She is considered to be amongst the top 3% of scientists globally according to her last 6 years i10 Index and citations (Adscientific index) with 10659 citations overall and an h-index of 57 and i-10 index of 183. Prof Petrik has received numerous awards such as the Water Legends Award of the Water Research Commission of South Africa, the Businesswomen of the Year Science and Technology Award, the National Science and Technology Forum NSTF-South32 award for her outstanding contribution to science, engineering, technology (SET) and innovation. She has supervised to completion and graduated 41 PhD, 72 MSc students and hosted 27 Post-doctoral fellows.

The internet of value (IOV)

Logan Pillay

The XRP Ledger (XRPL) is a decentralised, public blockchain created to advance the vision of the **Internet of Value (IoV)**—a concept pioneered by Ripple. The IoV imagines a world where money, assets, and value can move across the globe as seamlessly, instantly, and affordably as information travels on the internet today. Despite advances in digital technology, **cross-border payments remain slow, costly, and fragmented,** often taking days to settle and burdened with high fees. This challenge affects individuals, businesses, and even governments, especially in emerging markets where access to efficient financial infrastructure is limited.

The lecture will explore how **blockchain technology and the XRPL** are transforming this landscape. Attendees will gain insight into:

The inefficiencies of traditional cross-border payment systems.

How the XRPL provides fast, **low-cost, and transparent transactions.**

The broader implications of blockchain for **financial inclusion, remittances, and global commerce.** This can be expanded to the Internet of Value.

This is a timely opportunity to understand how innovations like the XRPL are **reshaping the global financial system** and paving the way for a truly connected digital economy.

Mr Logan Pillay

Logan Pillay, a distinguished professional engineer and thought leader in the energy sector. Mr. Pillay holds a BSc in Electrical Engineering from the University of Durban-Westville, a Diploma in Project Management, a Diploma in Management, and an Executive MBA from Henley Business School. His career began as a Transmission Line Design Engineer, advancing to Transmission Research Manager, where he led the creation of the internationally recognised Eskom Power Series (23 technical volumes) and pioneered the MSc in Power and Energy Systems at UDW. He later became Eskom's first Executive Head of Engineering Faculty at the Eskom Academy of Learning, and today serves as Eskom's Corporate Consultant for Research, Development, and Innovation. Join us for an inspiring lecture with one of South Africa's foremost leaders in engineering, energy, and innovation.

Metasurfaces: building blocks of tomorrow's optical technologies

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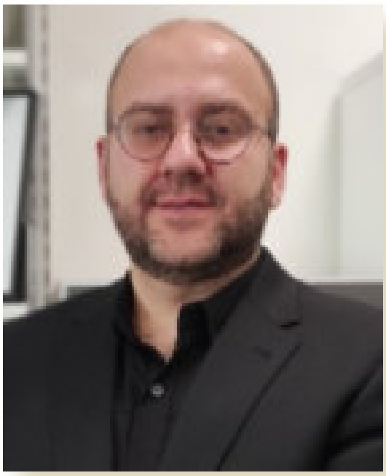
ABSTRACT
Recent advancements in nanofabrications, characterisations, and computer modelling have allowed the generation of arrays of engineered nanoparticles, called meta-surfaces, that extraordinarily control light characteristics. They can reproduce the functions of bulky geometrical optics such as lenses, mirrors or filters. Alongside that, occasionally, metasurfaces can offer some functionalities, such as tunability, that are not achievable by geometrical optics. Such advances have led to revolutionary applications in several fields, including but not limited to meta-lenses, polarisation converters, nano-sensors, and holograms. In this talk, I will briefly review the research activities of the Advanced Optics and Photonics Group at Nottingham Trent University on light-matter manipulation for real-life applications. I will discuss how engineering metallic, dielectric, and semiconductor nanoparticles enable us to control the light intensity, frequency, and propagation direction. I will demonstrate how such controls can help us to generate optical nano-switches with switching time faster than the human eye's response. Also, I will explain how we can engineer nanoparticles to convert images from the near-infrared region, invisible to human eyes, to the visible region. Finally, I will show our latest results on how nanostructures can help monitor individual proteins over time. These are a few examples, among many other technologies that are being developed in the community, of why many people consider photonics at the heart of cutting-edge technologies in the 21st century.

Professor Mohsen Rahmani



Mohsen Rahmani is a professor of optics and photonics and the leader of the advanced optics and Photonics laboratory at Nottingham Trent University (NTU), in the UK. He obtained his PhD from the National University of Singapore in 2013, followed by a postdoc fellowship at Imperial College London and the Australian Research Council Early Career Fellowship at the Australian National University. In 2020, he joined NTU via the Royal Society Wolfson Fellowship. Shortly after moving to the UK, he was also awarded the UK Research and Innovation Future Leaders Fellowship. Recently, he has secured an ERC Consolidator Grant. His research activities span over light-matter interactions with nanometre-scale particles for applications in flat optics, near-infrared imaging, bio-sensing, and reconfigurable optics. He has received several prestigious awards and prizes, including the Australian Eureka Prize (Australian Oscar of Science), the Early Career Medal from the International Union of Pure and Applied Physics, and the Australian Optical Society Geoff Opat Award. Professor Rahmani has delivered 40+ invited talks, seminars and keynotes at international conferences and has published more than 80 peer-reviewed journal papers (H-index=43). He is the past chair of the IEEE Nanotechnology Chapter across the UK and Ireland section (2021-2023) and a distinguished lecturer for the IEEE Nanotechnology Council 2024-2025.

KEY-19

Title: *Smart Material Strategies to Combat Microplastic Emission: From Thread to Threat*

Speaker: *Amit Rawal*

Affiliation: *Department of Textile and Fibre Engineering, Indian Institute of Technology Delhi, Hauz Khas 110016*

Abstract

Microplastic fibres are ubiquitous fragments originating from textiles, tyres, carpets, upholstery, fishing gear, and other synthetic materials. Carried by wind and water, these microscopic fibres infiltrate environments – from the deep sea to mountain tops – and are detected in over 1,300 species, spanning tiny invertebrates to apex predators. Their omnipresence raises significant concerns for ecosystems and human health, yet their impact often goes unnoticed. This lecture delves into the intricate journey of microplastic fibres – from their origins in textile-based materials generated through common activities, their movement through waterways, air, and soil, to the profound challenges they pose for ecosystems, human health, and our future sustainability. As the global textile industry scales, a transition to smart, sustainable material strategies is urgently needed to mitigate this pollution while maintaining performance and circularity. Accordingly, we explore a spectrum of smart material innovations designed to reduce microplastic fibre emissions at the source, during use, and at end-of-life. Emphasis is placed on low-shedding textile architectures, self-healing and friction-reducing coatings, stimuli-responsive and biodegradable fibres designed to degrade in marine or wastewater environments, as well as smart filtration systems and sensor-enabled laundry technologies. Furthermore, our findings demonstrate that strategically modifying yarn structure presents a smart material solution to significantly reduce microplastic shedding from woven textiles.

Professor Amit Rawal

Professor Amit Rawal obtained his PhD from the University of Bolton, UK, and a Master of Philosophy from The University of Manchester, UK. He is a recipient of the Alexander von Humboldt Research Fellowship for experienced researchers to conduct research in the field of nonwovens in Germany. He has also been awarded the Fulbright-Nehru Academic and Professional Excellence Fellowship to initiate collaboration with the Massachusetts Institute of Technology, USA. In addition, he has received numerous awards, including the Young Researcher Fellowship from the prestigious M.I.T, Cambridge, for exemplary research in Computational Mechanics, Fellowship of the Textile Institute, CSIR special research award, and an Outstanding Young Faculty Fellowship by the Indian Institute of Technology, Delhi (IITD). Currently, he is working as a Professor at the Department of Textile and Fibre Engineering, IIT Delhi. He has published over 100 papers in reputed journals and has delivered numerous keynote, invited, and plenary lectures at national and international conferences. He has developed various three-dimensional (3D) analytical models for predicting geometrical, mechanical, and wetting properties of a diverse range of textile and allied structures. His research interests are not only limited to the structure, mechanics, and wetting behavior of textile and allied materials but also focused on the structure-property relationship of buckypapers, battery separators, electrospun mats, superhydrophobic fibrous mats, geotextiles, composites, auxetic, piezoresistive, and piezoelectric materials. He is an editorial board member of Textile Research Journal, Journal of Industrial Textiles and Research Journal of Textile & Apparel. Recently, he was honored as the twenty-ninth recipient of the King Carl XVI Gustaf Professorship in Environmental Science for the year 2024/25.

Advancing The Circular Economy Through Waste Valorization: Tailoring Biochar For Absorptive Removal Of Pollutants

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Rapid industrialization, swift urban growth, and extensive human activity have given rise to numerous global challenges, with effective waste management and reduction emerging as particularly critical concerns. Among the many promising solutions, carbon-based functional materials derived from waste, especially biochar, are gaining significant attention for their role in combating pressing issues like water treatment and the ongoing energy crisis. Biochar, synthesized from waste biomass, are increasingly recognized for their remarkable physicochemical properties, including high surface area, tunable porosity, and versatile surface functionalities. These characteristics render them highly efficacious in diverse applications, ranging from sophisticated environmental remediation strategies to the advancement of sustainable energy technologies. Biochar-based adsorbents are especially noteworthy; their unique micro and nanoporous architectures and tailored surface reactivity facilitate innovative pathways for high-efficiency pollutant sequestration and catalysis. Methodologies such as pyrolysis offer a robust platform for the thermochemical transformation of waste, enabling meticulous control over the structural and chemical properties of the resultant biochar, thereby optimizing its functionality for targeted applications. Ultimately, the integration of such waste valorization strategies is a cornerstone of the circular economy, proving indispensable for addressing today's environmental and energy challenges while fostering responsible innovation for the future.

Keywords: Waste Valorization, Circular Economy, Biochar, Thermochemical Conversion, Adsorption

Dr Rangabhashiyam Selvasembian

Dr. Rangabhashiyam Selvasembian, currently working as Head and Associate Professor in the Department of Environmental Science and Engineering, School of Engineering and Sciences, SRM University-AP, India. Previously worked in the Department of Biotechnology, School of Chemical & Biotechnology, SASTRA Deemed University, India. He received his Doctor of Philosophy degree from National Institute of Technology Calicut, India. He was awarded a Post-Doctoral Fellowship by Max Planck Institute for Dynamics of Complex Technical Systems, 2015, Germany. He was further awarded the National-Post Doctoral Fellowship from SERB-DST, 2016-2018, India. Dr Rangabhashiyam Selvasembian was awarded as Young Scientist by DST, India for the BRICS Conclave held in Durban, 2018, South Africa and was the recipient of Hiyoshi Young Leaf Award from Hiyoshi Ecological Services, Hiyoshi Corporation, 2018, Japan. His major research interests are waste valorization and wastewater treatment. He is Editorial Board Member in Separation & Purification Reviews (T&F); Inorganic Chemistry Communications (Elsevier); Current Pollution Reports (Springer); Scientific Reports (Nature); Biomass Conversion and Biorefinery (Springer); Environmental Management (Springer). He is also serving as Associate Editor in South African Journal of Chemical Engineering (Elsevier); Frontiers in Environmental Chemistry; International Journal of Environmental Science & Technology (Springer); IET Nanobiotechnology (Wiley) and as an Academic Editor for Adsorption Science and Technology. He has published more than 130 peer reviewed articles and contributed several book chapters. He is editing books from prestigious publishers such as Elsevier, Wiley, CRC, and Springer. Dr Rangabhashiyam Selvasembian was listed in Top 2% (2021, 2022 and 2023) most cited research scientists in the world as per data published by Stanford University USA.

Smart Biomaterials Enabling Responsive and Accessible Medical Devices

Sudesh Sivarasu PhD

Biomedical Engineering Research Centre (BMERC), Department of Human Biology, Faculty of Health Sciences, University of Cape Town, South Africa

Smart biomaterials are driving a new wave of innovation in medical device design by enabling adaptive, programmable, and minimally invasive therapeutic interventions. This abstract presents an overview of emerging smart material technologies—shape memory alloys, 4D-printable polymers, bioprintable scaffolds, radiolucent composites, and electroactive polymers—and their integration into medical devices tailored for clinical and contextual relevance. Case studies include the FlexiGyn system, which employs Nitinol's thermomechanical memory for atraumatic access in gynaecological care, and novel devices from UCT MedTech using multi-phase shape memory materials for adaptable orthopaedic implants.

The role of radiolucent biomaterials—particularly polymeric and composite matrices—is examined for their potential to reduce imaging artifacts in diagnostic and interventional radiology. In parallel, the advent of 4D printing and bioprinting offers dynamic, stimulus-responsive constructs for tissue engineering, drug delivery, and implantable devices. Advances in metallic additive manufacturing further enable the fabrication of porous, biofunctional structures with customized mechanical properties. Electroactive polymers mimicking artificial muscles present promising applications in soft robotics and rehabilitation technologies.

This work critically assesses the design, fabrication, and translational potential of smart biomaterials in the context of regulatory compliance, manufacturing scalability, and clinical need—positioning these technologies as enablers of precision, personalization, and accessibility in global health.

Professor Sudesh Sivarasu

Prof. Sudesh Sivarasu is the SARChI Chair in Biomedical Engineering & Innovation at the University of Cape Town and Director of the Biomedical Engineering Research Centre (BMERC). A biomedical engineer by training, his work bridges MedTech innovation, regulatory science, and frugal biodesign to deliver scalable health technologies for low-resource settings. He has led national initiatives including the COVID-19 ventilator response and WHO collaborations on health technology access. With over 120 publications, 60+ patents, and several startup ventures, he is recognized globally for translating research into impact and mentoring the next generation of biomedical innovators across Africa.

Nanotechnology-Based Therapeutics, Diagnostics, and Drug Discovery for Advanced Malaria Management

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Professor Hulda Shaidi Swai

Malaria is one of the world's deadliest infectious diseases. Each year over 2 million people are infected and around half a million die. Sadly over 90% of deaths occur in sub-Saharan Africa where on average a child dies of malaria every 12 seconds. Currently there is no effective vaccine against malaria. The earliest drug was Quinine, which was discovered in 1820, but due to severe side effects it has lost its popularity. It's successor chloroquine was very potent has been withdrawn as the malaria parasite has acquired resistance. Presently, Artemisia, a herbal-based compound is the only potent treatment. However, resistance has already been reported in Cambodia and Southern Asia.

In summary all Antimalarials drugs available today are challenged by poor oral bioavailability, short half-lives and toxicity, hence the urgency to find solutions to resolve these shortcomings as well as developing new drugs.

Nanomedicine has revolutionized medicine due to its ability to improve the bioavailability of these compounds by increase solubility, reducing toxicity and improve dose and dose frequency. This technology will enhance research towards the development of novel antimalarial drugs from both potent isolated herbal compounds as well as the existing drugs which needs optimization.

My research will be looking into various methods of encapsulating anti malaria active compounds into nanocarriers which are able to cross all biological barrier due to their nano size. Using these nanocarrier we can also target the infected red blood cells and deliver Malaria drugs directly to the diseased cell. This will improve the bioavailability immensely

The Nanomedicine will create opportunities to innovate and commercialize new malarial drugs and improve the potency exiting once– an aspect that is long overdue in the region. This will save millions of lives in sub-Saharan Africa and the world at large.

Professor Hulda Shaidi Swai

Professor Hulda Shaidi Swai is a Nanoscientist and a Senior Professor in the School of Life Sciences and Bioengineering at the renowned Nelson Mandela African Institution of Science and Technology (NM-AIST) in Arusha, Tanzania.

Prof. Swai holds a PhD in Biomedical Materials Science in Biomaterials in Dentistry from the University of London, Queen Mary & Westfield College. Prof. Swai holds a Master of Science (MSc) degree in Technology and Development in Chemical Engineering from University of London, Imperial College of Science and Technology and a Bachelor of Science (BSc) degree in Statistics & Chemistry from the University of the Dar Es Salaam, Tanzania.

Prof. Swai is Research Chair under the Oliver Tambo (OR Tambo) African Research Chairship Initiative which was highly competitive and only 10 Professors were awarded in Africa in 2020. In this she is researching the use of Nanoscience in the development of novel antimalaria drugs as well as developing human critical mass in Nanoscience not only in Tanzania but the rest of Africa. So far she has made very good strides with very interesting Research results. In this project, she has recruited 3 post docs, and 1 assistant lecturer, 4 PhDs and 3 MSC students. These Research Scholars are working different Projects geared towards the fight against malaria using Nanomedicine.

Prof. Swai is also a Centre Director of a World Bank Funded Centre of Excellence, CREATES (African Centre for Research, agricultural Advancement, Teaching Excellence and Sustainability in Food and Nutritional Security in Africa). She was awarded this Center after a very stiff competition in Africa where only 24 professors were awarded. The Centers were formed through the World Bank's African Centers of Excellence (ACE II) initiative. This Centre of Excellence was formed through a 6 million USD grand from World Bank and it has been a performance-based project. Prof. Swai and her team managed to trigger all Disbursement linked indicators in due time and on a very exciting note, CREATES was one of the most successful ACE II.

Prof. Swai, who is a celebrated Nanotechnolology Scientist in Africa, is a Biomedical Researcher with 27 years of experience in Drug development and Drug delivery systems and over the years has focused on Poverty Related Diseases (PRDs) like HIV, Tuberculosis and Malaria.

Prof. Hulda has held other prestigious positions with high level of responsibilities. In 2013, she got a lifetime appointed as an Extraordinary Professor at the University of Pretoria, South Africa. In this role she is involved in developing and executing joint research projects, jointly supervising research for PhD and MSc. students and fund raising through joint proposal writing.

Prof. Hulda is the immediate former President of the African Materials Research Society (AMRS) following her appointment in May, 2018 and she is currently serving in the AMRS advisory Board and championing Nanoscience for Africa. In honor of her Presidency of this Transformational Society of Researchers, NM-AIST hosted the 10th AMRS International Conference in Arusha from 10th -13th December, 2019. https://www.africanmrs.net/ This was one of the most successful conference attracting up to 400 leading scientist from all over the world

Prof. Hulda has published immensely in high impact factor peer-reviewed journals with a h-index of 25 and has several book chapters. She has also obtained a number of international patents. Swai has won 16 other prestigious awards including the Tanzanian National Health Innovation Award. She was awarded by now President of Tanzania her Majesty Samia Suluhu and the Laureate of African Union Kwame Nkrumah Award in Scientific Excellence which she was awarded to her in the year 2020 by H.E. Sarah Anyang Agbor then Commissioner for Education, Science, Technology and Innovation (ESTI). Prof. Hulda has participated in very prestigious conferences as Keynote Speaker, scientific researches and outreach activities and these have further solidified her reputation as a leading authority in her Scientific niche. https://orcid.org/0000-0003-2180-8300 , Scopus Author ID: 6507987924

Prior to joining NM-AIST, Prof. Swai worked as a Senior Principal Researcher at the Council for Scientific and Industrial Research (CSIR), in South Africa, where she led the Encapsulation and Drug Delivery Research Group for 11 years. In this capacity, she proved her ability to independently formulate and execute research projects and implement scientific research programmes, both in public and private sectors. Prof. Hulda also instituted and headed the Department of Science and Technology (DST)/CSIR Pan-African Centre of Excellence in Applied Nanomedicine Research and Training. In this capacity, she won a grant in Research and Training on infectious diseases of poverty worth R 60 million (about US $ 7 million).

The Development of Multi-Pixel Field Emission X-ray Devices

Abstract:

The first concept of multi-source Computed Tomography (CT) systems originated in the 1980s, and opened the way to innovative system concepts in X-ray and computed tomography. Multi-source CT systems offer promising opportunities in system performance. In addition, multi-source X-ray radiographic systems are widely studied, namely for X-ray stereographic imaging, X-ray tomosynthesis imaging, and inverse-geometry imaging. One significant benefit of the multi-source X-ray technology is the ability to fabricate the source array in various two-dimensional configurations. The more complicated distributive source topologies are designed to improve the sampling of projection data, to further improve both in-plane and depth imaging resolution within the constraints of the limited-angle acquisition of projection data. In multi-source systems, the X-ray sources are arranged in an array format, and each source is launched individually. However, current X-ray generators are not suited for these systems because of their large size, huge power requirement, and slow response. This talk will focus on the field emission X-ray technology that enables to the realization of multi-source CT systems.

Professor John T. W. Yeow

John T. W. Yeow received the B.A.Sc. degree in electrical and computer engineering, and M.A.Sc. and PhD. degrees in mechanical and industrial engineering from the University of Toronto, Toronto, ON, Canada. He is currently a Professor and a University Research Chair in the Department of Systems Design Engineering at the University of Waterloo, Waterloo, ON, Canada.

He is focused on the development of micro/nanodevices for a wide range of applications. He is a recipient of the Professional Engineers Ontario Young Engineer Medal, Professional Engineers Ontario Engineering Excellence Award, Natural Science & Engineering Research Canada Innovation Challenge Award, Douglas R. Colton's Medal of Research Excellence, Micralyne Microsystems Design Award, Ontario Ministry of Research and Innovation's Early Researcher Award, University of Toronto Alumni Association 7T6 Early Career Award, 2011 IEEE NANO Excellence Paper award, Waterloo Institute for Nanotechnology Research Leader Award, and IEEE Canada Outstanding Engineer Award. He was a Canada Research Chair in Micro/Nanodevices (2009 – 2019). He served as the Editor-in-Chief of the IEEE Nanotechnology Magazine from 2014 – 2019. He is currently a Senior Editor of Microsystems & Nanoengineering, IEEE Transactions on NanoBioscience, and IEEE Transactions on Nanotechnology. He is an IEEE Fellow, and Fellow of the Canadian Academy of Engineering, the Engineering Institute of Canada, Engineers Canada, and a Member of College of New Scholars, Artists and Scientists of the Royal Society of Canada. He was a IEEE Nanotechnology Technical Council (NTC) Distinguished Lecturer, and a recipient of the 2021 IEEE NTC Distinguished Service Award. He was the IEEE NTC Vice-President of Educational Activities (2020-2022), and is the IEEE NTC Vice-President Elect of Conferences (2024 – 2026).

Sustainable fungal materials from food waste for textile, biomedical, and environmental applications

Akram Zamani

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Biopolymers offer promising resources for circular biomaterials. Over the past two decades, we have explored filamentous fungi—nature's recyclers—as a renewable source of biopolymers, particularly chitin and chitosan [1]. Filamentous fungi within Mucoromycota uniquely synthesize chitosan in their cell walls, forming a natural biocomposite of chitin and chitosan, which we developed into functional materials. Fungal cultivation was conducted using food waste as substrate in a scalable submerged process. The chitin- and chitosan-rich cell wall material was isolated and valorized into:

1. Textile fibers, produced by spinning the fungal cell wall, with properties comparable to conventional fibers [2-3].

2. Bioplastics, transparent films formed via wet-laying, showing promise for renewable packaging [4].

3. Antibacterial hydrogels, demonstrating biocompatibility and enhanced wound healing [5].

4. Antibacterial filters, suitable for disinfection.

Our research demonstrates fungal biopolymers as a sustainable material platform, integrating food waste valorization with material processing for textile, biomedical, and environmental applications.

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Professor Akram Zamani

Akram Zamani is a Professor of Industrial Biotechnology at the Swedish Centre for Resource Recovery, University of Borås, Sweden.
She earned her PhD in Biotechnology from Chalmers University of Technology in 2010.
Her research focuses on developing sustainable bio-based materials from waste through innovative bioprocesses, and she actively collaborates with academia and industry to promote bio-based innovations for real-world applications.

Advanced Materials from a Regulatory Perspective: Status Quo, Challenges and Insights from recent Research Projects

Andrea Haase, German Federal Institute for Risk Assessment (BfR)

Advanced Materials (AdMa) are being developed with increasing pace. They are applied in nearly every sector, e.g. renewable energy, energy storage/ batteries, building and construction, high performance computers, semiconductors, medicine, agriculture as well as in consumer products. A regulatory definition for AdMa does not exist and is also not rational for several reasons. Existing working definitions rather emphasize their advanced material properties and superior functional performance compared to conventional materials (CoMa). Accordingly, AdMa comprise a large heterogenous material class that continues to rapidly evolve through innovation. Even though AdMa hold highly promising potential, they may also raise concerns as several of them may indeed pose risks to human health and/or the environment. Problems arise, if these risks are not foreseen or detected in time, which is challenging as this firstly requires an appropriate methodology that secondly needs to be adapted continuously as science progresses fast. In general, highly innovative fields are characterised by a high level of complexity, uncertainty and generally they evolve at high pace such that amending existing regulations is very challenging.

Within the EU HARMLESS project (grant agreement ID 953183), an Early Warning System (EWS) was established as a practically applicable tool for screening plenty of materials in a reasonable time. It is organized in two tiers, each underpinned by a specific methodology and facilitated by a dedicated online tool (Decision Support System, DSS). The initial Tier 0 categorizes the materials using the Advanced Materials Earliest Assessment (AMEA) tool. Tier 1 firstly screens materials asking only 15 questions and is ideal for data-poor materials at early innovation stages. These questions cover issues related to human/ environmental exposure and hazard, sustainability and applicability of existing regulations. In a more elaborated version, experimental testing based on New Approach Methodologies (NAMs) is suggested. As outcome, the user is provided with 1) material-related concerns, 2) prioritization of AdMa and 3) recommendations for (regulatory) follow-up actions. The applicability of the HARMLESS EWS has been demonstrated using data from two industrial case studies.

Professor Andrea Haase

Andrea Haase studied biochemistry at the University of Tübingen, obtained a PhD from the University of Heidelberg, finished a postgraduate study in Toxicology at the University of Leipzig and completed her habilitation in pharmacology and toxicology at the Freie Universität Berlin. Since 2008 she is working at the German Federal Institute for Risk Assessment (BfR) in Berlin, where she is the Unit Head of the "Fibre and Nanotoxicology" Unit and the Deputy Department Head of the "Chemical and Product Safety" department. Her research is strongly focused on New Approach Methodologies (NAMs) and their application for human health risk assessments as well as for Safe-and-Sustainable-Innovation Approaches (SSIA). She has written more than 100 scientific publications and is involved in several large research projects such as GRACIOUS, NanoInformaTIX, HARMLESS, POLYRISK, NAMs4NANO. Furthermore, she is a national scientific expert in the EFSA Nano Network (Network for Risk Assessment of Nanotechnologies in Food and Feed) since 2024.

The impact of 2D nitrogen-doped reduced graphene oxide on metal-based (oxides & phosphates) nanoparticles and porous crystalline framework materials for advanced supercapacitors

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The unpredictability of renewable energy sources has heightened the demand for advanced energy storage solutions to efficiently harness and utilize the electricity generated by these sources.[1,2] Among various energy storage technologies, batteries and supercapacitors (SCs) are prominent electrochemical energy storage devices, recognized for their impressive specific energy and power densities. The expansion of SCs has surged in response to rising energy storage demands and efforts to tackle environmental issues. The latest advancements in SC electrode materials have underscored the importance of engineered nanostructures, cyclic stability, and extended lifespan, which are key factors in enhancing device reliability.[3] The 2D-structured materials, such as graphene doped with heteroatom-rich materials, have emerged as promising electrode materials for developing high-performance electrochemical energy storage devices.[4] This work focuses on the performance of carbon-based nanomaterials (with a special interest in nitrogen-doped reduced graphene oxide, N-rGO) decorated with metal-based (oxides & phosphates) nanoparticles and porous crystalline framework materials for advanced supercapacitors.

Hence, this work focuses on integrating the non-Faradaic charge storage mechanism of N-rGO with the Faradaic charge storage of either Mn_3O_4, $NH_4MnPO_4 \cdot H_2O$ or MOFs/COFs as a vital approach toward the construction of supercapacitors with improved energy and power outputs.[3,4] Some of the prepared nanocomposites, such as N, P-rich ammonium manganese phosphate hydrate ($NH_4MnPO_4 \cdot H_2O$, *Mn-AMP*) decorated on N-rGO, displayed battery-type behaviour with excellent performance for supercapattery application. The asymmetric electrochemical cell configuration of the N-rGO/*Mn-AMP* nanocomposite demonstrated great cycling stability through gradual capacity attenuation for 10 000 cycles, as evidenced by the retention of 74% of the initial capacity and coulombic efficiency of 98.8% after the 10 000th cycles.

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Professor Katlego Makgopa

Prof Katlego Makgopa is an Associate Professor of Physical Chemistry, Director of the Centre for Applied Chemistry Research (CACRe), and a Leader of the Nanomaterials for Electrochemistry Applications Research Team (NEART), Chemistry Department, Tshwane University of Technology (TUT), South Africa. He is a C2-rated researcher recognized by the National Research Foundation (NRF), South Africa, and serves as the President of the South African Nanotechnology Initiative (SANi). His current research interests entail the electrochemistry of nanostructured materials (i.e., carbon nanomaterials, metal oxide/ phosphate nanoparticles and metal-organic frameworks) and their potential applications in energy storage (i.e., supercapacitors and lithium-ion batteries) and conversion (i.e., fuel cells and photovoltaics), as well as hydrogen production and wastewater treatment. He has extensively published his research findings in various high-impact, internationally peer-reviewed journals in the form of articles and book chapters, and edited 1 book. He has supervised/ co-supervised several postgraduate students (MSc/MTech and PhD) to completion. He presented his research outputs at several scientific conferences both nationally and internationally as a keynote, Plenary, and Invited Speaker. He has participated as a reviewer for many accredited international journals in reputable publishing entities (i.e., RSC, ACS, Elsevier, etc.), is a member of several scientific/professional societies (SACNASP, SACI, and SANi), and has attracted several funding from NRF, South Africa.

Nano-engineered Materials for Environmental Sustainability

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Nano-engineered materials have been used extensively for a variety of applications. Environmental pollution raised bigger concerns on the discharge of textile waste. Nanotechnology is fast growing on research and bringing sustainable solution in the minimization of the waste. The minimization of the risk of risk and health hazards with the development of industry, environmental pollution and energy shortages have raised awareness of a potential global crisis. Nano-engineered materials can be better solution in finding solution of environmental sustainability more specific to the textile waste remediation due to the large surface areas, diverse morphologies, abundant surface states, and easy device modeling. It is a challenge of great importance to identify and design nano-engineered materials that are efficient, stable, and abundant for the remediation of textile waste. The current talk will be focused on the recent advancement and applications of nano-engineered materials for environmental sustainability.

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Professor Ajay Kumar Mishra

Professor Ajay Kumar Mishra MPhil, PhD, CSci, FRSC is currently working as Professor in the Department of Chemistry, University of The Western Cape, Cape town, South Africa. He is "B" rated researcher recognized by National Research Foundation, South Africa. Prof Mishra has published over 500 publications in peer-reviewed international journals/conferences, books and book chapters. etc Prof Mishra's research has been cited around 15200 times as per google scholar, with h-factor of 56. Prof Mishra have been named on a list of the top 2% of the most cited scientists in various disciplines globally which is continuously from yea 2019-to date and this data published by Stanford University, USA. Prof Mishra has been able to attract multimillion research grants from both internally and externally besides securing several research collaborations world-wide with all leading world institutions. Prof Mishra have attained considerable national and international recognition, as well as awards including "Fellow member" and "Chartered Scientist" by Royal Society of Chemistry, UK and Chancellor's Prize for excellent achievement in research. He has been finalist for prestigious NSTF award for year 2016, 2023, 2024 and 2025. Prof. Mishra also serving as Associate Editor as well as member of the editorial board of many peer-reviewed international journals and books. Prof Mishra's research addresses the need by combining fundamental science with engineering for real-world solutions on advances in materials science, chemistry, nanotechnology to tackle water problems previously deemed intractable. This includes designing filters at the nanometer scale and developing nano-catalysts that break down organic pollutants from wastewater streams. By treating "waste" as a resource, our work aligns with the circular economy – turning pollution into an opportunity. This approach not only cleans water but also yields valuable by-products contributing to both environmental sustainability and economic benefit for communities.

High-Performance Mn-Based 2-Dimensional Spinel Cathode Material for Lithium-Ion Batteries

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Abstract

Lithium-ion batteries (LIBs) are widely used in portable electronics, electric vehicles (EVs), and smart-grid energy storage systems due to their high energy density and long cycle life. Among various cathode materials, spinel-type Lithium Manganese Nickel Oxide ($LiMn_{1.5}Ni_{0.5}O_4$, LMNO) has gained attention for its high voltage, specific capacity, and cycle stability. However, capacity fading due to Mn dissolution and impurity phases remains a challenge [1-3].

In this work, 2D-LMNO spinel-type cathode materials were successfully synthesized using a solid-state method with α-MnO_2 nanorods as the Mn source. The resulting LMNO nanoplates exhibited a high specific capacity of 88 mAh/g at 1 C and 77 mAh/g at 7 C, with 98% capacity retention after 1000 cycles. The excellent electrochemical performance is attributed to the unique 2D nanoplate structure, which accommodates volume fluctuations during charge/discharge cycles, and the high lithium-ion coefficient, reduced Mn dissolution, and high interfacial stability of the material.

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Nithyadharseni Palaniyandy

Nithyadharseni Palaniyandy (NP) is an Associate Professor at the University of South Africa (UNISA). Her research expertise lies in developing advanced electrode materials for various energy storage applications, including secondary ion batteries, supercapacitors, and Recycling and Reuse of battery materials.

Oral Presentations

Reduced graphene oxide/poly (3-aminophenylboronic acid) hybrid nanostructure for enhanced electrochemical sensing

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Abstract

Nanostructured materials have increasingly advanced electrochemical sensors due to their ability to enhance signal transduction. Reduced graphene oxide (rGO) is characterized by high conductivity and surface-to-volume ratio. Poly (3-aminophenylboronic acid) (P (3-APBA)) is a conducting polymer with boronic acid functional groups that provide molecular recognition. Here, the rGO/P (3-APBA) nanocomposite was fabricated through electropolymerization of 3-APBA in the presence of rGO. Infrared (IR), untraviolet vissible (Uv-Vis) and X-ray diffraction (XRD), and scanning electron microscopy (SEM) analyses were perfomed for structural elucidation and confirmed material structural features. The hybrid film potential to amplify electrochemical signal transduction for sensor appplications was assessed using cyclic voltammetry (CV), differential pulse voltammetry (DPV) and electrochemical impedeance spectroscopy (EIS). The rGO/P (3-APBA) nanoconposite exhibited high current responses, good signal stability, reversibility and low resistance to charge transfer (Rct) compared to rGO and P (3-APBA) alone. The rGO/P (3-APBA) hybrid nanoarchitecture, therefore, can synergistically boost electrochemical performance.

Keywords: 3-aminophenylboronic acid, electrochemical sensor, reduced graphene oxide

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Mr Malefetsane Khesuoe

Mr. Malefetsane Khesuoe is a PhD candidate in Chemistry at the Cape Peninsula University of Technology and serves as a Senior Laboratory Analyst at the Department of Agricultural Research in Lesotho. He holds a Master's degree in Chemistry from the same institution. His research interests lie in analytical and electroanalytical chemistry, with a particular focus on the development of electrochemical sensors through nanotechnology and polymer chemistry.

Mr. Khesuoe has contributed to publications in nanomaterials and their applications in electrochemical sensing, and soil spectroscopy, and has co-authored a book chapter in this domain. He was awarded Best PhD Poster Presentation at the NanoAfrica Conference in 2024, recognizing his innovative work in the field.

Driven by a commitment to agricultural sustainability and public health, his work aims to develop tools for plant health monitoring, environmental and food safety.

O-EL-02

Morphology-Controlled Synthesis of Gallium Oxide Nanostructures for Enhanced Photocatalytic Hydrogen Production

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Abstract

Gallium oxide (Ga_2O_3) nanomaterials are gaining attention due to their exceptional physical properties, including a wide bandgap, high specific surface area, and enhanced reactivity, making them suitable for a variety of applications across different fields such as photocatalysis, gas sensing, and biomedicine [1, 2]. However, while Ga_2O_3 nanomaterials possess suitable bandgap positions for water splitting, their photocatalytic efficiency is limited by poor visible light absorption [3]. This study reports on the synthesis of Ga_2O_3 nanomaterials with various controlled morphologies and structures to enhance their photocatalytic hydrogen production using the hydrothermal method. The structural, optical, and surface properties of the prepared Ga_2O_3 photocatalysts were characterized using XRD, SEM, BET surface area analysis, and UV-Vis spectroscopy. The Ga_2O_3 with tailored morphology were used as catalyst for photocatalytic hydrogen production. The morphology-dependent Ga_2O_3 exhibited improved photocatalytic efficiency and higher hydrogen evolution rates as a result of enhanced surface area and improved charge carrier separation.

Key words: Gallium oxide, photocatalytic efficiency, hydrogen production

Theme: Smart materials in Electronics

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Tabitha Penina Alango

Tabitha Penina Alango is a PhD student in Physics at the University of South Africa, specializing in photocatalytic materials for hydrogen production using plasmonic silver nanoparticles. She holds an MSc in Physics from Maasai Mara University with research experience in silver nanoparticles for water treatment applications. Her current work focuses on morphology-controlled synthesis of gallium oxide photocatalysts and their characterization for enhanced hydrogen evolution. Beyond academia, Tabitha is also passionate about mentoring of young girls, in a bid to encourage more girls to pursue STEM career paths.

O-EL-03

Engineering Surface Properties of Semiconducting Metal Oxides for Enhanced Chemiresistive Gas Sensing

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Abstract:

The growing demand for reliable monitoring of toxic and hazardous gases has accelerated the development and deployment of advanced gas sensing devices across clinical, environmental, and industrial sectors. Semiconducting metal oxides, owing to their unique surface-mediated properties, have emerged as materials of choice for chemiresistive gas sensors due to their rapid response, robustness, and cost-effectiveness. However, limitations such as poor selectivity and high-power consumption, resulting from elevated operating temperatures, restrict their broader application.This research focuses on the rational design and surface engineering of metal-oxide nanomaterials, emphasizing modifications such as doping, partial substitution , and surface sensitization to tailor their catalytic activity and fundamental surface properties. Detailed investigations into the relationship between gas sensing performance and the structural, morphological, magnetic, optical, and chemical attributes of these metal oxides are presented. The enhanced capability to detect target gases including methane, ethanol, ethylene, and benzene under specific environmental conditions demonstrates the crucial role of surface science in optimizing sensor functionality. For example, the addition of cobalt to tin oxide significantly improved gas sensing performance toward ethanol, with the doping level playing a key role in optimizing material characteristics for enhanced sensing. **Figure 1** illustrates the response to ethanol as a function of Co-doping level, showing that 0.5 wt% is the optimal doping concentration for SnO_2, where the sensor response reaches its maximum. These findings highlight the significance of material innovation in advancing the next generation of selective, sensitive, and low-power chemiresistive gas sensors for a wide range of smart sensing applications.

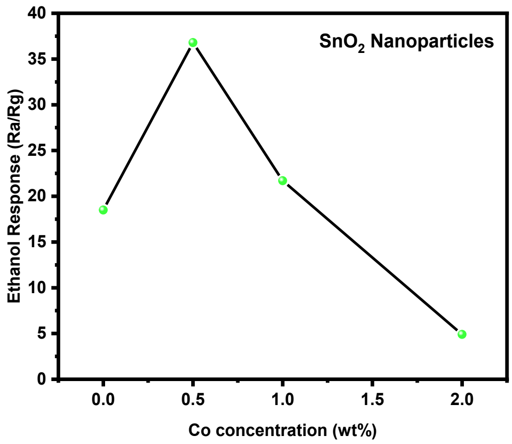

Figure 1: Response to ethanol as a function of Co-doping level, showing that 0.5 wt% is the optimal doping concentration for SnO_2, where the sensor response reaches its maximum.

Keywords: Semiconducting metal-oxides, Chemiresistive gas sensors, Surface engineering, Nanomaterials, Gas sensing performance, Doping and surface modification.

Dr Katekani Shingange

Dr. Katekani Shingange is a researcher at the Materials Physics Research Institute (MPRI) in the School of Physics, University of the Witwatersrand, South Africa. She specializes in the surface science of optoelectronic semiconducting metal oxides, with a focus on advancing gas sensing technologies for the selective detection of gas molecules. Her contributions to the field include over 25 peer-reviewed journal articles, 3 conference proceedings, 5 book chapters, and more than 24 presentations at national and international conferences. Her work is recognized by an h-index of 15. A dedicated lecturer, Dr. Shingange supervises Honours, Master's, and PhD students, actively mentoring the next generation of physicists. She serves as Chairperson of Women in Physics in South Africa (WiPiSA), where she advocates for gender equity and empowerment in STEM. Her accolades include the South African Women in Science Award, the CSIR Doctoral Excellence Award, the Inspiring50 in STEM Award, and recognition as one of the Mail & Guardian's 200 Young South Africans under 35 in Technology and Innovation. In 2019, she participated as a young scientist at the Lindau Nobel Laureates Meeting. In 2024, she was a finalist for both the TransUnion Rising Stars Award and the NSTF Khambule Emerging Researchers Award. Through her research, mentorship, and advocacy, Dr. Shingange has emerged as a respected leader, championing collaboration, excellence, and empowerment for aspiring scientists.

O-EL-04

Anisotropic Percolation Thresholds in Assemblies of Rectangles: Toward Smarter Conductive Materials

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Abstract

Percolation governs the formation of system-spanning networks critical for charge transport in functional composites. In this work, we present a smart modeling framework integrating analytical theory with Monte Carlo simulations to evaluate the percolation behavior of two-dimensional assemblies of fully penetrable, anisotropic rectangles. By proposing a corrected expression for the average excluded area, we address longstanding inaccuracies in classical models and predict critical area fractions and bond numbers as functions of aspect ratio and orientation anisotropy. These parameters are then applied to estimate electrical conductivity using a power-law relation, successfully matching simulation and experimental data. Our findings establish geometry-driven design rules that link particle shape and alignment with transport efficiency, offering a predictive pathway for engineering high-performance, sustainable conductive materials. This approach supports the rational development of next-generation smart composites optimized for electronic, sensing, and circular material applications.

Keywords: Percolation, excluded area, Monte Carlo simulations

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Danvendra Singh

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Comparative analysis of nanometric cutting of single-crystal and polycrystalline silicon: a molecular dynamics study

A molecular dynamics (MD) simulation is performed to compare the nanometric cutting behaviours of single-crystal silicon (sc-Si) and polycrystalline silicon (p-Si) using a diamond tool with a 0° rake and 10° clearance angles. The Tersoff potential models atomic interactions. Distinction mechanisms are observed due to grain boundaries (GBs) in p-Si, which increase dislocation density, cause amorphisation, and elevate friction. The sc-Si shows continuous chip formation and smooth plastic flow, whereas p-Si produces serrated chips, indicating a mix of ductile and brittle deformation. The sc-Si exhibits minimal dislocations with phase transformation, whereas p-Si displays multiple dislocation types and higher transformation rates, especially near GBs. Despite similar cutting forces, p-Si experiences higher friction and temperatures, suggesting greater tool wear and reduced surface quality. Interestingly, p-Si shows lower subsurface damage (SSD) because GBs hinder dislocation propagation. These findings provide insight into deformation mechanisms and suggest that a 0° rake angle is more suitable for nanometric cutting of single-crystal silicon than for polycrystalline silicon.

Keywords: molecular dynamics, dislocation, ultraprecision machining, brittle material, silicon

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Cubic Garnet $Li_7La_3Zr_2O_{12}$ (LLZO): Structural Insights and Electrochemical Performance for Solid-State Lithium-Ion Batteries

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Abstract

All-solid-state batteries (ASSBs) are emerging as next-generation energy storage systems, largely due to advancements in solid-state electrolytes (SSEs) [1,2]. Among these, cubic garnet-type $Li_7La_3Zr_2O_{12}$ (c-LLZO) stands out for its high lithium-ion conductivity (>1 S/cm), wide electrochemical stability window (>5 V), and robust stability against lithium metal, making it a strong candidate for safe, high-performance batteries [3,4]. However, challenges such as phase instability and poor electrode–electrolyte interfaces hinder its practical application. This study investigates co-doped LLZO with Ga, Y, and F, synthesized via a solid-state reaction method [5]. Structural and phase characteristics were analysed using X-ray diffraction (XRD), while microstructural morphology was examined by scanning electron microscopy (SEM). Electrochemical impedance spectroscopy (EIS) was employed to evaluate ionic conductivity and interfacial behaviour. The co-doped LLZO exhibits improved cubic phase stability and enhanced lithium-ion transport, offering valuable insights for developing safer, more efficient, and durable all-solid-state lithium batteries.

Keywords: Solid-state lithium-ion batteries (LIBs), Cubic garnet-type $Li_7La_3Zr_2O_{12}$ (LLZO), Phase instability, lithium-ion mobility

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Kaleab Habtamu

I am Kaleab Habtamu, a master's student at the University of South Africa (UNISA), specializing in solid-state batteries for lithium-metal applications. My research focuses on garnet-type solid electrolytes, particularly Li7La3Zr2O12 (LLZO), with an emphasis on improving ionic conductivity, phase stability, and interfacial compatibility. I apply advanced techniques such as electrochemical impedance spectroscopy (EIS), X-ray diffraction (XRD), and scanning electron microscopy (SEM) to understand material performance and address key challenges in next-generation energy storage systems. My long-term goal is to contribute to the development of safer, high-performance all-solid-state batteries for electric vehicles and renewable energy integration.

Biomass-Derived Hard Carbon as Sustainable Solution for Sodium-Ion Batteries Enhancement

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Keywords: Hard carbon, Anode, Initial Coulombic Efficiency, Biomass, Sodium-ion batteries.

Sodium-ion batteries have emerged as a promising next-generation energy storage solution, especially for medium to large-scale applications, due to their abundant sodium resources and environmental benefits [1]. The development of high-performance anode materials is key to advancing to commercialization [2]. Hard carbon (HC) has emerged as a promising alternative due to its disordered structure, and low redox potential [3].Herein, biomass-derived HCs are investigated at different preparation temperatures through chemical etching to explore the effects on the unique disordered microstructure characterized by graphitic and amorphous regions. The HCl pre-treatment of hazelnut shells showed a successful removal of biomass impurities, resulting in large interlayer spacing (0.383 nm), which directly translated into HC treated at 1400 °C with a high reversible capacity of 300 mA h g^{-1} and high ICE of 88% attributed to enhanced sodium-ion intercalation [4,5]. The electrode after 100 cycles exhibited excellent cycling stability with 91% capacity retention.

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Leonard Mamba

My name is Leonard Mamba. I hold a BSc in Chemistry and Biochemistry and a BSc (Hons) in Chemistry from the University of Venda, and I am a member of the South African Chemical Institute (SACI). Currently a master's candidate at the University of South Africa (UNISA-Florida Science campus), where I am conducting my research under the auspices of the Institute for Catalysis and Energy Storage (ICES), under the supervision of Professor Nithyadharseni Palaniyandy, Head of the energy group. My work focuses on the synthesis, optimization, and characterization of novel smart materials for next-generation energy storage. My current work focuses on advancing anode materials for sodium-ion batteries, intending to enhance their electrochemical performance.

Development of Advanced Nanocomposite Electrode Materials for High Performance Supercapacitors

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ABSTRACT

Recent advances in electrode materials for supercapacitors are vital for improving energy storage. Notably, supercapacitors excel in delivering power density, though they often fall short in energy density, and comparatively, they have lower energy density than batteries. This work focuses on synthesizing simple polyaniline-based ternary nanocomposite materials to enhance the energy density of supercapacitors. The composite material are PANI/SnO_2/RGO and PANI/WO_3/MXene(PWMx) hybrid nanocomposites. PANI/SnO_2/RGO was produced via a straightforward chemical oxidation polymerization technique, incorporating tin oxide nanoparticles onto reduced graphene sheets. The PANI/WO_3/MXene nanocomposite was prepared using a two-step method, involving ultrasonic treatment followed by chemical oxidation polymerization, which integrates WO_3 nanoparticles and conductive MXene in the PANI Matrix. The structural and morphological properties of the synthesized electrode materials were examined using physical and electrochemical characterization techniques and analyzed. Overall, the PWMx composite material exhibited superior performance, with a specific capacitance of 741 F/g and an energy density of 38 Wh/kg at a current density of 1 A/g, demonstrating excellent cycle stability and indicating practical potential in solid-state supercapacitors.

Key words: PANI based composite, energy density, supercapacitor

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ZnO Nanosheets as High-Capacity, Stable Anodes for Lithium-Ion Batteries: A Density Functional Theory Investigation

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Lithium-ion batteries (LIBs) require high-capacity, stable anodes to meet the growing demand for efficient and sustainable energy storage. Zinc oxide (ZnO) nanosheets, with a theoretical capacity of ~987 mAh/g, offer significant advantages over graphite but face challenges such as volume expansion, low conductivity, and unstable lithium adsorption. Using first-principles density functional theory (DFT), we investigated lithium adsorption, electronic properties, and ion transport in ZnO nanosheets. Adsorption at Zn, O, and hexagonal sites was compared, with the hexagonal site exhibiting the greatest stability, minimal lattice distortion, and enhanced charge transport. Density of states analysis revealed that single Li adsorption induces metallic behavior, while further lithiation reopens the bandgap, enabling tunable conductivity. Nudged elastic band (NEB) calculations identified the 2Li–4Li range as optimal for balancing energy density and diffusion efficiency. Open-circuit voltage (OCV) results confirm ZnO nanosheets as promising LIB anodes, offering high capacity, stable diffusion pathways, and suitability for next-generation energy storage systems.

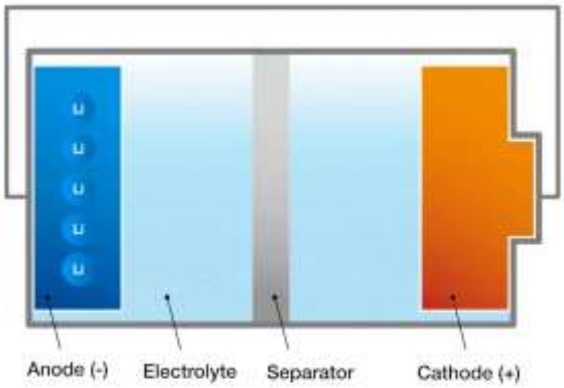

Figure 1: Working of Li-Ion Battery

Keywords: Li-ion battery, Density functional Theory, ZnO Nanosheets, Nudged elastic band

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He is a lifetime member of the Nanotechnology World Association, the Indian Association of Physics Teachers (IAPT), and the Society for Materials Chemistry (SMC), as well as an active member of the Centre for Advanced Computational Research, New Delhi. He has published four research articles in peer-reviewed journals. His work has been recognized with the Young Scientist Award and the ACS Best Poster Award at international conferences.

Advances in Thermoelectric Materials: From Materials Design to Manufacturable Thin-Film Devices

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Abstract:

Thermoelectric (TE) materials are poised to move from laboratory curiosities to practical platforms for waste-heat harvesting and solid-state cooling. Recent progress spans band and defect engineering to tune carrier concentration and mobility, microstructural control to scatter heat-carrying phonons without penalizing charge transport, and scalable thin-film routes compatible with microelectronics. Across classical compounds (Bi_2Te_3 near room temperature) and emerging families (half-Heuslers, skutterudites, Zintl phases, and oxide/chalcogenide heterostructures), the field is converging on a process-informed paradigm: the right electronic structure is necessary, but the pathway to it, textures, grain connectivity, stoichiometry, and interfaces set by fabrication, ultimately governs device performance and reliability.

In this talk, I present our contribution within that paradigm: a simple, industry-friendly workflow to translate processing choices into predictable TE outcomes for Bi_2Te_3 thin films. Using DC sputtering as a model platform, we map how deposition conditions steer stoichiometry, preferred orientation, and porosity, and in turn balance Seebeck coefficient, electrical conductivity, and thermal transport. The result is a practical window for producing dense, textured, device-ready films without exotic post-treatments, offering clear design rules that generalize to doped and multilayer stacks.

I will close with perspectives on integrating TE films into microsystems, adapting the same process–structure–property logic to flexible substrates and interfaces, and coupling it with targeted doping and interface engineering to accelerate reliable, scalable thermoelectric modules.

Dr Mahmood Akbari

Dr. Mahmood Akbari is a Senior Postdoctoral Research Fellow at the UNESCO–UNISA–iThemba LABS/NRF Africa Chair in Nanoscience & Nanotechnology (South Africa), where he integrates DFT/MD modeling with thin-film and laser-assisted synthesis to engineer nanomaterials for energy, biomedicine, and electronics. His current focus spans thermoelectric materials, nanofluids, and nano-bio interfaces. He holds a PhD in Physics from the University of South Africa (2022) and an MSc in Electrical Engineering from the University of Cape Town (2018) and actively mentors graduate researchers within international collaborations.

O-EN-07

Hydrothermal Liquefaction of Agricultural Biomass and Sewage Sludge for Biofuel Production: A Review

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ABSTRACT

The urgent need for sustainable energy sources and a reduction in greenhouse gas emissions has led to the emergence of alternative bioresources, especially biomass, as a key contributor to the future energy landscape. Hydrothermal liquefaction has become prominent as a transformative thermochemical process capable of converting wet biomass into biocrude. This review offers a comprehensive assessment of HTL processes, emphasizing the influence of key operating parameters, including temperature, pressure, catalyst, and residence time, on biocrude yield and quality. Additionally, feedstocks and co−liquefaction of different biomass feedstocks are discussed in detail. The review also highlights some challenges facing HTL, such as high-moisture feedstocks, material corrosion, and efficient upgrading of crude products. To improve the efficiency, sustainability, and scalability of HTL, research should focus on optimizing process parameters, enhancing reactor designs, and developing innovative catalysts. The review underscores the vital role of HTL in promoting the circular economy and accelerating the shift toward environmentally responsible, waste-to-energy systems.

Keywords: hydrothermal liquefaction; biomass conversion; biofuel production; renewable energy; operating parameters.

Victor Fatokun

Victor Fatokun is a doctoral student of Chemical Engineering at Durban University of Technology, Durban, South Africa. His research focuses on waste-energy nexus; renewable energy and computational modelling, and process optimisation. Victor is currently working on production of biocrude from renewable biomass using hydrothermal liquefaction process.

O-EN-08

Synergistic Effects in Catalytic Co-Pyrolysis of Biomass and Plastic Waste Using Metal-Doped ZSM-5 Catalysts for Enhanced Bio-Oil Production: A Review

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Abstract:

Catalytic co-pyrolysis of biomass and plastic waste offers a sustainable approach for converting heterogeneous waste streams into valuable products such as bio-oil, syngas, and a platform of chemicals. This review explores synergistic interactions, particularly hydrogen transfer from hydrogen-rich plastics to oxygenated biomass intermediates, which enhances deoxygenation and aromatisation. Metal-doped ZSM-5 catalysts, particularly those modified with Ni, Cu, and Fe, have been found to play a crucial role in steering product selectivity by facilitating bond cleavage, hydrogen transfer, and catalytic upgrading reactions. Likewise, key operational parameters such as temperature, heating rate, feedstock mixing ratios, and catalyst loading significantly influence the product yields and quality. Analytical techniques such as Gas chromatography-mass spectrometry (GC-MS), Thermogravimetric analysis (TGA), Fourier-transform infrared spectroscopy (FTIR) and Scanning electron microscopy and energy dispersive X-ray spectroscopy (SEM/EDS) provide comprehensive characterisation of products and catalysts, offering mechanistic insights. Furthermore, advanced experimental design tools, like Design Expert Software, employing response surface methodology and factorial designs, enable optimisation pathways of the reactions and understanding of their synergistic effect. Challenges such as catalyst deactivation through coking and sintering, feedstock variability, and scale-up complexities remain critical areas for future research. Standardising synergy metrics and optimising the co-pyrolysis process is essential for consistency and industrial transition. Above all, catalytic co-pyrolysis has the potential to contribute to sustainable waste management and renewable fuel production by upgrading mixed biomass plastic into bio-oils with enhanced energy content and reduced oxygenates.

Keywords: Co-Pyrolysis, Biomass, Plastic Waste, Metal-Doped ZSM-5 Catalysts, Synergy.

Catalytic pyrolysis of torrefied MSW using locally sourced iron improves bio-oil yield and energy efficiency: Advancing South African renewable energy security

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Abstract

South Africa faces rising environmental and energy challenges from increasing municipal waste and dependence on fossil fuels. Waste-to-energy technologies offer a solution. Torrefaction enhances MSW as a fuel, but conventional pyrolysis produces low-quality bio-oil. Iron-based catalysts offer an affordable, sustainable improvement in catalytic pyrolysis, with higher-quality bio-oil production. This study investigates catalytic pyrolysis of torrefied MSW at 450–550 °C (1 atm) using Fe_2O_3. The torrefied feedstock contained 38.76% volatile matter and 65% carbon, producing 55.3 wt.% bio-oil. The chemical structures of torrefied MSW resemble those of typical biomass. GC-MS analysis revealed hydrocyclic, phenolic, nitrogen- and oxygen-containing compounds. Compared to non-catalytic pyrolysis, Fe_2O_3 reduced the carbon content of the bio-oil to 52.53 wt.% and increased the yield to 68.5 wt.%. The higher heating value (HHV) of the catalytic bio-oil increased from 24.8 to 32.5 MJ kg^{-1}, demonstrating a significant improvement in fuel quality and energy recovery.

Keywords: MSW, Catalytic iron, Renewable Energy, Pyrolysis, Energy Security

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Ahmed Mohammed Inuwa is a Doctor of Engineering researcher in the Department of Chemical Engineering/Faculty of Engineering & the Built Environment, Durban University of Technology, South Africa, specializing in renewable energy, waste-to-energy conversion, circular economy and sustainable catalysis. His current research focuses on catalytic pyrolysis of torrefied municipal solid waste (MSW) using locally derived iron-based catalysts to enhance bio-oil yield, improve product quality, and support South Africa’s renewable energy security. He has a strong academic background in chemical engineering, thermodynamics, process control, process design and optimization, computational chemical engineering, process modelling and simulation, and environmental engineering, with experience in process design and simulations, experimental thermochemical conversion processes, and energy system evaluation. His work contributes to advancing cost-effective, environmentally sustainable technologies for energy transition in developing economies.

Green synthesis of undoped and metallic-doped cerium oxide nanoparticles using waste pineapple leaves as an electron extraction layer in perovskite solar cells

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Keywords: Green synthesis, nanoparticles, pineapple leaves, perovskite solar cells

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This research initiative is part of the biomass and nanotechnology project at Nelson Mandela University, which focuses on transforming agricultural waste into a value-added product for use in perovskite solar cells [1]. In this study, metallic doping with Sn, Cu, Zn, is employed to improve the efficiency of the cerium oxide nanoparticles in facilitating electron extraction layer within perovskite solar cells. Perovskite solar cells present a promising photovoltaic technology due to their high efficiency and low manufacturing costs. Their stability poses a significant challenge for commercialization [2]. The objective of this study is to synthesize cerium oxide nanoparticles through a green method and enhance the stability of the electron extraction layer. The synthesized nanoparticles were characterized using various techniques. All analyses demonstrated the successful synthesis of both undoped and metallic-doped cerium oxide nanoparticles and the results indicated an improvement in the stability of perovskite solar cells prototype.

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Structural and Optical Characterization of TiO_2 and $MAPbI_3$ Thin Films for Integration in Perovskite Solar Cells

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Perovskite solar cells (PSCs) have gained significant interest due to their high efficiency and low-temperature, solution-based fabrication. This study reports the synthesis, fabrication, and characterization of glass/FTO/TiO_2/$MAPbI_3$ thin films for PSC applications. TiO_2 nanopowders were synthesized via a sol–gel method and annealed at 450 °C, producing anatase-phase nanocrystals. TiO_2 and $MAPbI_3$ layers were deposited by sequential spin coating. Structural and optical properties of the TiO_2 and $MAPbI_3$ films were characterized using X-ray diffraction (XRD), ultraviolet–visible (UV–Vis) spectroscopy, and Rutherford Backscattering Spectrometry (RBS). XRD confirmed high crystallinity and phase purity, UV–Vis revealed bandgaps narrowing from 3.54 to 3.22 eV for TiO_2 and a bandgap of 1.61 eV for $MAPbI_3$, while RBS provided elemental composition and layer thickness measurements. The findings establish critical processing–structure–property parameters for PSC layers, laying a foundation for optimizing PSC device architectures.

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Mr. Dakalo Mashamba is a PhD candidate in the Department of Physics at Tshwane University of Technology (TUT), within the Photovoltaic Nanocomposites Group. His interdisciplinary research combines numerical simulation, machine learning, synthesis, and fabrication of perovskite solar cells (PSCs). He focuses on developing and optimizing perovskite absorber layers and charge transport materials. His work advances the design and integration of PSC technologies by bridging simulation-driven machine learning predictions with experimental validation.

Compression-Induced Piezoresistive Behaviour in PEMFCs: Towards Smart Gas Diffusion Layers

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Abstract

Proton Exchange Membrane Fuel Cells (PEMFCs) are a pivotal technology for sustainable energy conversion, where gas diffusion layers (GDLs) play a critical role in governing electrochemical performance. Woven GDLs, fabricated from carbon-based fabrics, perform multiple essential functions, including facilitating gas transport, providing electron conduction pathways, and offering mechanical support. Beyond these conventional roles, they exhibit compression-induced piezoresistive behaviour, positioning them as multifunctional smart materials within PEMFC assemblies. During operation, GDLs typically experience 40–60% compressive strain, which enhances fibre–fibre contacts and reduces electrical resistance, but simultaneously decreases porosity and gas permeability. Managing this trade-off is vital to ensure efficient reactant diffusion without compromising electronic transport.

In this study, we investigate the piezoresistive response of woven carbon GDLs under compression, employing X-ray micro-computed tomography (microCT) to capture their three-dimensional microstructural evolution. A multiscale analytical model is developed, based on the work of Chen et al.[1], treating yarns as fibre bundles and individual fibres as cantilever beams, to predict resistance variations arising from changes in fibre volume fraction and inter-yarn contact. Model predictions are validated against measurements from commercial woven GDL samples, showing excellent agreement between simulated and experimental resistance–compression behaviour. The findings highlight that woven GDLs are not merely passive structural elements but also active electromechanical smart materials. By harnessing their compression-induced piezoresistive response, GDL architectures can be tailored to simultaneously enhance conductivity and mass transport, thereby improving the performance and durability of next-generation PEMFCs.

Keywords: *Fuel Cell, Gas Diffusion Layer, Piezoresistivity*

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Siddharth Shukla

Siddharth Shukla is a textile engineer based in New Delhi, India, and is currently pursuing his PhD at the Indian Institute of Technology (IIT) Delhi, where he also earned his Master of Technology degree. He is a recipient of the Prime Minister’s Fellowship for Doctoral Research, awarded in collaboration with Elofic Industries Limited. As part of his doctoral work, he has developed several new products for Elofic and filed three patents. His research has extensively explored the analysis of nonwoven structures using X-ray Micro-Computed Tomography, with findings published in various high-impact journals. At present, his work focuses on developing robust, scalable, and highly porous nonwoven metamaterials with tailored interfacial properties for applications in energy materials, filtration, and strain sensing.

O-EN-13

Unlocking the Potential of P2-Type Manganese Oxide Cathodes for High Performance Sodium-Ion Batteries

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Abstract

Sodium-ion batteries (SIBs) are emerging as sustainable and cost-effective alternatives to lithium-ion technology for large-scale energy storage and electric vehicles [1]. Their performance largely depends on cathode materials, with P2-type layered manganese oxides (P2-Na_xMnO_2) being attractive due to their high theoretical capacity, simple synthesis, and low cost [2], [3]. However, these oxides suffer from structural instability, voltage decay, and capacity fading during cycling, mainly caused by Jahn-Teller distortions and irreversible phase transitions [4], [5]. To overcome these limitations, strategies such as elemental doping, nano structuring, surface coating, and electrolyte optimization have been explored to stabilize the layered structure and enhance Na-ion transport. In this study, Fe- and Ti-doped P2-type sodium manganese oxides with metal oxide surface coatings were synthesized via solid-state reaction and characterized using X-ray diffraction, electron microscopy, and electrochemical techniques. The results demonstrate improved structural stability and cycling performance compared to pristine P2 oxides, offering valuable insights for next-generation sodium-ion cathodes.

Keywords: Sodium-ion batteries; P2-type layered manganese oxides; Transition-metal doping; Aluminium oxide (Al_2O_3) coating; Electrochemical performance

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Nahom Dawit

My name is Nahom Dawit, and I am currently pursuing my Master's degree in the Institute of Catalysis and Energy Storage (ICES) at the University of South Africa (UNISA). My research is titled "Development of P2-type Manganese-based Metal Oxides Cathode Materials for Sodium-ion Batteries." I am passionate about energy storage technologies and the role of smart materials in advancing sustainable and cost-effective solutions for future applications.

Performance optimization of $Na_3V_2(PO_4)_3$ (NVP) Cathode Materials for next generation Sodium-Ion Batteries

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Keywords: energy, sodium vanadium Phosphate cathode, electrochemical performance, Sodium-ion battery

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Abstract

Sodium-ion batteries (SIBs) are promising for large-scale grid storage and electric vehicle due to the abundance, wide distribution, and low cost of sodium resources[1],[2]. The electrochemical performance of SIBs strongly depends on the intrinsic properties of cathode materials. Among them, sodium vanadium phosphate ($Na_3V_2(PO_4)_3$) has gained attention due to its robust NASICON-type framework, offering stable sodium-ion insertion sites, excellent thermal and structural stability, a three-dimensional ion diffusion network, and a high theoretical energy density [3],[4]. However, its practical application is limited by low electronic conductivity, limiting capacity, especially at high rates. To address this, strategies such as carbon coating, particle downsizing, integration with carbon nanostructures, and elemental doping have been investigated [5].in this study, Cationic (Sn) and Anionic (F) doped NVP@carbon quantum dot (CQD) composite were synthesised via hydrothermal method and calcination.Characterizations confirmed single phase nanoparticles, and electrochemical analysis revealed improved stability and capacity retention compared to pristine NVP cathodes.

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Dibora Temesgen

I am Dibora Temesgen, a graduate of Chemical Engineering (B.Sc.) from Hawassa University, Ethiopia (2022) and a member of the South African Chemical Institute (SACI). I am currently pursuing my M.Sc. in Chemical Engineering at the University of South Africa (UNISA), Florida campus, under the supervision of Professor Nithyadharseni Palaniyandy, head of the Energy Research Group. My research focuses on the development and performance optimization of sodium-ion battery cathode materials, with the aim of advancing their commercialization for sustainable energy storage solutions.

O-MD-01

Computational modelling of aptamer-poly (lactic-co-glycolic acid) nanoparticles targeting mannosylated lipoarabinomannan on Mycobacterium tuberculosis

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Abstract

Tuberculosis is one of the leading causes of death from infectious diseases. *Mycobacterium tuberculosis* (*M. tb*) causes infectious TB(*Global Tuberculosis Report 2024*. 1st ed, 2024). Mannosylated Lipoarabinomannan (ManLAM) is a cell wall lipoglycan involved in immunomodulation and survival(Pan *et al.*, 2014). Aptamers have been shown to bind to and inhibit ManLAM function. Aptamers have also been used to functionalize nanoparticles, like poly (lactic-co-glycolic acid) PLGA, for targeted drug delivery systems(Hashemi *et al.*, 2020; Borah Slater *et al.*, 2023), but their application to ManLAM has not been explored. This study aims to investigate whether PLGA, when functionalized with aptamers, will bind to ManLAM of *M. tb* H37Rv using molecular docking and molecular dynamics simulations to present a multi-purpose model for the nanoparticle drug delivery system.

Keywords: ManLAM, Aptamers, PLGA NPs, modelling, molecular dynamics

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Harrison Abrahams

Msc Candidate in Nanoscience with research focus areas in tuberculosis, nanomedicine, bioinformatics and structural biology.

O-MD-02

Cytotoxicity of phytochemically functionalised silver nanoparticles against breast, prostate and colon cancer cell lines.

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The green synthesis of silver nanoparticles (Ag NPs) derived from plant extracts is gaining popularity due to its economical synthesis, biocompatible nature, and widespread biomedical applications [1,2]. Cancer is a major public health concern responsible for multiple mortalities worldwide, and current chemical treatments are toxic and prone to resistance [3]. The current study aims to synthesise Ag NPs using an aqueous extract of *Cannabis Sativa* and evaluate their cytotoxicity against Prostate (PC-3), breast (MDA-MB-231 and MCF-7), and colon (HCT-15) cancer cell lines using the 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide assay. The Ag NPs exhibited dose-dependent anticancer activity with IC_{50} values of 36.76, 13.91, 9.95, and 34.68 µg/mL for PC-3, MDA-MB-231, MCF-7, and HCT-15 cells, respectively. UV–Visible spectroscopy confirmed nanoparticle formation, while high-resolution transmission electron microscopy revealed predominantly spherical particles with an average diameter of 19.5 nm. Dynamic light scattering analysis indicated a zeta potential of −31.45 mV, suggesting good colloidal stability. Furthermore, qPCR analysis showed that treatment with the biosynthesised Ag NPs upregulated the expression of Caspase-3, Caspase-9, and TNF-α genes in HCT-15 cells, indicating the activation of apoptotic pathways. These findings demonstrate that C. sativa-derived AgNPs possess significant anticancer potential and may serve as promising candidates for future cancer therapeutics.

Keywords: Nanoparticles, Green synthesis, Cancer, Silver and Cytotoxicity

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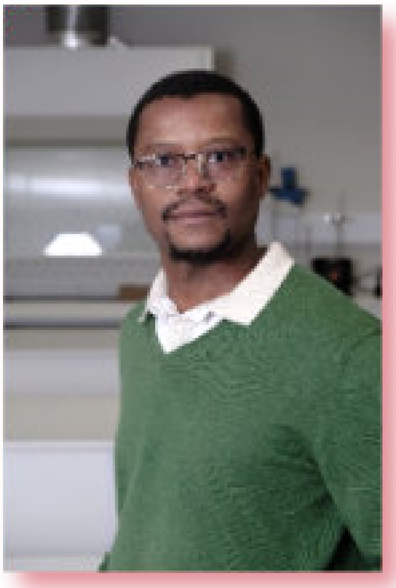
Dr Kulani Mhlongo



Dr. Kulani Mhlongo is a researcher of pharmacology at the University of the Free State, South Africa. His work focuses on the characterisation and mechanistic evaluation of phytochemicals from medicinal plants used in African traditional medicine, with a special emphasis on anti-cancer, anti-inflammatory, and anti-diabetic activities. He holds a PhD in Biotechnology from the University of the Western Cape. His current research investigates the mechanisms and application of nanoparticles as delivery vehicles for bioactive phytochemical compounds in various mammalian cell models, focusing on the treatment of cancer, inflammation, and diabetes.

Designing and Modelling of Transition Metal and Anion Co-Doped $ZnSnO_3$ for Improved DSSC photoanode

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Abstract

Advanced modelling techniques plays an important role in designing nanomaterials for improved solar energy application [1]. Zinc stannate ($ZnSnO_3$) is a promising photoanode material for dye-sensitized solar cells (DSSCs), but its ability to absorb visible light is limited [2]. In this study, we use first-principles density functional theory (DFT+U) to explore how adding transition metals (Cu, Ni, and Co) at zinc sites, along with co-doping non-metal elements like sulphur (S) and nitrogen (N), can improve the electronic and optical performance of $ZnSnO_3$ [3]. The results show that these dopants help narrow the bandgap and introduce energy states that make it easier for $ZnSnO_3$ to absorb sunlight. Optical analysis reveals a red shift in the absorption edge and increased absorption in the visible spectrum, particularly in Cu and S/N co-doped systems. This work demonstrates the potential of computational modelling in guiding the design of $ZnSnO_3$-based photoanodes for more efficient DSSC devices.

Key words: DFT+U, DSSC, Co-oping, $ZnSnO_3$, Band gap , Visible spectrum.

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Ms Letsoalo

Ms Letsoalo is a PhD candidate at the University of the Witwatersrand, where she is researching dye-sensitized solar cell (DSSC) applications. She is also a Physics lecturer at the University of Limpopo, editor assistant for SAIP PC magazine and an alumna of the 2024 Lindau Nobel Laureate Meeting in Physics. She holds an MSc in Physics with Cum Laude from the university of Venda, with expertise in gas sensing. Her current work combines experimental and computational approaches to design advanced electrode materials for solar energy conversion. A recipient of the prestigious 2023 DSI-Ndoni Mcunu Masters Fellowship (SAWiSA), Ms. Letsoalo is also a passionate science communicator and mentor, actively promoting women in physics across South Africa.

Magnetic modulation as a tool for unlocking reaction pathways of nickel nanoparticles

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Keywords: magnetism, nanoparticles, *in situ* catalysis, syngas

This study investigates the *magnetocatalytic effect* [1-2] in CO methanation over bulk nickel nanoparticles using UCT's patented *in situ* magnetometer.[3] Nickel's ferromagnetic-to-paramagnetic transition ($T_C \approx 358°C$) coincides with an increase in CO conversion and CH_4 formation. This suggests a magnetic ordering-dependent activation mechanism whereby the paramagnetic phase, characterized by higher surface symmetry and unrestricted magnetic moments, enhances CO adsorption and dissociation, the rate-limiting steps in CO methanation <350°C.[4] These findings highlight the potential of magnetic ordering as a property of smart materials to control reaction pathways, offering a new paradigm for catalyst design in energy conversion applications.

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Adli Peck is a Postdoctoral Researcher at the Catalysis Institute of Chemical Engineering at UCT, with a multidisciplinary background in Chemistry (SU), Solid-State Physics (UJ), and Chemical Engineering (UCT). His research focuses on advanced characterization using novel in situ and operando techniques including Mössbauer spectroscopy and magnetometry to advance sustainable catalysis and material science.

Nanostructured Membrane-Electrodes For Trace Toxic Metal Detection

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This work reports on the development of novel nanostructured membrane-electrodes for the sensitive electrochemical detection of mercury(II) ions in aqueous matrices. Nanoporous poly(vinylidene fluoride) membranes were fabricated by means of energetic ion irradiation and subsequent chemical etching of latent tracks. The objective of the present study was to achieve functionalization through radiation-induced graft polymerization to introduce mercury-specific binding ligands within porous structure. A study of grafting process is presented, including the chemical post-modification of the grafted polymers to enhance ligand density and metal ion pre-concentration efficiency. The resulting membrane-electrodes operate on a passive adsorption principle, enabling detection of trace mercury concentrations. The sensor design combines high sensitivity with important advantages, such as simplicity and portability, facilitating rapid *on site* water analysis without the need for complex instrumentation or sample pre-treatment.

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Key-words: Track-Etched Membranes, Radiation Grafting, Sensors, Toxic Metals

Dr Uliana Pinaeva

Dr. Uliana Pinaeva earned her Ph.D. in 2019 from École Polytechnique (France), specializing in Radiation and Polymer Chemistry, Physical Chemistry, and Electrochemistry. Her doctoral research led to the development of innovative electrochemical sensors using functionalized track-etched membranes for uranium detection in water. She continued her research as a post-doctoral fellow at the Reims Institute of Molecular Chemistry, exploring electron-beam effects on polymers and radiolytic synthesis of gold nanoparticles. Since 2022, Dr. Pinaeva has been working at the Flerov Laboratory of Nuclear Reactions (JINR, Dubna), advancing her work in radiation chemistry of polymers.

Preparation and Characterization of TiO_2-MWCNT Hybrid and TiO_2-Fe_2O_3-MWCNT Trihybrid Nanofluids

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Abstract

Advancements in science and technology have led to the development of miniaturized thermal devices that require efficient cooling solutions. Nanofluids have gained significant attention as promising alternatives to replace conventional heat transfer fluids [1, 2]. The purpose of this study was to prepare TiO_2-MWCNT hybrid and TiO_2-Fe_2O_3-MWCNT trihybrid nanofluids using deionized water. Nanoparticles were characterized using XRD, TEM, SAED, and EDS before dispersion. The XRD results showed that all nanoparticles had a hexagonal structure. TEM revealed that Fe_2O_3 appears as nanorods, MWCNT as tubular, and TiO_2 as spherical particles. SAED confirmed that the nanoparticles are polycrystalline in nature. EDS analysis revealed all primary elements of the nanoparticles, along with minor impurities. Then, the nanofluids were processed using the two-step method. Both classes of nanofluids were found to be stable after preparation. The thermophysical properties of nanofluids were measured. Among the nanofluids, trihybrid nanofluids exhibited enhanced thermal properties compared to hybrid nanofluids.

Keywords: Nanoparticles, Nanofluids, Hybrid nanofluids, Trihybrid nanofluids

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Mziwandile Sibiya

Mziwandile Sibiya is a master's candidate in the Department of Physics and Astronomy at the University of the Western Cape, currently doing research in nanofluids. He holds a BSc degree in Computer Science and Physics. He also completed a BSc Honours degree in Physics at the University of Zululand.

Two-Dimensional Metal–Organic Framework Superstructures Based on Transition Metals, Tryptophan, and Bipyridylethylene Supported on Track-etched Membrane

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Abstract

Metal-organic frameworks (MOFs) are versatile and promising materials for wastewater treatment, medicine and other applications. However, most experiments to explore the application potential of MOFs have been carried out using powders that may limit applications. To solve this problem, an approach to design composite membranes (CMs) based on track-etched membranes, electrospun nanofibers and homo- and heterometallic MOFs was proposed in the work. The M-MOF (M = Co, Ni, Cu, Ni/Co, Ni/Zn) superstructures based on L-tryptophan and 1,2-bis(4-pyridyl)ethylene were synthesized via low-temperature green synthesis. The adsorption-desorption properties of the M-MOFs powders and CMs towards model anionic methyl orange and cationic rhodamine B pollutants were studied. Additionally, antibacterial and antifungal activity including minimum inhibitory concentration against *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus* and *Candida albicans* was studied. The study demonstrates the synergy of novel approaches for designing advanced materials.

Nikita Drozhzhin

Nikita Drozhzhin is a young researcher specializing in expanding the application scope of track-etched membranes by combining their properties with promising metal-organic frameworks. These composite membranes are next-generation materials for sensing and removal of organic pollutants, metal ions or advanced wound healing.

Nikita Drozhzhin is currently a Ph D student in Dubna State University and an engineer at the Center of Applied Physics in the Joint Institute for Nuclear Research in Dubna, Russia. Additionally, he collaborates with colleagues at the Cape Peninsula University of Technology to design novel composites for atmospheric water harvesting.

Valorization of waste from green plantain species (three) for the development of biodegradable film

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Abstract

Plantain (*Musa* spp.), an important economic crop, generates substantial waste during processing (Mono et al., 2023). Valorization of this bio-waste supports the climate neutrality goals 2020 (EEA, 2023). This study assessed plantain waste for creating biodegradable green packaging. Starches (16.16–26.83%) extracted from green plantain species (*M. paradisiaca*, *M. orinoco*, and *M. balbisiana*) were formulated into bio-based films and analyzed for physicochemical, mechanical, and thermal properties (AOAC, 2020). SEM showed rough, uneven surfaces in *M. balbisiana* films. *M. paradisiaca* had the lowest lightness (43.96), light transmittance (31.63), and highest opacity (1.02). FTIR spectra indicated broad hydroxyl groups (399–4000 cm^{-1}), while moisture contents (14.10–15.49%) were similar ($p > 0.05$). Breaking forces were 152.17 N, 140.34 N, and 136.82 N, and tensile strengths were 11.46, 10.71, and 10.49 MPa for *M. balbisiana*, *M. orinoco*, and *M. paradisiaca*, respectively. *M. balbisiana* films demonstrated superior strength for packaging applications.

Keywords: Green plantain peels, sustainable films, functional attributes, thermal performance

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Monono, E. Y., Egbe, A. E., Monono, E. M., Levai, L. D. and Asiedu, E. (2023). Influences of organic waste and inorganic fertilizer for sustainable production of plantain (Musa spp. AAB) in a humid forest zone of Cameroon. *African Journal of Agricultural Research*, *19*(7), 727-742.

A. I. Lawal

A. I. Lawal, lecturer at Abiola Ajimobi Technical University, Ibadan, Nigeria, researches food science, bio-waste valorization, and underutilized crops of sub-Saharan Africa. His work spans edible insects, functional foods, and starch-based bioplastics, promoting nutrition, sustainability, and food security. He is passionate about teaching, mentoring, and advancing eco-friendly food solutions.

O-SM-09

A humidity-resistant and room temperature carbon soot@ZIF-67 composite sensor for acetone vapour detection

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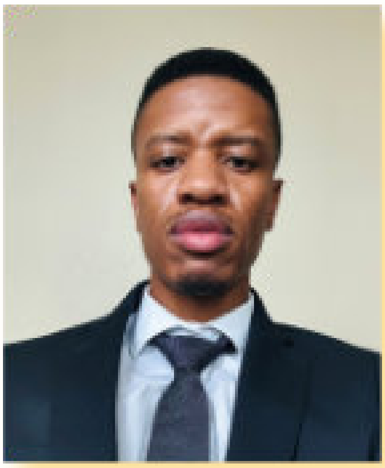
ABSTRACT

Zeolitic imidazolate framework-67 (ZIF-67), carbon nanoparticles (CNPs), and the CNPs@ZIF-67 composite were prepared and used to fabricate sensors for the detection of acetone vapour. The prepared materials were characterized using transmission electron microscopy, powder X-ray diffraction, X-ray photoelectron spectroscopy, Raman spectroscopy and Fourier-transform infrared spectroscopy. The sensors were tested using an LCR meter under the resistance parameter. It was found that the ZIF-67 sensor did not respond at room temperature, the CNP sensor had a non-linear response to all analytes, and the CNPs/ZIF-67 sensor had an excellent linear response to acetone vapour and was less sensitive to 3-pentanone, 4-methyl-1-hexene, toluene and cyclohexane vapours. However, it was found that ZIF-67 improves carbon soot sensor sensitivity by 155 times, wherein the sensitivity of the carbon soot sensor and carbon soot@ZIF-67 sensor on acetone vapour was found to be 0.0004 and 0.062 respectively. In addition, the sensor was found to be insensitive to humidity and the limit of detection was 484 ppb at room temperature.

Dr Lesego Malepe



Dr Lesego Malepe is an academic and researcher at the University of Johannesburg, based in the Department of Chemical Sciences at the Doornfontein campus. His primarily research focuses on advanced materials and sensor technologies—specifically composites such as carbon materials and zeolitic imidazolate frameworks (ZIFs) for volatile organic compound (VOC) detection at room temperature and in humid environments. His secondary research focus on electrochemistry wherein he utilises nanostructured materials for supercapacitor applications. He has published his research findings in various high-impact factor internationally peer-reviewed journals in the form of articles and currently supervising postgraduate students.

Ag-imprinted magnetic carboxylated cellulose nanocrystals-PEI crosslinked adsorbent for efficient adsorptive removal and recovery of Ag from e-waste leachate.

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Amanda Thobeka Ngema

Urban mining of precious metals from electronic waste is currently ineffective due to complex extraction, health risks, and environmental concerns [1,2]. However, recycling and recovery of valuable metals, like silver, offers a promising way to mitigate supply risks [3]. Herein, we describe a novel, environmentally friendly adsorbent based on ion-imprinted polymers on the surface of magnetic carboxylated cellulose nanocrystals functionalized with polyethlenimine, (MCCNs-PEI-IIPs) for highly selective adsorptive removal and efficient recovery of silver from e-waste. The optimum conditions obtained were pH value: 6, contact time: 60 min, extraction temperature: 55 ˚C, initial concentration: 25 mg/L, and adsorbent mass: 20 mg. The adsorption method showed good precision and accuracy for Ag ions. Selectivity of MCCNs-PEI-(Ag)IP for Ag ions was evaluated in synthetic solution with various metal ions. The distribution coefficient was calculated to represent the affinity of the adsorbent for different metal ions. The MCCNs-PEI-(Ag) IP exhibited a high selectivity towards silver (I), with a value of 0,9099, which was higher than other metal ions.

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Amanda Thobeka Ngema

I am a postgraduate researcher and seasonal laboratory assistant at the University of South Africa. I also worked as a laboratory technician at Tronox KZNSands where I gained experience with mineral processing. I have a strong foundation in analytical and materials chemistry, my work focuses on the development of advanced functional materials for environmental sustainability particularly in the fields of waste management and metal recovery from secondary resources (urban mining).

My current research focuses on the design and application of ion-imprinted magnetic adsorbents for the selective recovery of gold from electronic waste streams. My latest innovation combines green chemistry with strategic material functionalization to achieve high adsorption capacity, selectivity, and recyclability. This work reflects my commitment to addressing the pressing challenges of e-waste management through scalable, eco-conscious technologies. As a member of the Golden Key International Honour Society, I have demonstrated academic excellence and a deep commitment to scientific advancement. I have guided undergraduate students in practical chemistry modules, ensuring both experimental rigor and conceptual clarity in laboratory settings.

I am currently working towards publishing my findings in high impact journals and actively involved in securing collaborative opportunities and funding mechanisms to scale up my research outcomes. My participation in the Smart Material Conference 2025 will be a significant milestone for sharing my findings with the scientific community and promoting dialogue about sustainable metal sourcing with this innovative material.

Polarized Neutron Reflectometry For Investigation of Low-Dimensional 2d Magnetic & Superconducting Periodic and Quasiperiodic Heterostructures

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Low-dimensional magnetic and superconducting heterostructures exhibit a rich array of phenomena stemming from the interplay of competing order parameters. While numerous studies exist on periodic superconducting(S)/ferromagnetic(F) systems, the investigation of quasiperiodic arrangements presents a significant frontier. Previous work utilizing polarized neutron reflectometry (PNR) has successfully characterized proximity effects in simpler systems [1-3]. This research expands upon these efforts by focusing on more complex layered architectures and investigating the emergence of novel properties in quasiperiodic structures. Polarized neutron reflectometry measurements were performed using the REMUR reflectometer at the IBR-2 reactor in Dubna. The technique provides depth-resolved information on both nuclear and magnetic scattering lengths, enabling the determination of isotopic and magnetic depth profiles. Samples were prepared using various thin film deposition techniques. Data analysis involved modeling the reflectivity profiles using appropriate scattering length density profiles. These investigations are actual for superconducting spintronics and quantum computing.

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Vladimir Zhaketov

WORK EXPERIENCE:

Frank Laboratory of Neutron Physics, JINR (Dubna)

2014-2017 - engineer

2018-2020 - junior research fellow

2021 and up to the present - research fellow since September 2023 - part-time research fellow

MIPT - Moscow Institute of Physics and Technology (Dolgoprudny), Laboratory of Superconducting Nanoelectronics

09.2023÷09.2025 - postdoc as senior research fellow

Research interests: nuclear physics methods of analysis, neutron and synchrotron scattering, complementary methods, superconductivity, magnetism, strongly correlated phenomena, nanostructures, quantum and nuclear technologies, nanoenergy.

Web page: https://colab.ws/researchers/R-386DA-0B7B8-FE31E

O-SM-12

3D Schottky contacts fabricated on ion track etched membranes: structural and electrical properties

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This study presents the fabrication and characterization of three-dimensional (3D) Schottky contacts on ion track-etched polyethylene (PET) membranes. By employing heavy ion irradiation followed by chemical etching, well-defined nanoporous PET membranes with uniform pore structures were developed. Gold contacts were deposited onto these PET membranes, enabling the electrodeposition of Polyaniline (PANI) within the pores to form nanorods, which establish Schottky junctions and create 3D contact architectures. Scanning electron microscopy confirmed the consistent pore morphology and successful PANI growth inside the nanopores. Electrical characterization through current-voltage (I-V) measurements revealed pronounced rectifying behaviour, indicating effective Schottky barrier formation. This work highlights the potential of integrating ion track technology with diode fabrication to develop high-aspect-ratio 3D electronic components. Such structures open new avenues for advanced device applications, including sensors and nanoelectronics, and hold promise for future innovations like 3D solar cells with enhanced efficiency and performance.

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4. Mafa G T, Mavuso A, Madhuku M and Msimanga M 2024 Structural properties of ion track etched micropores in polyethylene coated with aluminium through electron beam deposition *Proceedings of SAIP 2024,* 70-77. ISBN: 978-1-0370-2645-4

Grant Tshepo Mafa

Grant Tshepo Mafa is a doctoral candidate in Physics (Condensed Matter) at the Tshwane University of Technology. His research focuses on ion irradiation induced modification of polyaniline nanorods grown in PET membranes, exploring their structure-property relationships for potential applications in organic solar cells. Grant holds a master's degree in physics, and his work has been presented at the South African Institute of Physics Conference. He is passionate about advancing knowledge in applied physics and engaging with the academic community.

Development of SMART multifunctional carbon nanotube supported catalysts for the valorization of glycerol to 1,2-propanediol

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The goal of the CRC 1615 SMART-reactors is to develop a reactor capable of converting various renewable biomass and more sustainable resources into a range of products (multipurpose) while functioning autonomously. This approach aims to create more resilient processes that are transferable across different scales and locations. A significant challenge within the project is the design of SMART multifunctional catalysts for the selective hydrogenolysis of GL into 1,2-PD under mild reaction conditions. To enhance the catalyst's resilience against poisoning, it is essential that the catalyst's wettability can be adjusted, allowing rare noble metals to last longer and be utilized more sustainable. In this context, carbon nanotubes (CNTs) appear to be a promising support material. Identifying the optimal CNT support and the ideal combination of transition and noble metals is a crucial step in the development of the SMART catalyst.

Jakob Albert

Prof. Dr.-Ing. habil. Jakob Albert is Professor for Technical Chemistry and Deputy Director of the Institute of Technical and Macromolecular Chemistry at the University of Hamburg. Jakob’s key activities are in the research fields of biomass valorization, Power-to-X technologies, polyoxometalate catalysts, as well as scale-up and process design.

O-WW-02

Fabrication and Optimization of CNC-ZIF/PES Nanocomposite Membranes for Enhanced Removal of Dimethyl Phthalate from Water

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Abstract

The growing presence of persistent organic pollutants such as dimethyl phthalate (DMP) in water sources poses a significant environmental and public health concern. This study presents the development of nanocomposite membranes incorporating cellulose nanocrystal-functionalized zeolitic imidazolate frameworks (CNC-ZIF) into a polyethersulfone (PES) matrix via the phase inversion method. Characterization using FTIR, SEM, and BET analyses confirmed successful integration of the nanomaterials, with improved surface morphology and porosity. The membranes were evaluated through dead-end filtration, demonstrating enhanced water flux and high DMP rejection efficiency. To optimize the fabrication parameters, Response Surface Methodology (RSM) based on a Box-Behnken design was employed. Optimal conditions of pH 8, DMP concentration of 5 mg/L, 9% CNC-ZIF loading, and 120 µm membrane thickness, achieved a remarkable DMP rejection efficiency of 95.8%. These results underscore the potential of CNC-ZIF/PES nanocomposite membranes as smart and effective materials for advanced water purification systems.

Keywords: Dimethyl phthalate, cellulose nanocrystals, ZIF, Response Surface Methodology

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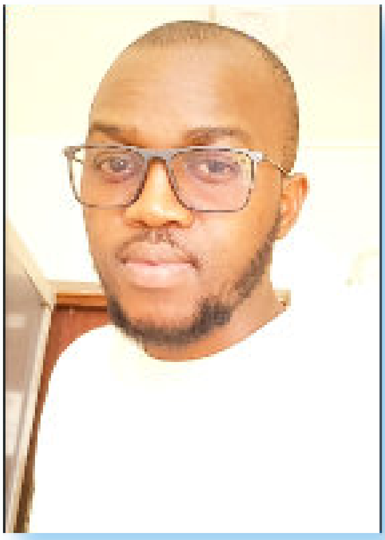
Dr Mbongiseni Lungelo Dlamini



Dr. Mbongiseni L Dlamini is a Postdoctoral Research Fellow in Chemistry at the University of the Witwatersrand, South Africa, and a Part-time Lecturer in Chemistry at Tshwane University of Technology. He holds a PhD in Environmental and Analytical Chemistry from Wits University, an MSc in Applied Chemistry from the University of Johannesburg, and a BSc in Biological Sciences and Chemistry from the University of Eswatini.

His research focuses on the development and optimization of nanostructured materials, particularly nanocomposite embedded membranes for advanced water treatment and catalytic degradation of organic contaminants in water. He has published in several peer-reviewed journals in the fields of environmental, analytical, and materials chemistry. Dr Dlamini's work integrates experimental approaches with statistical modelling tools such as Response Surface Methodology (RSM) to develop sustainable remediation technologies. He currently serves as a reviewer for journals including those of the Royal Society of Chemistry and Journal of Water Process Engineering (Elsevier).

Dr. Dlamini has supervised both Honours and Master's students and has substantial experience in undergraduate teaching, laboratory coordination, and student mentorship. His multidisciplinary contributions bridges materials chemistry and environmental science in pursuit of global water sustainability solutions.

O-WW-04

Abstract: Atmospheric Recrystallisation of Phosphogypsum waste: Rare Earths Recovery and Extraction

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The need for rare earths elements (REEs) in high tech-based materials is vital while the global economy, deposits of natural REEs are limited [1]. Recycling of REEs from industrial wastes such as phosphogypsum (PG) is becoming a sustainable and viable approach due to the low energy consumption, low waste generation, few emissions, environmentally friendliness, and economically feasibility [2]. PG generated from the production of phosphoric acid is a potential resource containing a total REE concentration of over 2000 mg/kg [3]. Various physicochemical approaches such as carbonation, roasting, microwave heating and grinding have been used for REE recovery and extraction but were deemed to be either ineffective or costly [4]. Amongst other approaches, atmospheric recrystallization of PG appears to show promising advantages due to both high REE recovery as well as the pure PG phase that can be obtained. This work mainly focuses on the fabrication of whisker fillers from PG with subsequent REE extraction.

Keywords: Phosphogypsum, rare earths elements, recrystallisation, recovery, extraction

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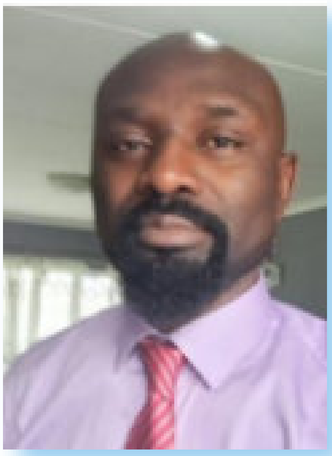
Dr JL. Mukaba



Dr. JL. Mukaba obtained his PhD degree (2022) in Chemistry at the University of the Western Cape and is currently on his NRF/DST postdoctoral fellowship at Nelson Mandela University. His current research focuses on the design and fabrication of track-etched membranes for recovery of platinum group metals from mining waters and other wastewaters.

Waste-derived Silica nanoparticles for the removal of PAHs from contaminated water.

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Abstract

Keywords: Sugarcane bagasse, SiO_2 nanoparticle, Polycyclic Aromatic Hydrocarbons

Agricultural waste materials have gained a lot of attention about extracting nanosilica that have wide technological interests owing to their excellent set of physical, chemical, electronic and optical properties [1]. Among the agricultural waste material, sugarcane bagasse is one of the readily available resources. The report from literature have shown that sugarcane bagasse has sufficient silica content, making it a good source for extracting silica [2]. Here in this study, a sugarcane bagasse was adopted as the waste material of interest for the synthesis of SiO_2 nanoparticles. Their TEM analysis showed the presence of uniform spherical particles. XRD and FTIR confirmed crystalline structure and functional group composition. Furthermore, the surface area was measured by the BET. SiO_2 nanoparticles were further explored for their adsorption of Polycyclic Aromatic Hydrocarbons (PAHs). About 80% removal of PAHs was achieved. The study has shown that different PAHs can be removed by SiO_2 nanoparticles.

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Munyai Shonisani

Munyai Shonisani is currently pursuing her PhD degree at the University of Johannesburg in the field of nanomaterials, with a particular interest on the adsorption processes and the removal of polycyclic aromatic hydrocarbons (PAHs) from contaminated water sources using nanoparticles derived from agricultural waste. Her research expertise spans nanomaterial synthesis, surface functionalization, and environmental remediation applications. She has contributed to scientific knowledge through published several peer reviewed works and presented at various national platforms. She aspires to continue contributing to the scientific community through impactful research, teaching, and collaborative projects that address pressing environmental challenges.

O-WW-06

Eco-friendly microextraction technique of trace parabens from water samples using magnetic activated carbon derived from avocado seeds.

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Water plays a crucial role in the ecosystem and human activities such as providing drinking water, supporting biodiversity, and facilitating agriculture. Parabens are preservatives in cosmetics, pharmaceuticals, and food. However, these parabens constantly enter the water bodies from both domestic and industrial sources and can be found as contaminants in water bodies. The presence of parabens in water has become an environmental concern due to their classification as emerging pollutants. This emphasizes how crucial it is to create sensitive water extraction methods. This study focused on developing an eco-friendly magnetic adsorbent synthesized from avocado seeds to efficiently extract parabens from contaminated water sources. Fe_3O_4@MAC was characterized using various techniques such as FTIR, SEM, and XRD. The results indicated that the desired adsorbent was successfully synthesized. Adsorption parameters, including adsorbent mass and elution time, were optimized using statistical modeling techniques such as CCD. HPLC was used for the analysis of the targeted parabens. The findings demonstrated high adsorption efficiency, with extraction rates exceeding 90% for parabens under optimal conditions. Analytical figures of merit proved that the developed method was compatible with the analytical technique. The findings will support long-term environmental monitoring in South Africa, inform policies for mitigating emerging pollutants contamination, and align with the SDG 6 goal.

Keywords: Avocado seeds, Parabens, Fe_3O_4@MAC, microextraction, and river water samples.

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Shirley Kholofelo Selahle

Dr Shirley Selahle graduated with a Doctor of Philosophy degree in chemistry from the University of Johannesburg. After obtaining her PhD degree, she started her post-doctoral research fellowship at the University of Johannesburg. She joined the University of Venda later in 2023 as a lecturer in Analytical Chemistry. Dr Selahle's arrival at the University of Venda saw her establish an Analytical Environmental Chemistry Research Laboratory/ Group. This research group focuses primarily on the development of sample preparation methods for the analysis and removal of emerging pollutants in water matrices using nanomaterials. Emerging pollutants are chemical substances that fall out of standard monitoring and regulatory programmes. These chemicals often include new generations of pharmaceutically active compounds, pesticides, surfactants, and personal care products, among others. These chemicals occur at low concentration levels, which makes their monitoring a challenge. Therefore, her research focus is on the development of adsorbent materials for the determination of emerging pollutants in environmental water matrices. Taking into consideration Green Chemistry, her research also involves the use of waste materials to make composites that are friendly to the environment, and to utilize them for water treatment. The materials are designed in such a way that they result in a high percentage of recoveries of the targeted pollutants and improve the detection limits of the analytical instruments used for analysis.

She has contributed to the body of knowledge through research publications and presentations at local and international conferences. In 2024, she was recognized as one of the young 200 South Africans making a positive impact in the country by the Mail and Guardian.

Graphene oxide-carbon@biomass-based nanostructured materials for efficient solar steam generation and seawater desalination

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Abstract

Solar steam generation has received a lot of attention because of its ability to produce clean water with minimal energy consumption [1-3]. However, obtaining an environmentally friendly, long-lasting, and powerful solar absorber with a practical large-scale system to generate efficient fresh water remains a challenge [4]. Thus, in this work, a new system of graphene oxide-carbon/microalgae (GO-C@algae) hybrid nanomaterials with high light absorption and photothermal conversion efficiency was prepared to enhance the steam generation of water/desalination performance. The GO-C@algae hybrid nanomaterials evaporator system was generated by a simple dip-coating process. The resulting GO-C@microalgae-based system showed exceptional mechanical properties, resilience, thermal insulation properties, and broad sunlight absorption, as well as rapid water transmission that was conducive to vapor diffusion and enhanced desalination performance. Therefore, GO-C@biomass-based nanohybrids are very promising as affordable and reusable materials for converting solar energy, which can be used for practical application in seawater distillation, wastewater treatment, and other applications.

Keyword: Graphene-based nanomaterial, Microalgae biomass, Solar steam generation

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Dr Kholiswa Yokwana

Dr. Kholiswa Yokwana obtained her MTech in Chemistry from the University of Johannesburg. She received her PhD in chemistry from the University of South Africa (UNISA) in 2020. Her research focus was based on water treatment, nanotechnology, and membrane technology. She also pursued a postdoctoral fellowship in the Chemistry Department at Nelson Mandela University from 2023 to Feb 2025. Where she worked on the development of nanostructured graphene-biomass hybrid materials. These graphene-biomass hybrid materials were used for water treatment as adsorbents and for efficient solar desalination of seawater, owing to their superior light absorption capacity. In addition to her postdoctoral role, she participated in co-supervising master's and PhD students and teaching chemistry modules. From her research, she has produced several DHET-accredited publications. Currently Dr. Kholiswa Yokwana is a postdoctoral fellow at UNISA in the Physics Department. Her research focus is based on the development of nanostructured materials as a catalyst for enhancing hydrogen production from biomass through anaerobic digestion.

The potential of hybrid membrane systems in mining effluent treatment: A pathway to sustainable effluent recycling.

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Abstract

Freshwater scarcity intensified by industrialization and population increase has increased the need for efficient treatment and reuse of mine wastewater. Mining operations generate effluents laden with heavy metals, sulphates and processing reagents that threaten nearby ecosystems and communities. Membrane technologies offer a potent solution for the metal recovery and wastewater recycling but their application in the mining sector is limited by membrane fouling. This review explores recent in hybrid membrane systems especially in nanocomposite membranes coupled with conventional treatment methods designed to enhance the treatment and performance of membranes. Key gaps in current membrane systems is identified with emphasis on innovations such as nanocomposite membranes and integrated pre-treatment methods. By addressing and enabling metal recovery, the hybrid membranes technologies underscores the paradigm of sustainable mining focussed on not only removal but also recovery of valuable resources from mine effluents. Hereby, supporting circular water use and environmental protection.

Keywords: Metal removal, circular economy, hybrid membrane, mining effluents, water reuse, metal recycle.

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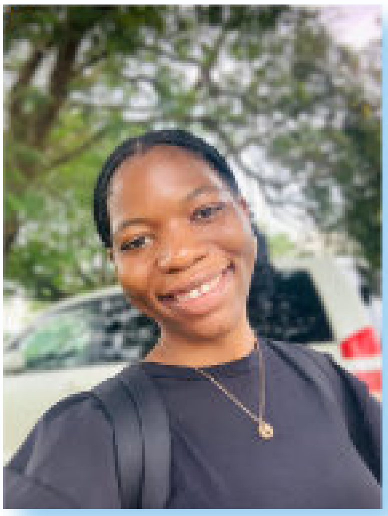
Eunice Zulu



Eunice Zulu is a MPhil student in environmental engineering, with a research focus on treatment of mine effluents using membranes. She holds a bachelor's degree in Chemistry, providing a strong foundation in analytical and environmental chemistry. Eunice is passionate about environmental protection and advancing innovative technologies for water resource management.

Integrated Analysis and Treatment of Rare Earth Elements Contamination in Natural and Industrial Environments

Mr Nehemiah Mukwevho

Rare earth and critical elements have become menace of pollutants, and their increasing demand in the economy is making it hard for environmentalists to find solutions. Understanding of possible pollution and ecological risks of REE in river sediments assists in planning. Samples were analysed and characterised for REEs using Inductively coupled plasma mass spectrometry (ICP-MS), inductively coupled plasma optical emission spectroscopy (ICP), and X-ray Diffraction(XRD) . This study's focused was on ways to reduce REE-related pollution throughout the entire supply chain, from mining to managing products at the end of their lives. Innovative extraction technologies, and eco-friendly recycling processes to get rare earth elements (REEs) out of industrial waste and electronic trash was big step towards reducing pollution. The study highlighted the importance of pollution control and economic benefits that can be achieved.

Mr Nehemiah Mukwevho

Nehemiah Mukwevho is a PhD candidate currently working as a laboratory supervisor at Mintek with over 20 years' experience in analytical chemistry laboratories. Over the past several years, he has contributed extensively to research on environmental pollution, authoring and co-authoring several papers published in reputable scientific journals. His current doctoral work further strengthens his commitment to advancing knowledge in environmental science and chemistry.

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O-WW-10

Recovery of Valuable Minerals from Acid Mine Drainage (AMD) Using Nanofiltration Membranes

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Abstract

Acid Mine Drainage (AMD) presents a major environmental challenge due to its high acidity and elevated concentrations of dissolved metals and sulfates. This study explores the use of nanofiltration (NF) membranes as a sustainable solution for the dual purpose of mineral recovery and water quality improvement. AMD samples sourced from Sibanye Stillwater were treated under systematically optimized NF conditions, with variations in pressure, temperature, and flow rate. Results demonstrated high removal efficiencies exceeding 99% for key divalent and multivalent ions, including Ca, Co, Mg, Mn, S, and Sr. The NF system also produced a permeate stream of significantly improved quality, suitable for reuse in industrial operations or further treatment for potable applications. In addition to mineral recovery, the project highlights the potential for water reuse, contributing to circular economy practices in the mining sector. The outcomes provide a practical foundation for scaling up NF technology for AMD remediation and resource recovery at industrial scale.

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Elizabeth Gaobodiwe Masibi

Elizabeth Gaobodiwe Masibi, a postdoctoral researcher with a specialization in water treatment, membrane technology, and mineral recovery. With a Ph.D. in Chemistry from the University of Johannesburg and experience at Mintek, her work focuses on using nanofiltration membranes to treat Acid Mine Drainage and recover valuable resources. I am passionate about sustainable water solutions and am actively pursuing opportunities in environmental consulting and resource management.

O-WW-11

Density Functional Theory Insights into Arsenic Adsorption on CuS Surfaces: Toward Data-Driven Water Treatment

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Arsenic contamination in water remains a critical environmental and health concern. In this study, density functional theory (DFT) calculations were employed to investigate the adsorption of arsenic species on CuS surfaces synthesized via green chemistry. Results highlight strong binding at specific surface sites, accompanied by favorable charge transfer and structural stabilization, underscoring CuS as an effective adsorbent for arsenic removal. Theoretical insights are supported by adsorption energy profiles and electronic structure analysis, providing a mechanistic understanding of surface interactions. Beyond case-specific findings, this work emphasizes the potential of integrating first-principles data with machine learning models to rapidly screen and predict optimal materials for water purification. Such an approach accelerates the identification of smart materials for wastewater and groundwater remediation, contributing to sustainable and efficient environmental protection strategies.

Dr Razieh Morad

Dr. Razieh Morad is a physicist and postdoctoral researcher at iThemba LABS–NRF, South Africa. She received her Ph.D. in Physics from the University of Mazandaran, Iran. Her expertise lies in density functional theory (DFT), molecular dynamics (MD), and computational modeling of nanomaterials for applications in energy, drug delivery, and environmental remediation. Since 2020, she has published extensively on nanophysics and materials science, including studies of silver nanoparticle interactions and functional nanomaterials. She is an active member of the scientific community, contributing to training, workshops, and international collaborations, and is a recipient of the UNESCO–UNISA Africa Chair in Nanosciences & Nanotechnology fellowship.

O-WW-12

Systematic review for synthesizing Fe-TiO_2 and rGO-TiO_2 photocatalysts for phenolic compound wastewater treatment

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Abstract:

Photocatalytic technology has drawn a lot of interest as a solution to the global environmental and energy challenges. This technology is extensively applied in environmental remediation for water treatment due to its capability to absorb solar energy, transform it into chemical energy, and accelerate reactions, while providing a highly efficient and environmentally friendly approach to mineralizing pollutants. Despite extensive research, photocatalysis suffers from several limitations that prevent its widespread application in real-world industrial applications. Low visible light absorption and rapid charge recombination are the key limitations that hinder the effective use of photocatalysis in environmental applications. Therefore, a systematic review for synthesizing Fe-TiO_2 and rGO-TiO_2 photocatalysts for phenolic compound wastewater treatment is presented. The study explored the various mechanisms of photocatalyst and synthesis methods, highlighting the catalyst composition, optimal conditions, and potential applications for water and wastewater treatment. Among the synthesis methods explored, the sol-gel and hydrothermal synthesis methods were recommended for Fe-TiO_2 and rGO@TiO_2 photocatalysts, respectively, for phenolic compound degradation. Furthermore, the challenges and prospects of applying synthesized Fe-TiO_2 and rGO@TiO_2 photocatalysts for sustainable water and energy were discussed.

Keywords: photocatalysis; iron-doped titanium dioxide photocatalyst; reduced graphene-doped titanium dioxide photocatalyst; synthesis method; phenols; phenolic compounds

The Life Cycle Assessment of PET and HDPE Waste Plastics Management Strategies in South Africa

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Plastics such as polyethylene terephthalate (PET) and high-density polyethylene (HDPE) are widely used in South Africa, yet their disposal presents significant environmental challenges. This study applies a cradle-to-grave life cycle assessment, following ISO 14040/14044, to quantify the environmental impacts of producing one-ton of PET and HDPE and managing their end-of-life through landfilling, incineration, and recycling. Using the ReCiPe 2016 (v1.07) method in SimaPro, midpoint and endpoint categories including global warming potential (GWP), ozone depletion (ODP), eutrophication, acidification, human toxicity, and resource depletion were assessed. Results showed PET production generated higher environmental burdens than HDPE across most categories, with GWP of 3.81 kg CO_2 eq versus 3.28 kg CO_2 eq, and ODP of 1.99E-05 kg CFC-11 eq versus 6.37E-07 kg CFC-11 eq. Recycling consistently demonstrated the lowest impacts, while landfilling and incineration increased emissions and resource depletion. The study emphasizes recycling as the most sustainable strategy for PET and HDPE management.

Nhlanhla Nkosi

Nhlanhla Nkosi is a sustainable development researcher and practitioner with over six years of experience covering the research and implementation of waste-to-energy projects aimed at achieving the United Nations Sustainable Development Goals, namely Good health and well-being (SDG 3), Affordable and clean energy (SDG 7), Industry, innovation and infrastructure (SDG 9), and Climate action (SDG 13). Her specific focus is on solid waste management, particularly waste tyres and plastics, where she incorporates integrated strategies on waste reduction, recycling, and reuse through material and energy recovery initiatives to achieve a circular economy. To date, she has written and co-authored 25 research papers (in the form of journal articles in high-impact, peer-reviewed journals and full peer-reviewed conference papers) on the use of different alternative energy processes from waste materials.

Systematic Recovery of Base Metals (Zn, Cu, and Mn) from Acid Mine Drainage Using Magnetic-Bioadsorbents (magnetite, chitosan, and magnetite-chitosan).

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Abstract

This study investigates the systematic recovery of valuable base metals (Zn, Cu, and Mn) from acid mine drainage (AMD) using novel magnetic-bioadsorbents. Three adsorbents were synthesized and evaluated: pristine magnetite nanoparticles (Fe_3O_4), chitosan biopolymer, and a magnetite-chitosan composite. The adsorption performance was rigorously analyzed by applying both linear and nonlinear regression methods to fit various adsorption isotherms and kinetic models, aiming to identify the most accurate description of the equilibrium and rate processes. The results demonstrated that the magnetite-chitosan composite exhibited superior performance, leveraging the high surface area and magnetic properties of magnetite with the excellent chelating functionality of chitosan. High recovery efficiencies were achieved for several metals: 99.5% for Cu, 92.65% for Zn, and 81.72% for Mn. The study confirms that the magnetic-bioadsorbents, particularly the composite, are highly effective for the selective recovery of base metals from complex wastewater like AMD, presenting a promising, sustainable, and efficient treatment strategy for environmental remediation and resource recycling.

Keywords: Adsorption, Acid mine drainage, Base metals, Magnetic-chitosan, and Bio-adsorbents.

O-WW-16

Dual Heteroatom-doped Smart Hydrochar Carbocatalyst for Metal-Free Peroxymonosulfate Activation

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Abstract

Metal-free carbocatalytic peroxymonosulfate activation offers a sustainable, energy-efficient approach for organic pollutant removal [1,2]. In this work, we present a novel nitrogen- and sulfur-co-doped hydrochar catalyst (NSCDHC-600), engineered via catalytic hydrothermal carbonization followed by controlled pyrolysis, which demonstrates exceptional performance in activating peroxymonosulfate (PMS) for the rapid degradation of the carcinogenic azo dye, Direct Blue 6. Under mild, eco-friendly conditions (pH 7, 5 mM PMS, 20 mg catalyst), NSCDHC-600 enabled near-complete dye removal within 10 minutes, exhibiting a high rate constant (0.3410 min^{-1}). The catalyst's honeycomb-like porous structure (21.5 m^2/g) ensured high reactivity and PMS activation capability. Interference studies revealed that humic acid and chloride ions synergistically enhanced performance, while nitrate and carbonate ions caused slight inhibition, highlighting the catalyst's robustness. Mechanistic analysis confirmed the roles of sulfate and hydroxyl radicals, singlet oxygen, and the dominance of a non-radical-based degradation pathway.

Keywords: Peroxymonosulfate, Carbocatalysis, Heteroatom, Hydrochar, Singlet oxygen.

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Ragavan Chandrasekar

Ragavan Chandrasekar is a Prime Minister's Research Fellow at the Indian Institute of Technology Guwahati, where he focuses on engineering biochar and hydrochar-based materials for the adsorption and catalytic degradation of emerging contaminants. His research emphasizes sustainable water treatment using advanced oxidation processes, particularly metal-free catalytic systems. He has published 13 scientific papers as first and co-author and was awarded Best Oral Presenter for his work titled “Ultrafast degradation of organics by dual heteroatom doped metal-free hydrochar/ PMS system: Modeling and mechanistic insights” at the International Conference on Environmental and Sustainable Development (ICESD-2025), organized by IESD, Banaras Hindu University. His work was also selected for journal publication in conjunction with the EAAOP-7 conference hosted by the University of Salerno, Italy. Ragavan serves as a reviewer for leading journals, including Bioresource Technology, Journal of Environmental Management, and Journal of Environmental Chemical Engineering. He is proficient in handling high-end instrumentation like HPLC, GC-MS, BET surface area analyzer, FTIR, DLS, and UV-Vis spectrometer, and has strong analytical expertise in interpreting data from XPS, XRD, BET, Raman, and FTIR techniques.

O-WW-17

Fabrication of thin film nanocomposite (TFN) membranes modified with copper oxide carbon aerogel (CuO-CA) nanocomposite for enhanced antifouling properties for water treatment

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Abstract

Many communities in South Africa, including the Limpopo province, rely on boreholes due to limited access to clean piped municipal water supplies[1, 2]. In many cases, these boreholes are contaminated with salts, heavy metals, or bacteria[1, 3]. Prolonged use of such water poses serious health risks and can also affect quality of life by damaging household appliances and water pipes, and reducing agricultural productivity by inhibiting photosynthesis and lowering crop production[1]. To address this, the study investigated the use of copper oxide-carbon aerogel (CuO-CA) modified polyamide thin-film nanocomposite (PA-TFN) membranes for the removal of salts and heavy metals from borehole water in Bochum, Limpopo Province, South Africa. These PA-TFN membranes combine the high removal efficiency of PA-TFN with the antibacterial properties of CuO and the hydrophilicity of both CuO and CA, which together help mitigate fouling of the PA-TFN membrane, making it a promising solution for water treatment[4, 5].

Keywords: Borehole, salts, heavy metals, polyamide, CuO, carbon aerogel

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Mokibelo Joy Hlaraka

Mokibelo Joy Hlaraka, MSc candidate in Chemistry at the University of Johannesburg, holds a BSc (Hons) degree in Chemistry and is currently researching water treatment using membrane technology. The work focuses on the development of nanomaterials to improve the antifouling properties of polyamide thin-film membranes, particularly for groundwater treatment.

O-WW-18

A Comparative Study of MOFs for Atmospheric Water Harvesting Efficiency and Composite Performance on Functionalized Substrates

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Abstract

Water scarcity remains a major global challenge, particularly in semi-arid regions such as Cape Town, South Africa, where rapid urbanization, industrialization, and climate change have strained traditional freshwater sources. Atmospheric Water Harvesting (AWH) offers a sustainable alternative by capturing water vapor directly from air. Among emerging AWH materials, metal–organic frameworks (MOFs) exhibit exceptional potential due to their high surface area, tunable pore structures, and strong water adsorption capacity even at low relative humidity. This study investigates the green synthesis and solvothermal methods, characterization, and comparative water uptake performance of several MOFs designed for AWH applications. To enhance their practicality and overcome limitations associated with handling fine MOF powders, the synthesized materials are integrated into Ti-coated track-etched membranes, as well as electrospun polymer nanofiber composites. Characterization techniques including X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), and Fourier-Transform Infrared Spectroscopy (FTIR) were employed to assess crystal structure, morphology, and chemical interactions. Water uptake experiments were conducted under controlled humidity conditions (30–90% RH) using a gravimetric desiccator–balance setup to determine equilibrium adsorption capacity. Preliminary findings demonstrate that the incorporation of green-synthesized MOFs into structured supports could significantly enhance water sorption efficiency, structural stability, and reusability compared to pure MOF powders. The results will contribute to the advancement of sustainable materials and scalable technologies for atmospheric water harvesting, addressing both environmental and societal water security needs in arid regions.

Keywords: Atmospheric water harvesting, green synthesis, solvothermal synthesis, metal–organic frameworks, track-etched membranes, electrospun composites, water uptake.

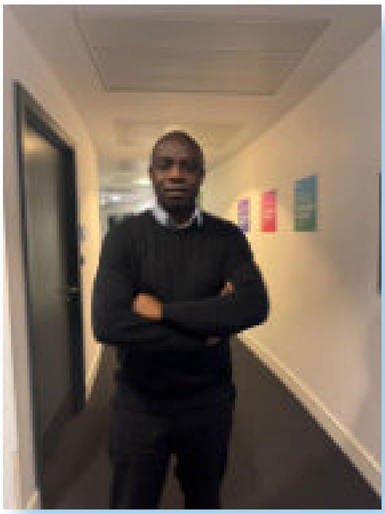
O-WW-19

Life Cycle Assessment of Smart Self-Healing Materials for Hydrogen Sensing: Comparative Evaluation of Pd-CNT Coatings and Pd-WO_3 Polymeric Tapes

Authors: Alexander Oburoh, Oludare Amos Solademi, Augustine Chukwuemeka, Abdulsalam Abdulkarim, Achukwu Emmanuel O, Tirmidhi Olaniyan, Chukwudubem Idoko, Frances Amadhe, Abiodun Williams, Ibukun Matthew, Abdulkadir Sambo, James Njuguna.

The safe and efficient use of hydrogen as a clean energy vector requires innovative sensing technologies with enhanced durability, responsiveness, and adaptability. This study presents a comparative Life Cycle Assessment (LCA) of two emerging smart materials for hydrogen applications: (I) self-healing superhydrophobic conductive coatings composed of palladium-decorated carbon nanotubes (Pd-CNTs), polydimethylsiloxane, and fluorosilane, and (II) a stretchable, self-healing, and self-adhesive chemochromic hydrogen sensing tape based on Pd-WO_3 nanocomposites embedded in a PBS-Ecoflex hybrid polymer. The LCA follows a cradle-to-grave approach, evaluating environmental impacts across the value chain. The ReCipe impact category is used which includes CO_2 emissions, energy demand, human/ecotoxicity, etc. While Pd-CNT-based coatings exhibit superior electronic sensitivity, their potential results suggest higher CO_2 emissions, the Pd-WO_3 tape potentially demonstrates lower energy demand and offers improved reusability, but faces challenges related to WO_3 recycling. The analysis underscores the importance of material choice in balancing performance and sustainability.

Engr Oludare Amos Solademi



Engr. Oludare Amos Solademi has worked as a maintenance and project engineer in Oli and gas sector of Nigerian downstream sector for almost 2 decades, presently studying as a research student and research assistance at Robert Gordon University, Aberdeen United Kingdom. As a sustainable energy researcher specialising in hydrogen transportation and storage systems. With a strong commitment to advancing clean energy solutions, I am investigating cutting-edge technologies for hydrogen distribution and usage, by using composite materials in place of the traditional steel pipeline, aiming to make hydrogen a practical cornerstone of the global energy transition.

My current research explores the development of self-healing hydrogen infrastructure, embedding advanced sensors during manufacturing to enable real-time monitoring, predictive maintenance, and enhanced safety across hydrogen pipelines and storage facilities. By integrating smart materials, sensor networks and using machine learning algorithm, I seek to create resilient energy systems that reduce costs, minimise risks, and accelerate the adoption of hydrogen as a sustainable fuel.

I am passionate about bridging the gap between science and the industry, contributing to academic publications, collaborative projects and conferences, sharing insights that drive innovation in renewable energy. My work reflects a vision of a cleaner, smarter, and more reliable energy future powered by hydrogen.

Application of functionalised electrospun polymer nanofibers as potential water filters for point-of-use systems

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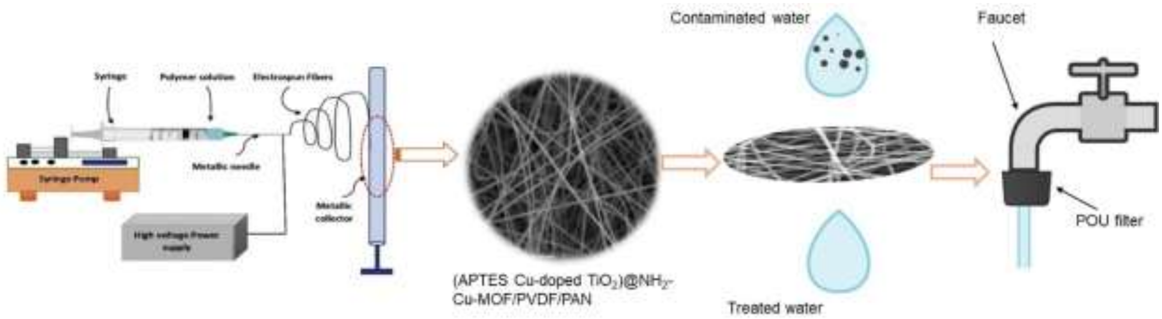
Abstract

Water scarcity is a global crisis affecting over 1.2 billion people and is severe in South Africa due to inefficient treatment systems[1,2]. Contaminated water poses serious health risks, prompting the promotion of point-of-use (POU)[3]. Current POU methods like membranes face challenges such as membrane fouling and low efficiency[4,5]. This study develops an advanced POU filter using electrospun polyvinylidene fluoride (PVDF)/polyacrylonitrile (PAN) nanofibers functionalized with (APTES-Cu-doped TiO_2)@NH_2-Cu-MOF. The material will be characterised by Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Energy Dispersive X-ray Spectroscopy (EDS), Fourier Transform Infrared Spectroscopy (FTIR), etc. Performance will be evaluated through heavy metal rejection, antibacterial assay against *Escherichia coli* (*E. coli*) and *Staphylococcus aures* (*S. aureus*) and filtration metrics. River water from Durban will be used for testing. The filter POU filters aims to offer multifunctional capabilities, including effective contaminant rejection, antibacterial activity and high filtration efficiency.

Keywords: nanofibrous membrane, POU water filter, antibacterial activity

Graphical abstract:



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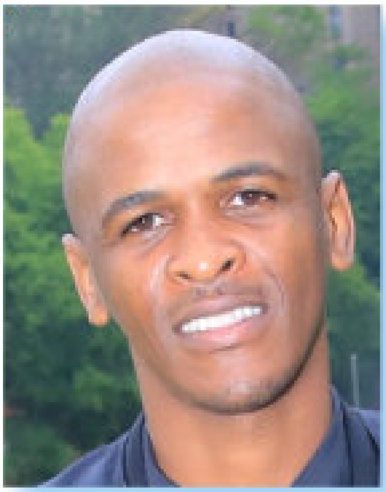
Njabulo Sondezi



Njabulo Sondezi is a PhD candidate in the Department of Chemical Sciences at the University of Johannesburg, specialising in electrospun nanofiber for water purification. He holds an MSc in Chemistry, awarded with distinction in 2024.

O-WW-21

Environmental and Socio-Economic Impacts of Quarrying and Acid Mine Drainage in Estcourt, KwaZulu-Natal Province: A Case Study of the Bushman's River

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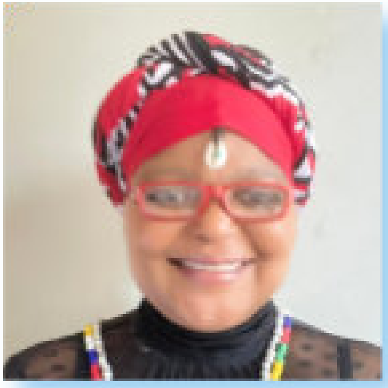
Quarrying and acid mine drainage (AMD) pose significant environmental challenges in Estcourt, KwaZulu-Natal Province, South Africa, leading to water and soil degradation marked by high concentrations of heavy metals (HMs), which threaten ecosystems and human health. Communities near quarry sites face a dual burden: potential economic benefits from mining are overshadowed by long-term socio-economic stressors, including health impacts and limited access to clean water. This review aimed to (1) evaluate geohydrochemical changes in water quality related to quarry AMD and (2) assess socio-economic and health implications for affected communities. Findings indicate consistent deterioration of water quality due to elevated HMs such as arsenic, copper, iron, cadmium, and sulphates. While communities demonstrate awareness and resilience, their concerns are often exacerbated by inadequate regulatory enforcement and a lack of involvement in decision-making. To protect public health, it is crucial to treat water from the Bushman's River before it is used for domestic and agricultural purposes.

Keywords*:* Acid Mine Drainage, Bushman's River, Estcourt, Heavy Metal Contamination, Quarrying.

Dr Innocentia Gugulethu Mkhize



Dr. Innocentia Gugulethu Mkhize is currently a Senior Lecturer and the Deputy Head of Department at the Durban University of Technology. She is a registered candidate engineering technologist with the Engineering Council of South Africa. Dr. Mkhize holds a Doctor of Philosophy in Chemical Engineering from North-West University and a Master's of Technologiae in Chemical Engineering from Cape Peninsula University of Technology. With over eight years of teaching experience, she has taught various chemical engineering subjects to both undergraduate and postgraduate students. She also founded and serves as the CEO of ELOZI-NPC, a non-profit company focused on integrating Science, Technology, Engineering, Art, and Math into community projects in rural areas. Her research interests include mining, industrial wastewater treatment, and water resources. She has

Polyethersulfone-Based Membranes for the Efficient Removal of Salts and Heavy Metals from Environmental Wastewater

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Abstract

Rapid population growth, expanding industries, and relentless economic development contribute significantly to water contamination, a major obstacle to achieving sustainable quality water. The increasing presence of contaminants like heavy metals, salts, and industrial effluents exacerbates the global water crisis, demanding advanced water filtration solutions. Therefore, the architectural evaluation for effective performance of nanofiltration (NF) membranes is of paramount importance. This study focuses on the morphological structure, analysis of chemical composition, permeation, and rejection of Polyethersulfone/Fe_3O_4/ZnO membranes. The SEM images showed porous, interconnected tunnels and finger-like morphological structures. The water uptake, porosity, and thickness contributed to membrane performance. The contact angle improved significantly with incremental addition of trimesoyl chloride. 0.50 wt% of PES/Fe_3O_4/ZnO was highly hydrophilic with a contact angle of 55.22°, offering maximum rejection of Na_2SO_4 (50.91%), NaCl (52.64%), and Pb(II) (80.39%). This study highlights that synergistic effects of the pore-former, solvent evaporation time, metal oxides, and monomers are crucial for effective NF membrane performance.

Keywords: Polyethersulfone, Fe_3O_4/ZnO, monomers, membranes, wastewater.

Ms Nompumelelo S.M Kubheka

Ms. Nompumelelo S.M Kubheka is a PhD student at University of South Africa under the Institute of Nanotechnology for Water Sustainability. Her research interest is in membrane science technology, nanostructured materials, and polymeric materials for water treatment applications. She is committed in addressing the presence of contaminants in wastewater utilizing advanced nanomaterials and separation technologies. She has published several manuscripts under peer-reviewed accredited journals. She has mentored students and presented at various local and international conferences. She is a Professional Natural Scientist (SACNASP), and a member of various professional associations such as Water Institute of Southern Africa (WISA), South African Chemical Institute (SACI) , African Materials Research Society (AMRS).

Magnetic mesoporous silica nanocomposites modified with polymeric materials for wastewater treatment

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Abstract

Magnetic mesoporous silica nanocomposites were successfully synthesized and modified with polymeric materials for the removal of heavy metals and metalloids in wastewater. The preparation of iron oxide (Fe_3O_4) was achieved through the coprecipitation method [1], then coated and functionalised with silica (SiO_2) and chitosan (CS) [2], resulting in two magnetic nanocomposites, namely Fe_3O_4@SiO_2 and Fe_3O_4@SiO_2-CS. The structural, morphological, and surface chemistry of the materials were confirmed using various analytical characterisation techniques. The TEM and BET results confirmed the successful formation of core–shell structures, the improvement of surface functional groups, and a nanoscale spherical morphology (15±3 nm). These results confirmed that the prepared nanocomposites were mesoporous and had a BET surface area of 87.6 m2/g. Suitable surface charges and improved textural properties were observed in the composite materials, while retaining the mesopores and magnetic recoverability. These preliminary findings indicate that the synthesised composites possess promising characteristics for wastewater treatment applications.

Keywords: Magnetic nanocomposites, heavy metals and wastewater.

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Miss P. Mavuso

Miss P. Mavuso is an emerging and dedicated young researcher in the field of Environmental and Analytical Chemistry. She is currently pursuing her master's degree at the University of Johannesburg, her research centres on the innovative design of polymeric and magnetic nanomaterials for advanced wastewater treatment. She holds an Honours degree in Chemistry, with research experience in natural polymers and nanomaterials, which reflects her commitment to sustainable solutions in water purification and to contribute to the development of next-generation materials for environmental remediation.

O-WW-24

Metallic Pollution Assessment and Source Apportionment Using Statistical Analysis Approaches

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Abstract

To address pervasive pollution, it is vital to implement approaches that identify and quantify the contributions of different sources to overall pollution levels to comprehend their impact on the environmental impact and the establish effective pollution management strategies. This study employed a robust methodology to identify pollution sources, examine sediment quality, and evaluate potential ecological risks. The levels of toxic elements in the sediments were determined ranking in decreasing order as follows: Fe, Pb, U, Th, As, Cd, Hg. The pollution index revealed very high and moderate contamination factors for Pb and U, respectively. The toxic elements ecological risk index calculated in this study showed low and moderate potential index risk across the study area. Pearson's correlation revealed significant correlation between As-Pb and Th-U. A combination of Principal Component Analysis and Positive Matrix Factorization identified potential sources of sediment contamination. The sources of pollution were identified as atmospheric disposition, gold mining activities, domestic and urban activities waste, agricultural practices, and unidentifiable sources with contributions of 23.9%, 19.0%, 18.7%, 8.1% and 8.0%, respectively. The economic advantages of river pollution rehabilitation mandate a balance between ecological integrity and socio-economic constraints to ensure an integrated approach to water management.

Keywords: Source apportionment, Sediment quality, Multivariate, Water pollution Economics, Toxic element pollution

Poster Presentations

Photoinduced Silver Shell Growth on Gold Nanostars for Electroanalysis

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Amongst numerous synthetic routes for $Au_{(core)}$-$Ag_{(shell)}$ nanostars, light-assisted methods have offered great promise to (i) control the surface coating, (ii) reduce the use of harsh reducing agents, and (iii) lower the activation energy required—allowing for synthesis under milder conditions. Herein, we propose a systematic investigation of the effects of different wavelengths of light (i.e., UV, 470-, 530-, 591-, and 655-nm) on the light-mediated Ag-coating of gold nanostars (AuNSs)—prepared through a green, rapid, seedless synthesis method. The surface plasmon resonance, size, morphology, elemental composition, and redox properties of AuNSs and $Au_{(core)}$-$Ag_{(shell)}$ bimetallic NSs were observed using techniques such as UV-Vis spectroscopy, HR-TEM, cyclic voltammetry (CV), and differential pulse voltammetry (DPV). The electrochemical activity of the $Au_{(core)}$-$Ag_{(shell)}$NSs offered a high active surface area and enhanced conductivity through improved electron transfer. Furthermore, visible, 530–nm light offered the most efficient surface coating of Ag onto nanostar structures and enhanced redox activity.

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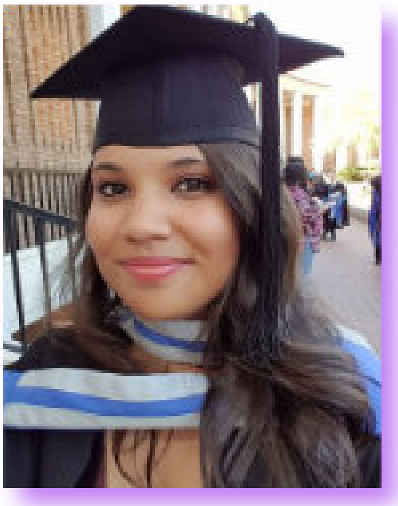
Riccarda Thelma MacDonald



Riccarda MacDonald is a Postdoctoral Fellow hosted by Dr Keagan Pokpas at the University of the Western Cape and her research focuses on the development of a p-type EGOFET Point-of-Care apta-sensing device for early detection of the breast cancer biomarker, MiRNA. She has experience in nanotoxicity and electrochemistry and completed her Ph.D. research on the development of new strategies towards the sensitive and selective detection of dexamethasone using gold-nanomaterial based chemical and biosensors under the supervision of Dr Candice Cupido, Dr Keagan Pokpas, and Prof. Emmanuel Iwuoha. She also conducted research on light-assisted silver-coating of gold nanostars at the University of Missouri-Columbia under the supervision of Prof. Gary Baker. She earned her MSc (Nanoscience) degree with research focus on "The Fate and Transport of Carbon-Based Nanomaterials in the Environment" and “The Effect of pH and Ionic Strength on the Adsorption of Sulfamethazine onto Laser-Induced Graphene” under the supervision of Prof. Leslie Petrik. Her BSc (Honors) degree focused on “Dendritic Multichannel Biosensor System for the Detection of TB Drug” under the supervision of Dr Candice Cupido. She has been a Golden Key International Honour Society member for 10+ years. She participated in the South Africa-Joint Institute for Nuclear Research (SA-JINR) Bilateral Agreement in Dubna, Russia (2017) based on the JINR Fields of Research - Statistical Methods in Environmental Studies, Mapping and Modeling using GIS technology, Gamma-ray Spectrometer and related electronics. She holds a certificate of completion for the 10-week CODATA-RDA School of Research Data Science-South Africa 2021.

P-EN-01

Enhanced thermal conductivity of B_4C-EG nanofluids by pulsed laser ablation in liquid

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ABSTRACT

James Clerk Maxwell conceptualized the notion of nanofluids as early as 1768. A homogeneous dispersion of nanoparticles in a conventional coolant host fluid, such as water, oil, or ethylene glycol (EG), among others, constitutes a nanofluid —a type of molecular fluid. At normal temperatures, the thermal conductivity of any common heat transfer fluid is typically less than <1 W m−1 K−1, while metals and their equivalent oxides have thermal conductivities that are two to three orders of magnitude greater. Therefore, adding such metallic nanoparticles, or their oxides/carbides, to a regular coolant host fluid in the form of a nano-suspension would significantly increase the nanofluid's thermal conductivity. This contribution reports on the physical properties of boron-ethylene glycol nanofluids synthesized using a Nd-YAG (1062 nm) Pulsed Laser Ablation in Liquid Solution (PLAL).

Key Words: Boron carbide (B_4C), thermal conductivity (*K*), nanofluids (NF), pulsed laser ablation in liquid (PLAL), ethylene glycol (EG), and polyvinyl alcohol (PVA).

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Temnotfo Fakude

My name is Temnotfo Fakude. I graduated with a BSc in Geography and Physics in 2022 from the University of Zululand. I also completed my BSc (Hons) in Physics at the same university, graduating in 2023. Currently, I am pursuing an MSc in Physics at the University of South Africa under the supervision of Prof. M. Maaza and Prof. MS. Dhlamini.

Nanocomposite Materials for the Photocatalytic Generation of Hydrogen

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Abstract

Exploration of clean energy and carbon-free fuels is motivated by the pressing need for decarbonization, with hydrogen largely emerging as a solution. Photocatalysis provides a simple and environmentally friendly method for energy conversion and environmental cleanup by generating hydrogen from ammonia. Plant-mediated synthesized nanomaterials are becoming increasingly more popular because of their superior physicochemical properties, availability, ease of application, ease of preparation, and environmental friendliness. In this study we investigated the efficiency of Fe_2O_3 and NiO coupled with pyrrole to form more stable nanocomposites for the generation of hydrogen from ammonia using *Spinacia oleracea* and *Moringa oleifera* as plant extracts acting as stabilizers and reducing agents in nanoparticle synthesis. Using biomaterials, the nanocomposites were successfully synthesized, and their structure, morphology, and composition were analyzed using characterization methods such as XRD, FTIR, ZETA, UV-vis and SEM. This thorough characterization highlights the potential of nanocomposites for use in hydrogen generation in the future.

Keywords: Photocatalysis; Hydrogen; Ammonia degradation, Metal oxide nanoparticles; Decarbonization; Green synthesis

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Thembalethu Mkhonza

Thembalethu Mkhonza is currently enrolled in the Master of Science in Nanoscience program at the University of the Free State in South Africa. She obtained her undergraduate degree in Chemistry and Biochemistry in 2021, followed by an Honours degree in Chemistry in 2023. Her current research is centered on the biosynthetic preparation of polymer-metallic oxide nanocomposites for ammonia decomposition, with the objective of developing eco-friendly and efficient photocatalysts for sustainable hydrogen production. Her academic journey reflects a strong interest in nanomaterials for energy and environmental solutions.

Electrooxidation of ethanol on silver-reduced graphene oxide (Ag/rGO) surface – Effect of alloying with palladium

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Abstract

The study examined the impact of alloying palladium (Pd) with silver-reduced graphene oxide (AgrGO) nanocomposites on ethanol electrooxidation. The electrocatalysts were synthesised using wet chemical method and characterized using conventional spectroscopic and microscopic techniques. The Pd1Ag1rGO composite demonstrated superior performance compared to Pd2Ag1rGO and AgrGO, attributed to its relatively smaller particle size of 5.3 nm, which enhances catalytic activity, a higher density of defects for better electron transfer, and improved electrochemical properties. It achieved an impressive exchange current density of 1.70 µA cm^{-2}, indicating rapid reaction kinetics, alongside lower charge transfer resistance. This research highlights the potential of Pd1/Ag1-rGO nanocomposites as an alternative to platinum electrocatalyst for efficient ethanol oxidation, supporting advancements in sustainable fuel cell technologies.

Keywords

Silver, Palladium, rGO, Ethanol, Electrooxidation

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Vhahangwele Mudzunga

Vhahangwele Mudzunga is a PhD student at the University of South Africa (UNISA). Her research focuses on designing and utilizing non-platinum-based electrocatalysts for the electrooxidation of alcohols and organic compounds in fuel cell devices.

Computational investigation of Ge–Br Codoped $CsSnI_3$ for Lead-Free Perovskite Solar Cells and Smart Energy Applications

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Abstract

The demand for eco-friendly energy solutions has accelerated research into lead-free perovskite solar cells (PSCs), with $CsSnI_3$ emerging as a promising candidate due to its excellent optoelectronic properties [1, 2]. However, challenges with stability and degradation remain [3]. This study investigates the codoping of Ge at the Sn site and Br at the I site in $CsSnI_3$ using density functional theory (DFT) within the CASTEP framework. A 2×2×2 supercell model reveals that Ge–Br codoping effectively tunes the band structure, enhances charge separation, suppresses recombination, and increases visible light absorption. Codoping also passivates defects while preserving structural integrity [4]. Density of states and charge density analyses show improved carrier delocalization and the formation of intermediate states. These enhancements benefit photovoltaic performance and position Ge–Br codoped $CsSnI_3$ as a multifunctional material suitable for smart energy systems, including adaptive solar panels and energy-harvesting devices, advancing sustainable and intelligent energy technologies.

Keywords: Lead-free perovskites, $CsSnI_3$, Co-doping, Density functional theory, Band-gap engineering.

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Dr Neelam Saghir

Dr. Neelam Saghir recently earned a PhD in Physics from the University of South Africa, specializing in computational physics and materials science. With a strong research focus on sustainable energy and smart materials, Neelam has contributed to three publications advancing the understanding of next-generation photovoltaic materials. Passionate about developing eco-friendly technologies, she aims to drive innovations in energy-efficient and intelligent material systems.

Investigating Pyrrolidinium Ionic Liquids as Electrolytes for Sodium-Ion Batteries: A Molecular Simulation Study

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Sodium-ion batteries (SIBs) have attracted significant attention as a cost-efficient and sustainable substitute for lithium-ion batteries (LIBs), utilizing the natural abundance and extensive availability of sodium. This project investigates pyrrolidinium-based ionic liquids (ILs), including ether-functionalized analogues, as advanced electrolytes for sodium-ion batteries (SIBs) [1-2]. The goal is to enhance sodium ion mobility and conductivity by optimizing the physicochemical properties of these ILs [3]. Classical molecular dynamics simulations employing the CL&P force field will be used to evaluate key macroscopic transport properties, viscosity, ionic conductivity, diffusion coefficients, and sodium transference number. Microscopic structural insights, such as solvation environments and ion-pairing dynamics, will also be assessed[4-5]. Following best practices in simulation, this study ensures reproducibility and accuracy of results. The findings will guide rational design of functionalized ILs, offering a promising route to high-performance, sodium-conductive electrolytes for next-generation SIBs.

Keywords: Ionic Liquids, Sodium-ion Batteries (SIBs), Molecular Dynamics, Pyrrolidinium, Electrolyte

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Basheerah Sulliman

Basheerah Sulliman is currently completing her BSc. Hons in Chemistry at the University of the Western Cape, under the supervision of Dr. Natasha Ross and Dr. Gerhard Venter. Her research focuses on the computational design and analysis of novel electrolyte materials for energy storage devices. She is particularly interested in molecular dynamics simulations of ionic liquids to explore ion transport mechanisms towards advancing sodium-ion batteries.

Two-dimensional Cu-grafted carbon nanofluid for high-performance solar PV Cooling

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Abstract

Advancing thermal management in solar photovoltaic (PV) systems requires nanofluids with exceptional thermal conductivity and stability. This work presents copper (Cu)–grafted carbon nanostructure nanofluids, specifically Cu–graphene and Cu–carbon nanotube (CNT) dispersions in ethylene glycol (EG), synthesized via pulsed laser ablation in liquid (PLAL) without surfactants. A two-step process was used: carbide pellets were first ablated to form carbon nanostructures, followed by Cu target ablation for nanoparticle decoration. Optimized laser parameters enabled uniform Cu deposition on graphene sheets and CNTs, confirmed by morphological analysis. Both nanofluids achieved thermal conductivity enhancements of up to 17% over EG and exhibited excellent optical stability, with Cu–graphene nanofluid retaining integrity for 60 days. Microchannel cooling experiments with Cu–graphene demonstrated significant performance gains: 26% higher heat transfer coefficient, 21% lower thermal resistance, and ~20% increase in Nusselt number. These findings highlight the promise of 2D nanocomposite plasmonic nanofluids as high-performance, durable coolants for PV thermal regulation.

Keyword: *Solar plasmonic nanofluid; 2D Nano-composite nanofluid; Laser Ablation; Thermal Conductivity; Solar PV.*

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Meisam Aligholami

Meisam Aligholami is a final-year PhD student at the UNESCO–UNISA Africa Chair in Nanoscience & Nanotechnology (U2ACN2), South Africa. His research focuses on the synthesis, characterization, and application of advanced nanocomposite-based nanofluids for solar thermal and electronic cooling systems. Specializing in pulsed laser ablation in liquid (PLAL) techniques, he explores the interplay between laser parameters, nanomaterial stability, and thermal transport properties. His work bridges nanomaterials engineering and applied thermal sciences, with published contributions in journals such as *Solar Energy* and *Scientific Reports*.

P-EN-08

High-Capacity Mn-Rich $Li(Ni_{0.1}Mn_{0.8}Co_{0.1})O_2$ Cathode Materials for Lithium-Ion Batteries

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Keywords: $Li(Ni_{0.1}Mn_{0.8}Co_{0.1})O_2$, Cation disordering, Lithium-ion batteries, Electrochemical performance, Hydrothermal synthesis

Abstract

$Li(Ni_{0.1}Mn_{0.8}Co_{0.1})O_2$ is a high-capacity Mn-rich layered oxide cathode material with potential for next-generation lithium-ion batteries (Saavedra-Arias et al., 2008). This study explores the impact of cation disordering on its structural and electrochemical performance, using hydrothermal synthesis to tailor the material (Orlova et al., 2021). Structural, physical, and chemical properties will be examined via XRD, SEM, EDS, TEM, and XPS (Lee et al., 2014; Zhao et al., 2017). Electrochemical behaviour will be evaluated using two-electrode coin-type cells, with characterization including cyclic voltammetry, electrochemical impedance spectroscopy, and galvanostatic cycling. The optimized cathode will be integrated into full-cell coin cells to assess real-world applicability. Preliminary findings suggest that cation disorder enhances lithium-ion mobility, suppresses phase transitions, and improves thermal stability (Zhuang and Bazant, 2022). These results position cation-disordered $Li(Ni_{0.1}Mn_{0.8}Co_{0.1})O_2$ as a promising smart material for safer, high-performance energy storage systems.

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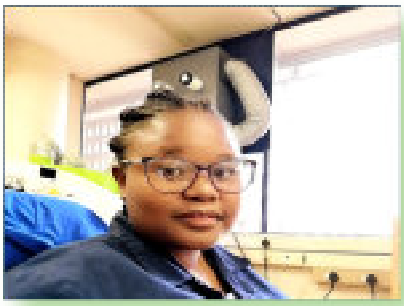
Mmabatho Dinala



Mmabatho Dinala, a PhD candidate, is a passionate researcher and aspiring scientist specializing in advanced lithium-ion battery technologies. Her work focuses on the design and optimization of cation-disordered Li/Mn-rich and Ni-rich NMC cathode materials, aiming to enhance energy storage performance for next-generation batteries. She is particularly interested in sustainable energy solutions, electrochemical performance improvement, and scalable material synthesis. Beyond her research, Mmabatho is driven by curiosity, innovation, and a commitment to making impactful contributions to clean energy technologies.

P-MD-01

Formulation and characterisation of a rifapentine loaded multiparticulate system for the treatment of drug susceptible tuberculosis

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Tuberculosis continues to be a health crisis due to resistance of Mycobacterium Tuberculosis (*M.tb*) to first-line drugs. The newer drug, rifapentine, effectively eradicates *M.tb*, with a longer half-life and lower inhibitory concentration compared to its widely used analogue rifampicin, however, a 98% protein binding and low intracellular penetration significantly reduces the amount available to destroy *M.tb* in circulation and host alveolar macrophages. In this study, a rifapentine loaded, pH responsive multi-particulate system was developed. The physicochemical characteristics of the particles was evaluated using DLS, HPLC, PXRD and SEM. Binding of the formulation to plasma proteins and its cytotoxicity were investigated using fluorescence microscopy and an MTT based assay respectively. This formulation has the potential to reduce the administered dose of rifapentine by firstly reducing the drug – plasma protein binding, and secondly localising the drug in the intracellular compartments of the macrophages.

Keywords: rifapentine, tuberculosis, protein binding

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Dr Mellisa Chikukwa

Dr Mellisa Chikukwa is a pharmacist by profession with experience in teaching and learning. She holds a Masters and PhD Pharmaceutics from Rhodes University, South Africa, and currently works as a lecturer and researcher at the University of the Western Cape, South Africa. Dr Chikukwa is well versed in formulation development, optimisation and testing. She is a part of the Infectious disease Nanomedicine Group, that focuses on development of nano formulations for the delivery of small drug molecules for the treatment and immunomodulation of infectious diseases such as tuberculosis and malaria. Dr Chikukwa has a special passion for developing age-appropriate drug delivery systems for paediatric populations.

P-MD-02

Copper decorated porphyrin-based porous organic polymer as an electrocatalytic layer in TB drug detection

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Electrochemical sensor technology has rapidly advanced in analytical chemistry, offering high selectivity, sensitivity, and cost-effectiveness over conventional techniques [1]. In this study, we develop an electrochemical sensor modified with a copper-decorated porphyrin-based porous organic polymer (Cu-TriPOP), acting as an electrocatalyst to enhance sensitivity, selectivity and current response of target analytes. The polymer's structure, composed of multiple porphyrin units, provides high surface area and redox-active copper sites, promoting electron transfer [2]. Cu-TriPOP is investigated for the electrochemical detection of pyrazinamide and ethambutol, two first-line anti-tuberculosis drugs. According to the World Health Organization, TB remains the second leading cause of death from a single infectious agent, with a high burden in low-income regions such as South Africa. Improved detection of these drugs enables rapid monitoring, supports personalized dosage adjustments, and enhances therapeutic outcomes while minimizing adverse effects [3], highlighting the potential of Cu-TriPOP as a smart sensing material for TB treatment monitoring.

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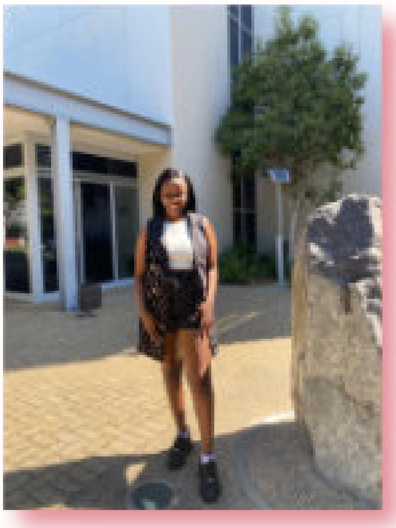
Miss Sivenathi Davani



Miss Sivenathi Davani obtained both her undergraduate and Honours degrees in Chemistry at the University of the Western Cape (UWC). Her passion and determination for research led her to pursue a master's degree at the same institution, where she focuses on developing electrochemical methods that optimize treatment and improve the use of tuberculosis (TB) drugs. Specifically, her project involves designing sensor modified with a copper-decorated porphyrin-based porous organic polymer (Cu-TriPOP) for the sensitive and selective detection of ethambutol and pyrazinamide using voltammetric techniques.

Physical Properties of Nano- Scaled silver in Boron Nitride Matrix

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Abstract

In this study we transformed the characteristics of silver nanoparticles from non-magnetic to magnetic by enclosing them in a boron nitride matrix, which seprates the silver nanoparticles from each other, making their magnetic moment parallel. The chemical method used to manufacture the silver nanoparticles in boron nitride matrix (Ag NB) was freeze- drying .XRD data revealed that the average size of Ag BN nanoparticles was 6.41 nm, which is similar to the particle size obtained by TEM, 11 nm. We also discovered that Ag BN nanoparticles have ferromagnetic characteristics at 300 K (room temperature) with magnetic parameters such as magnetic saturation ,coercivity and retentivity of Ms=0.0115 emu/g, Hc=0.017 T, and Mr=0.0007 emu/g. In addition to photoluminescence at 430 nm (2.8 eV), in the visible and blue light regions. Our investigation of Ag BN nanoparticles has revealed unexpected magnetization in silver nanoparticles, as ferromagnetic (FM) ordering is normally observed in transition-metal systems generally originates from partially filled d-electron shells. Thus, the mechanism responsible for this observed magnetization remains ambiguous. We utilize first-principles spin-polarized density functional theory to examine the magnetization in Ag nanoclusters. Silver nanoparticles with enhanced magnetic capabilities allow them to be used in a variety of essential applications, including magnetic storage, medical imaging, medication delivery, cancer treatment, and water purification [1,2,3].

Key words: silver, Boron Nitride, Freeze drying,Magnteic properteis ,Nano

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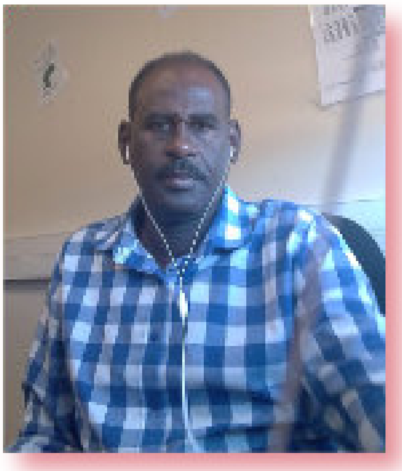
Awadelkrim Ibrahim



Awadelkrim is a Sudanese physicist as masters student from the University of South Africa (UNISA). His postgraduate research focused on investigating the physical properties of Gd-doped boron nitride (Gd-BN) and Ag-doped boron nitride (Ag-BN), exploring their structural, electronic, and magnetic characteristics using computational and theoretical methods. Awadelkrim is particularly interested in materials science and condensed matter physics. He is set to begin his PhD studies, where he aims to further explore advanced materials with potential applications in nanotechnology and spintronics. His dedication to scientific research reflects his commitment to contributing to both academic knowledge and practical innovations.

Smart Pulmonary Drug Delivery: Inhalable Protein-based Nanoparticles for treatment of Multi-Drug Resistant-Tuberculosis

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Key words: Multi-drug Tuberculosis, protein nanoparticles, pulmonary drug delivery

Abstract

Multi-drug-resistant Tuberculosis (MDR-TB) remains a persistent health challenge with treatment involving administration of injectable aminoglycosides. These drugs cause serious renal, neurotoxicity and ototoxicity; and their administration is lengthy costly, invasive and requires hospitalisation, making them an undesirable albeit effective treatment option. In this study a model drug, capreomycin, was loaded in heparin-albumin nanoparticles. The nanoparticles were formulated using desolvation method and their physicochemical properties were determined using techniques such as DLS, HPLC, NMR and SEM. The nanoparticles were further developed into a dry powder inhalable formulation through spray drying and characterised. Cellular uptake and cytotoxicity studies were done using RAW 264.7 macrophage cell line and the uptake was visualised and quantified using fluorescence microscopy and flow cytometry respectively. The results showed that the formulation was synthesised successfully, and the inhalable protein-based nanoparticle system was a promising drug delivery system for the treatment of MDR-TB.

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Ms Pamela Kadare

Ms Pamela Kadare is a PhD candidate at the School of Pharmacy in the Faculty of Natural Sciences, at the University of the Western Cape, Cape town, South Africa. She is a pharmacist by training with working experience in regulatory pharmacy and formulation science. She holds a Master of Science degree in Drug Delivery from Aston University, UK. Currently, she is part of the Infectious disease Nanomedicine Group (IDNM) under Professor Admire Dube. Her research focus is on the development of nanomaterials for targeted drug delivery, and she is currently working on the development of an inhalable nano formulation for treatment of Tuberculosis integrating nanotechnology and pulmonary drug delivery systems.

P-MD-05

Exploring the biocompatibility and therapeutic potential of plant-based gold nanoparticles using zebrafish as a model organism.

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Abstract

Diabetes mellitus is a chronic condition characterised by insufficient insulin production or ineffective utilisation. Current treatment options face challenges, including poor bioavailability and side effects. This study introduces a novel approach using gold nanoparticles (TT-AuNPs) synthesised from *Tetrapleura tetraptera* extract to improve diabetes treatment. The nanoparticles were characterised using UV-Vis spectroscopy, DLS, FTIR, TEM, XRD, and SEM-EDS. The UV-Vis analysis revealed a surface plasmon resonance peak at 528 nm, while DLS analysis indicated a hydrodynamic diameter of 36.5 nm and a zeta potential of -22.3 mV, suggesting moderate stability. FTIR analysis confirmed the presence of plant-derived functional groups that facilitate the reduction and stabilisation of the gold nanoparticles. XRD results showed a face-centred cubic structure, and TEM images depicted predominantly spherical and well-dispersed nanoparticles. These findings indicate that TT-AuNPs possess suitable properties to function effectively as nanocarriers for diabetes treatment.

Keywords: *Tetrapleura tetraptera*, nanocarriers, diabetes mellitus.

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Sharon Modjela

Sharon Modjela is a master's student in Nanoscience at the University of Johannesburg. She holds a BSc in Biochemistry and Microbiology and an Honours degree in Microbiology from the University of Limpopo, as well as a Postgraduate Certificate in Education (PGCE) from the University of the Witwatersrand. Her research focuses on the green synthesis of gold nanoparticles using Tetrapleura tetraptera extract and their potential application in diabetes treatment. She combines nanotechnology with zebrafish models to investigate biocompatibility and glucose-regulating effects. Sharon is passionate about science and committed to advancing sustainable nanomedicine for chronic disease management.

P-MD-06

Exploring the wound healing capacity of *Chromolaena odorata*-synthesized silver nanoparticles using zebrafish as a model organism

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Abstract

This study explores the wound healing capacity of AgNPs synthesised using a plant extract of *Chromolaena odorata* (Co) and compares it to the Turkevich method (chemical-AgNPs). The synthesized AgNPs were characterized using UV-Vis, FTIR and DLS. Furthermore, it was evaluated for antioxidant activity, antimicrobial activity, and toxicity. The green-AgNPs were confirmed by a pale brown colour change, with absorption wavelength at 450 nm, hydrodynamic size of 150 nm, and a Zeta-potential of -18,9 mV, slightly similar to chemical AgNPs. The Green-AgNPs were stable for months better than the chemical-AgNPs and showed antioxidant activity. The green AgNPs showed antibacterial activity and were biocompatible with zebra fish. The findings of this study provided valuable insights into the difference between green and chemical-AgNPs and the potential of Co-synthesized AgNPs as a wound healing reagent against antimicrobial infection.

Keywords: Silver nanoparticles, zebrafish, wound healing, toxicity

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Munyai Lucas

I, Munyai Lucas holds a bachelor’s degree in microbiology and Biochemistry, with an Honors in Microbiology. I am a postgraduate researcher with a growing focus on nanobiotechnology and the biomedical applications of green-synthesized nanoparticles. My recent work centers on the antimicrobial and wound-healing properties of silver nanoparticles (AgNPs) derived from medicinal plant extracts. I am passionate about translational research, and I aim to bridge natural product chemistry and nanomedicine for public health impact.

The formulation of vanadium nanoparticles using Oleanolic acid: Green synthesis and effects on glucose metabolism

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ABSTRACT

Transition metals such as vanadium have gained considerable interest due to their medicinal benefits, particularly antidiabetic effects achieved through enhancing glucose transport, facilitating adipocyte oxidation, and promoting glycogen synthesis in the liver [1]. Despite considerable investigation into vanadium-based substances for controlling glucose metabolism, their practical application remains restricted due to adverse effects such as toxicity, instability, and poor absorption by the body [2]. To overcome these effects while maintaining glycaemic control, this study used the green synthesis approach to produce vanadium nanoparticles (Vnps) using oleanolic acid (OA)—a pentacyclic triterpenoid abundant in medicinal herbs and plants, as both a reducing and capping agent. Particle morphology, size distribution, and surface functionality were characterized using UV-Vis spectroscopy, TEM, DLS, and FTIR. *In vitro* assays investigated cytotoxicity and effects of OA-Vnps on glucose metabolism in HepG2 and C2C12 cell lines. UV–Vis spectroscopy confirmed the successful formation of OA-VNPs, showing an absorption peak at 263 nm. DLS analysis determined a hydrodynamic diameter of 178 nm with a zeta potential of −14.1 ± 0.9 mV. TEM showed a spherical morphology, FTIR confirmed the presence of OA functional groups on the nanoparticle surfaces, and MTT assay revealed no cytotoxicity on C2C12 cell line after treatment with the nanoparticles. These results provide a foundation for future in vivo studies on the antidiabetic potential of green-synthesized OA-Vnps.

Keywords: Vanadium, oleanolic acid, green approach, glucose metabolism, nanoparticles.

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Ms Olebogeng Noge

Ms Olebogeng Noge is a Master’s candidate in Nanoscience at the Nelson Mandela University, with an Honours degree in Microbiology. Her research focuses on the green synthesis of vanadium nanoparticles and their biomedical applications in glucose metabolism.

Investigation of antimicrobial activity of green-synthesized silver nanoparticles from *Camellia sinensis* against *Mycobacterium smegmatis*

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Abstract

Tuberculosis (TB) remains a major global health threat, particularly with the rise of multidrug-resistant (MDR) strains. Silver nanoparticles (AgNPs), especially those synthesized via green methods using plant extracts, offer a promising alternative for antimicrobial therapy. *Camellia sinensis* (green tea), rich in polyphenols, serves as both a reducing and stabilizing agent in AgNP synthesis. This study aimed to synthesize AgNPs using *Camellia sinensis* extract and evaluate their antimicrobial activity against *Mycobacterium smegmatis*, a non-pathogenic model for TB. Characterization was conducted using UV-Vis spectrophotometry and dynamic light scattering (DLS). UV-Vis spectra showed absorption peaks between 400–500 nm, confirming AgNP formation. The hydrodynamic sizes were 204, 206, and 290 nm for concentrations of 3, 6, and 9 mg/mL, respectively. Antimicrobial activity was assessed using the Microplate Alamar Blue assay. These results suggested that green-synthesized AgNPs have the potential to serve as sustainable and effective antimycobacterial agents.

Keywords: Tuberculosis, *Camellia sinensis*, Silver nanoparticles, *Mycobacterium smegmatis*, Green synthesis, Antimicrobial activity of nanoparticles

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P-MD-09

Biosynthesis of calcium carbonate ($CaCO_3$) nanoparticles via plant extracts for therapeutic as phytonanomedicine

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Abstract

In this study, we report for the first time the biosynthesis of single-phase crystalline calcite $CaCO_3$ nanoparticles using *Spinacia oleracea* extracts as an effective chelating agent. Green synthesis of calcium-based biomaterials are highly biocompatible and biodegradable and have been utilized in biomedicine. The synthesis of $CaCO_3$ NPs at room temperature was confirmed using plant as a natural chelating agent (e.g. phytochemicals and biomolecules) and water as a universal solvent, using calcium chloride and carbon dioxide as sources. The particles were characterized by Ultraviolet-visible absorption spectroscopy, (UV-Vis), sanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD), infrared (FTIR) spectroscopy, dynamic light scattering (DLS) and RAMAN spectroscopy.

Keywords : Calcium carbonate, nanoparticles, Biosynthesis

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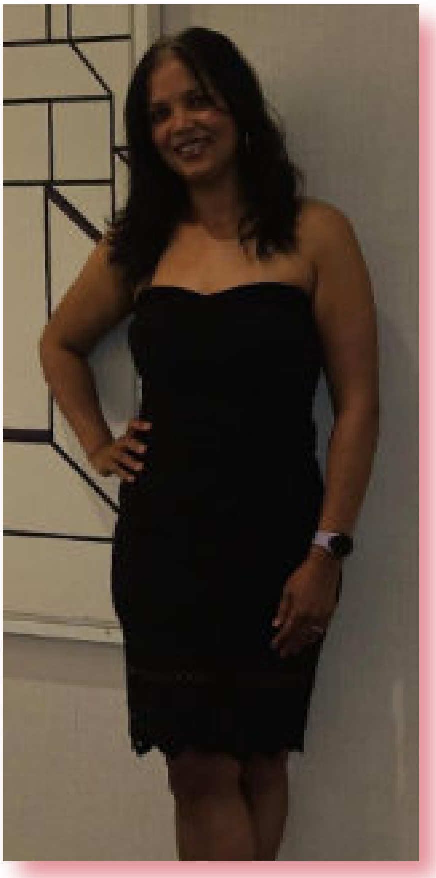
Letoya Williams-Cozyn



Letoya Williams-Cozyn is a PhD Fellow at the UNESCO-UNISA partnership with expertise in sustainable nanotechnology applications. She holds an MSc in Nanoscience and Bsc Honours in Biotechnology from the University of the Western Cape (UWC). Her interdisciplinary research spans biotechnology, nanotechnology, and green chemistry, focusing on sustainable solutions for global health and environmental challenges. Letoya specializes in phytonanomedicine—an approach to biomaterial engineering that prioritizes biological compatibility and biodegradation. Her current work advances novel treatment approaches using biodegradable nanomaterials, particularly targeting reconstructive bone material, antimicrobial resistance and climate-health intersections. She is recognized for her contributions to green nanotechnology as a driver of sustainable development goals and environmental remediation.

Investigation of Zinc Oxide Doped in Low Density Polyethylene (LDPE) to Produce Chemical Resistant Thin Films

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Keywords: low density polyethylene, zinc oxide doped films, photocatalysts, permeation

Chemical protective garments are mostly bulky and heavy; made of multi-layered materials with the inner layer laminated with activated carbon (AC) to absorb toxic chemicals. Others have replaced AC with different metal oxides, like CuO, TiO_2, MgO, to entrap permeating chemicals through the materials. In this study, LDPE will be doped with (0, 5, 10, 15%) of photocatalyst, ZnO, to produce thin films. The synthesized films' physico-chemical properties were characterized by SEM, TGA, FTIR, and tensile tester. The uniform lightweight zinc oxide doped LDPE films were successfully produced with fairly good ZnO particles distribution. Synthesized ZnO doped LDPE films showed improved physical properties when compared to the neat LDPE film. The synthesized ZnO doped films exhibited interesting chemical resistance trends when permeation times of 2-chloroethyl ethyl sulfide (CEES), were evaluated. In conclusion, the neat LDPE performed better as a barrier against permeating CEES when compared to the synthesized ZnO doped films.

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BIOGRAPHY:

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Tina E. Lefakane is a research scientist whose early career involved testing fertilizers, pesticides, and pilot-scale chemical products at AECI before joining Protechnik Laboratories. She is currently involved in research and development initiatives focused on personal protective equipment (PPE), with a strong emphasis on innovation and protection capabilities. Her academic interests span nanotechnology, polymer chemistry, and materials chemistry. Currently undertaking a PhD at Tshwane University of Technology, where she continues to expand her expertise in advanced materials and protective technologies.

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Sawdust-Biochar/gC3N4 Magnetic Nanocomposite for Efficient Atrazine Removal from Water

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Abstract

The increasing demand for sustainable, cost-effective strategies to remove toxic heavy metals from mining wastewater highlights this study's significance. A magnetic biochar/gC_3N_4 nanocomposite was synthesized from pine sawdust waste and applied to mine tailings in South Africa. Detailed characterization using FTIR, PXRD, SEM-EDX, and TGA confirmed the successful synthesis, thermal stability, and uniform elemental distribution of the composite. The material's functional groups provided promising adsorption sites, while its magnetic properties promote separation and recovery. This environmentally friendly nanocomposite offers a promising approach for remediating heavy metal-contaminated mining effluents, contributing to improved environmental management.

Keywords: Magnetic nanocomposite, Heavy metal removal, Biochar

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Dr Matin Naghizadeh

Dr. Matin Naghizadeh holds a PhD in Nanoscience and Technology (Nano Chemistry) from Kerman University, Iran, specializing in nanocomposites and their applications in smart drug delivery, photocatalysis, and magnetic nano-absorbents. His prolific research includes over 32 publications in leading journals, an H-index of 14, three co-authored books, one patent, and extensive peer-reviewed contributions. He has been recognized as the top PhD student in Iran (2017-2018, 2019-2020) and awarded the Iran Nobel Prize in 2020.

Dr. Naghizadeh's international experience includes a visiting researcher role at Universidad Autónoma de Madrid, where he studied covalent organic frameworks and 2D materials, as well as collaboration with Xi'an University, China. Since 2023, he has been a Postdoctoral Research Fellow at the University of the Free State (UFS) under the supervision of Professor Karel Von Eschwege, focusing on sustainable materials, including wood reinforcement, water harvesting from air, and biochar applications. In 2025, he was also recognized as a Y2-rated researcher by the National Research Foundation (NRF).

P-SM-03

Physicochemical and optical properties of green-synthesized black TiO_2 nanoparticles using Hibiscus Sabdariffa flower extract and its application

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Abstract

A wide range of technological applications, from energy storage to catalysis, can benefit greatly from the synthesis of nanomaterials. From these materials, titanium dioxide (TiO_2) nanoparticles have attracted a lot of interest because of their special optical, electronical, and photocatalytic properties. In this study, we will use green chemistry synthesis to investigate the properties of black nanoscale titanium dioxide (TiO_2). The black nano-scaled titanium dioxide (TiO_2) will be obtained by using the natural extract Hibiscus Sabdariffa mixed with distilled water and the titanium precursor titanium (IV) bis ammonium lactato dihydroxide 50 wt % solution in water at room temperature. The effect of these factors on the structural, morphological, and optical properties of TiO_2 nanoparticles were studied utilizing various characterization techniques which included X-ray diffraction (XRD), Ultra-violet visible spectroscopy (UV-VIS), Photoluminescence (PL), and Diffusion Reflectance (DR) to mention a few.

Keywords: Green synthesis, black nanoscaled TiO_2 ,natural extract Hibiscus Sabdariffa, optical properties

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Omphulusa Nelwamondo

I am Omphulusa Nelwamondo an MSc Candidate in Material Science (Chemistry) at the University of South Africa, based at iThemba LABS NRF. My research focuses on the Properties of green Chemistry Synthesis of Black nanoscaled Ti, with an interest in its optical and functional applications. I hold a BSc Honours degree in Chemistry, and I am preparing to enrol for PhD once I am done with my MSc.

P-SM-04

Understanding the fundamental properties of 1-D Co_3O_4 - ZnO nanofibers for enhanced gas sensing performance

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Abstract:
Chemiresistive gas sensors are widely used for gas detection due to their low cost, simple fabrication, and rapid response [1]. However, challenges such as low selectivity, reduced sensitivity in complex environments, and instability under varying conditions often limit their performance [1].

To overcome these issues, this study explores the development of p–n heterojunction sensors based on cobalt oxide (Co_3O_4) and zinc oxide (ZnO). Co_3O_4 offers p-type conductivity and catalytic activity, while ZnO is a stable n-type semiconductor with high electron mobility. Their combination enhances charge separation and gas response [2]. Incorporating one-dimensional (1D) nanostructures like nanofibers further improves performance by increasing surface area and facilitating gas diffusion [3].

Structural, morphological, and electronic properties of Co_3O_4-ZnO nanofibers are characterized using XRD, SEM, PL, UV-Vis, Raman, and XPS techniques. These analyses establish a connection between material properties and sensing behavior. The study highlights Co_3O_4-doped ZnO nanofibers as promising candidates for high-performance gas sensing applications.

Keywords: Chemiresistive gas sensor, p-n heterojunction , 1D nanomaterials.

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Nkuna Khanyisile

Nkuna Khanyisile is an MSc Physics student at the University of the Witwatersrand. Her research focuses on chemiresistive semiconductor - based gas sensors for environmental applications. She is passionate about Science innovation and communication and academic mentorship.

P-SM-05

Size-dependent computational study of the stability, and toxicity of biomolecules of iron oxide nanoparticles.

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The significant growth in nanotechnology has resulted in the formation of various nanoparticle (NPs) types. Their small size allows them to actively travel intravascularly or intracavity for drug delivery. Despite their advantages, the toxicity of iron oxide NPs (IONPs) remains largely unexplored. In this study, research has been done in the mathematical modelling of magnetite (Fe_3O_4) NPs for the use in drug delivery systems. The modelling of these NPs with different shapes made it convenient to experiment with different sizes of the NPs. Furthermore, with the identified sizes, polyethylene glycol (PEGs) was attached onto these NPs so that various biomolecules can be attached onto these PEGs and ultimately developing the optimal drug delivery system. The PEGylated NPs with the attached biomolecules were used in simulations to evaluate the interaction with bilipid layers and the toxicity challenges that it can present.

Keywords: nanoparticle, drug delivery, PEGs, biomolecules, toxicity

Word Abstract: 140

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Danell van Wyk

My name is Danell van Wyk, and I've always had a strong curiosity for how the world works, which naturally led me to study Mathematics and Physics at the University of the Free State. After completing my undergraduate degree, I went on to do my Honours in Physics, and I am now finishing my Masters degree in Solid State Physics, where my research focuses on nanoscience and computational modelling. Over the years, I've developed not only a solid technical foundation but also a genuine passion for using physics and mathematics to solve complex problems and explore new ideas in science.

P-SM-06

Polyoxometalates for Smart Catalysis – Design Principles, Synthetic Strategies and Implementation

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As the environmental impact of the petrochemical industry and climate change become more urgent, researchers focus on developing alternative resources like biomass for the production of platform chemicals, which requires new types of catalyst materials. Keggin-type polyoxometalates (POMs), molecular clusters of transition metals (Mo, W) and heteroelements (P, Si), are promising due to their high acidity and stability. Modifying these clusters, such as metal exchange, enhances their catalytic properties. We utilize synthesis methods like self-assembly and lacunary routes, along with nanofiltration to separate by-products such as NaCl. Keggin-POMs are water-soluble and are used as homogeneous catalysts for processes like hydroformylation and sugar conversion, but can also be immobilized on supports for heterogeneous catalysis, e.g., producing dimethyl ether from CO_2 and H_2. These advances bring us closer to designing smart catalysts for sustainable, climate-friendly processes.

Dr-Ing Dorothea Voß

Dr.-Ing. Dorothea Voß studied chemical engineering at the TU Dortmund. She received her master’s degree in 2015 and earned her doctoral degree from the FAU Erlangen-Nuremberg in 2020. She is currently a head engineer at the Institute of Technical and Macromolecular Chemistry of the University of Hamburg. Her particular research focus is on catalytic conversion of biomass using homogeneous polyoxometalate catalysts.

BIO-ENGINEERED $MgCO_3$ NANOSTRUCTURE FOR CO_2 FOOT PRINT MINIMIZATION

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ABSTRACT

Magnesium carbonate trihydrate ($MgCO_3 \cdot 3H_2O$) is a promising material with diverse applications in environmental remediation, carbon sequestration, and sustainable construction. This study explores the green synthesis of magnesium carbonate trihydrate ($MgCO_3 \cdot 3H_2O$) using aqueous leaf extract of *Eucalyptus globulus* L. as a natural chelating and stabilizing agent. The process leverages the phytochemical constituents of the plant such as polyphenols, flavonoids, and organic acids to facilitate the precipitation of $MgCO_3 \cdot 3H_2O$ under ambient conditions, offering an eco-friendly alternative to conventional chemical routes. The synthesized material was extensively characterized using X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), photoluminescence (PL), transmission electron microscopy (TEM), thermogravimetric analysis (TGA), and UV- Vis spectroscopy. XRD confirmed the formation of phase-pure crystalline $MgCO_3 \cdot 3H_2O$, while FTIR spectra revealed characteristic carbonate and hydration bands. PL studies indicated defect-related emission features, suggesting potential optoelectronic applications. TEM images reveal that $MgCO_3 \cdot 3H_2O$ exhibits a rod-like or needle -like morphology. UV- Vis spectroscopy shows $MgCO_3 \cdot 3H_2O$ is largely transparent, with low reflectance due to the absence of electronic transitions in Mg^{2+} and CO_3^{2-} at Visible and UV Regions. TGA revealed a multi-step dehydration process and thermal stability profile consistent with trihydrate behavior. The green synthesis route demonstrated reduced energy input, minimized chemical waste, and potential scalability for eco-friendly applications. This work highlights the viability of plant-mediated synthesis for functional carbonate materials and opens new pathways for sustainable CO_2 mineralization, capture and storage technologies.

Keywords; Bio-engineering, CO_2 capture, Magnesium carbonate trihydrate, and Optical characterization

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Mrs Zerfie Marshet Mihabaw

I am Mrs. Zerfie Marshet Mihabaw, a dedicated physics lecturer at Debre Berhan University, Ethiopia. I earned my BSc in Physics from Debre Berhan University in 2018 and completed my MSc in Physics at the University of South Africa in 2023. Since then, I have been actively engaged in teaching intermediate and senior-level physics courses, while also contributing to community service initiatives through the Department of Physics.

Currently I am PhD student under the supervision of Prof. Maaza Malek and Prof. Noto Luyanda at university of South Africa my research related to CO2 conversion to carbonates.

Experimental and Computational Insights into the Surface-Enhanced Raman Scattering (SERS) of Saffron Bioactives on Silver Nanoparticles

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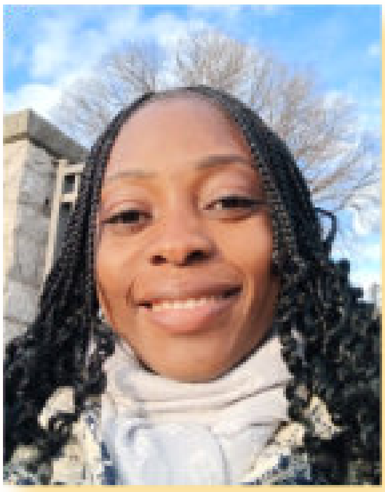
Abstract:

This study integrates experiment and theory to elucidate the Surface-Enhanced Raman Spectroscopy (SERS) mechanism of saffron compounds on silver nanoparticles (AgNPs). AgNPs were synthesized in-situ via laser ablation in a saffron extract, yielding a conjugate whose SERS spectrum showed intensely enhanced fingerprint peaks for crocin. Computational DFT simulations (M02X/6-311+G(d,p)/LanL2DZ) for a safranal-Ag model complex predicted a massive Raman intensity increase, unequivocally validating a charge-transfer-based chemical enhancement mechanism upon adsorption. Identical enhancement was computed for other key bioactives (crocetin, crocin, picrocrocin), confirming a universal affinity for silver. This synergy between practical spectroscopy and quantum mechanics not only authenticates the experimental chemisorption hypothesis but also establishes a robust, mechanistic foundation for using SERS in ultrasensitive saffron quality control and authentication.

Keys Words: Plasmonic nanoparticles, Organic molecules, Surface-enhanced Raman Scattering, Density functional theory

Erna Leticia Tchinda Ngounou



Erna Leticia Tchinda Ngounou is a passionate Doctoral Researcher at the UNESCO-UNISA Africa Chair in Nanosciences and Nanotechnology (U2ACN2). She holds a double master's degree in physics from the University of Dschang (Cameroon) and the Université de Lorraine (France), where she specialized in condensed matter and nanomaterials.

Her current research explores the fascinating interplay between organic molecules and plasmonic nanoparticles, aiming to tailor their linear and nonlinear optical properties for next-generation applications in photonics, sensing, and advanced materials. Driven by curiosity and innovation, her work contributes to the growing field of smart and functional nanomaterials.

P-SM-09

Influence of the Alkaline Earth Ions (Ca and Mg) on the Luminescence Properties of Gd^{3+} doped BaB_8O_{13} Phosphor.

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Abstract

Phototherapy is vital in treating skin conditions such as vitiligo and eczema. This study synthesised Gd^{3+} co-doped alkaline earth octaborate phosphors, $M_xBa_{1-x}B_8O_{13}$: 2% Gd^{3+} (M = Ca^{2+}, Mg^{2+}; x = 0.20 mol% respectively), via solid-state reaction. X-ray diffraction patterns confirmed an orthorhombic structure formation, with peak shifts and lattice deformation, which indicated successful ion substitution. Scanning Electron Microscope (SEM) and Energy Dispersive X-ray Spectroscopy (EDS) characterized the surface morphology and elemental composition. UV-Vis reflectance spectra and Tauc plots showed reduced bandgap energy, indicating changed electronic transitions and increased defect levels. Photoluminescence measurements showed intense Gd^{3+} blue emission at 313 nm, excited at 274 nm, especially with Ca^{2+} doping, due to improved energy transfer efficiency. Whereas Mg^{2+} doping led to emission quenching, possibly from non-radiative energy transfer. These findings implied that Gd^{3}-doped BaB_8O_{13} phosphors are promising for UV-excited photonic applications.

Keywords: Phototherapy, Gd^{3+} doped phosphors, Alkaline earth octaborates, and Luminescence properties.

Sabelo Ndlela

Sabelo Ndlela is a Master's candidate in Nanoscience(physics) from the University of Johannesburg. His research focuses on the synthesis and characterization of alkaline earth borate phosphors doped with rare-earth ions for applications in phototherapy and solid-state lighting. He has experience in solid-state synthesis and advanced characterization techniques, including X-ray diffraction, UV–Vis spectroscopy, and photoluminescence studies. Sabelo is passionate about developing luminescent nanomaterials for biomedical and energy-related technologies. He plans to pursue doctoral studies, exploring the use of rare-earth-doped borates for photonic applications.

Polyethylene glycol stabilized rGO/AuNP nanocomposites: Enhanced stability for environmental biosensing applications.

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1. Abstract

Reduced graphene oxide/gold nanoparticle (rGO/AuNP) nanocomposites are versatile materials for environmental biosensing applications; however, their practical implementation is frequently hindered by poor colloidal stability and aggregation mainly attributed to the stripping of ligands by rGO, inadequate anchoring of AuNPs, and electrostatic disturbances. In this study, we addressed these issues by synthesizing polyethylene glycol (PEG)-stabilized rGO/AuNP nanocomposites and assessing their dispersibility and long-term stability in comparison to their unstabilized counterparts. A simple one-pot synthesis method was employed, utilizing PEG as a stabilizing agent to inhibit AuNPs aggregation. AuNPs were synthesized using the modified Turkevich method, while the rGO was prepared and dispersed in deionized water. The nanocomposites were prepared by combining rGO dilutions and AuNPs at a ratio of 1:1 (v/v), followed by sonication and stabilization with PEG. Transmission electron microscopy (TEM) revealed uniform AuNPs distribution on rGO sheets, with particle sizes averaging 20 - 25 nm. Raman spectroscopy indicated improved dispersion and colloidal stability, while ultraviolet-visible (UV-Vis) spectroscopy validated AuNPs integration within the rGO matrix. These results offer a scalable approach to address instability in nanocomposites, thereby facilitating improved performance in catalytic and environmental biosensing applications.

Keywords: Polyethylene glycol; reduced graphene oxide; gold nanoparticles; nanocomposites; stability

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Mr Eldas Maesela

Eldas is an accomplished technologist with an academic background in Industrial Physics (Photonics) and Material Sciences. He is currently working under Nano-Micro Manufacturing Facility at CSIR, South Africa. He is currently enrolled for Master of Applied Sciences (Industrial Physics) at Tshwane University of Technology, focusing on fabrication of environmental biosensing technologies. His visionary perspectives have earned him opportunities to work on innovation and R&D projects at CSIR over the past 5 years.

Phytosynthesis and the mechanism of biosynthesis of black nanoscaled titanium dioxide using Hibiscus Sabdariffa flower extract.

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Abstract

Green synthesis is superior to chemical and physical processes because it is less expensive, more environmentally friendly, and simpler to scale up for large-scale manufacturing. This process does not require expensive equipment, high temperatures, pressures, or even tiny amounts of dangerous chemicals. Using the green synthesis method, black Titanium dioxide (TiO_2) nps will be synthesized using the flower extract of the HS flower [1][2]. Numerous studies have demonstrated that biomolecules such as alkaloids, polysaccharides, and alcoholic and phenolic compounds found in plant materials may play a role in the formation, stabilization, and bioreduction of the nanoparticles. The precise mechanism by which plant extract biosynthesizes nanoparticles is still unclear [3][4]. In this study, the mechanism of the formation of black nanoscaled TiO_2 was investigated. These phytocompounds were then linked together to determine the mechanism of biosynthesis. The identification of phytocompounds of the prepared TiO_2 was studied using UPLC-UV-qTOF/MS and HPLC.

Keywords

Black titanium dioxide, green synthesis, phytocompounds, mechanism of biosynthesis

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Kwinda Humbelani

I am Kwinda Humbelani, A Master's student pursuing my degree in Chemistry from the University of South Africa. My research is titled Phytosynthesis and the mechanism of biosynthesis of black nanoscaled titanium dioxide using Hibiscus Sabdariffa flower extract under the supervision of Prof Malik and Dr Moema.

P-WW-01

Green-Synthesized Biochar-Nanoparticle Composites for Phosphate Recovery and Reuse from Wastewater

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Abstract

This study investigates a novel and sustainable approach for phosphate recovery from wastewater systems using biochar-based nanocomposites synthesized through green methods. The adsorbents investigated are composed of biochar derived from the bark of Acacia *mearnsii* and Acacia *decurrens* (black and green wattle), which are then functionalized with nanoparticles of ZnO, CaO, and MgO. These nanoparticles are synthesized using an aloe extract as a stabilizing agent. Characterization of the composites is carried out to elucidate changes in surface chemistry, morphology, and adsorption behaviour. Batch adsorption studies further evaluate the phosphate removal efficiency of these composites from simulated wastewater samples. Additionally, experiments are conducted to evaluate the potential of the composites as slow-release phosphate sources when applied to agricultural soil, highlighting its suitability for use as environmentally friendly fertilizers. This work is an example of transforming biomass waste into functional materials, creating a circular economy.

Keywords: Adsorption, Isotherm, Pollutant, Acacia, Biochar, Nanoparticles

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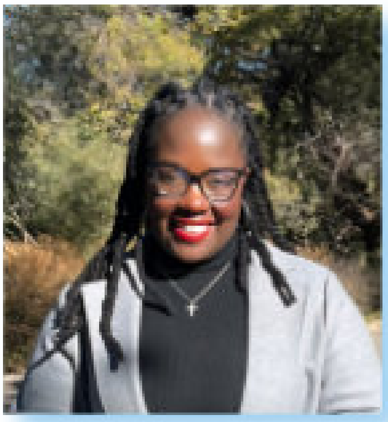

Karabo Rethabile Harejane is a master's student in Nanoscience with a strong academic background in the chemical sciences. She holds a Bachelor of Science degree in Chemistry and Biochemistry, as well as an Honours degree in Chemistry from the University of the Free State. Her research interests lie in the application of nanomaterials for sustainable solutions, with a particular focus on environmental remediation. Passionate about advancing sustainability through scientific innovation, she is currently investigating the use of nanomaterial-based systems for water treatment.

P-WW-02

Enhanced Phosphorus Recovery from Wastewater Using Nanoscale MgO-Modified Biochar Derived from Bark

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Abstract

Although phosphorus (P) is vital for plant development and maintaining environmental balance, its excess in water can cause eutrophication [1]. While adsorption is a potential solution to the issue, developing low-cost and efficient adsorbent materials is still a challenge [2]. The phosphate adsorption capacity of biochar was found to be limited. However, the generation of magnesium oxide (MgO)-biochar through modifying the crystal structure of biochar can enhance its phosphate adsorption [3]. An impregnation-pyrolysis technique was employed for synthesizing nanoscale MgO-doped bark biochar for enhancing the P recovery efficiency from wastewater and examination. The phosphate adsorption capacity of MgO-biochar at an initial concentration of 60 mg P L^{-1} was 70.01 mg P g^{-1}, which was higher than that of unmodified biochar (12.79 mg P g^{-1}). The results indicate that bark-derived MgO-biochar offers a promising strategy for phosphorus recovery and improved wastewater treatment.

Keywords: Bark biochar, Phosphorus recovery, Wastewater treatment, Phosphate adsorption.

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Dr Elham Jalali

Dr. Elham Jalali is a postdoctoral research fellow at the University of the Free State, South Africa, specializing in nanotechnology applications for environmental and agricultural advancement. She earned her Ph.D. in Nanoscience & Technology from Shahid Bahonar University of Kerman, Iran, in collaboration with the University of Valencia, Spain. Her research focuses on the synthesis and application of nanomaterials such as biochar-based composites, graphitic carbon nitride, graphene oxide, sulfur quantum dots, and metal oxides for improving pesticide performance, pollutant adsorption, photocatalytic degradation, dye removal, and the development of antibacterial textiles. She has published over ten peer-reviewed articles and possesses extensive expertise in advanced material characterization techniques. She has also contributed to book authorship and holds an Iranian patent in the field of nanoparticle-enhanced biopesticide formulation. Her work contributes to the development of sustainable wastewater treatment and nanomaterial-based environmental solutions.

P-WW-03

Enhanced Adsorption of Nitrogen, Phosphorus, and Potassium on $MnFe_2O_4$-Modified Activated Carbon Nanocomposite for Sustainable Nutrient Recovery

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Abstract

Excessive use of nitrogen (N), phosphorus (P), and potassium (K) fertilizers in agriculture, driven by losses from leaching and runoff, leads to inefficient nutrient use and environmental issues. The study investigates the adsorption of N, P, and K using activated carbon (AC), biochar, and a synthesized $MnFe_2O_4$@AC nanocomposite. The nanocomposite was prepared via the co-precipitation method and characterized using PXRD, FTIR, SEM-EDX, and elemental composition analysis. These techniques confirmed the successful impregnation of $MnFe_2O_4$ nanoparticles onto the AC surface and revealed enhanced surface functionality, porosity, and elemental distribution conducive to nutrient adsorption. Adsorption studies demonstrated superior retention capacities for N, P, and K by $MnFe_2O_4$@AC compared to both unmodified AC and biochar. The enhanced adsorption is attributed to the synergy between the magnetic nanoparticles and carbon support, positioning $MnFe_2O_4$@AC as a more effective and sustainable material for nutrient recovery in agricultural applications.

Keywords: $MnFe_2O_4$@AC nanocomposite, Adsorption, Nutrient recovery, AC.

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Mr Ramokwai Malimabe

Ramokwai Malimabe is a Master's student in Chemistry at the University of the Free State, holding an Honours degree in the same field. His current research focuses on the adsorption of fertilizers using nanocomposites, activated carbon (AC), and biochar an area aimed at improving the efficiency and environmental impact of agricultural practices. He is particularly interested in the application of nanotechnology in sustainable chemistry.

As part of his academic journey, he was awarded a prestigious scholarship through the national Nanoscience Programme, which enabled him to undertake advanced studies at the University of the Western Cape (UWC). His work contributes to the growing body of research on environmentally responsible fertilizer management and nano-enabled solutions in agriculture.

P-WW-04

Indigenous Biomass-Derived Carbon-based Materials for Environmental Remediation

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Abstract

Activated carbon and biochar are carbonaceous materials that are extensively utilized to remediate various environmental concerns faced throughout society, such as soil degradation, climate change, air and water pollution.[1,2]. This study involved the beneficiation of various indigenous biomasses into biochar and activated carbon through thermal treatment and physical activation, utilizing steam as an activating agent, respectively. The physical and chemical properties of the as-prepared materials were investigated using multiple analytical characterization techniques, including Brunauer-Emmett-Teller (BET), scanning electron microscopy, thermogravimetric analysis, and elemental analysis, among others. The moderate to highly porous nature, as well as the high surface areas, exhibited by both biochar and activated carbon from different biomasses, make them suitable for soil amendment and water treatment, among other applications.

Keywords:

Biomass; Thermal treatment; Physical activation; Biochar; Activated carbon

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Sampie Motloung

Sampie Motloung is a doctoral student in the Department of Chemistry at the University of the Free State, South Africa. His current research explores the beneficiation of various indigenous biomasses for production of biochar and activated carbon for new sustainable environmental remediation applications. He is passionate about contributing to the academic and industrial space for the betterment of the society.

Synthesis of AgNP-Cellulose Acetate Using Conventional and Green Approaches for the Efficient Removal of Neonicotinoids in Wastewater

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The increasing presence of neonicotinoid insecticides in water bodies poses significant environmental and health risks due to their high solubility, chemical stability, and neurotoxicity to aquatic organisms. [1], [2]. This study developed a cost-effective, eco-friendly nanocomposite for efficient removal of neonicotinoids from wastewater. Silver nanoparticles (AgNPs) were synthesised via a green method using *Vitellaria paradoxa* (Shea tree) stem bark extract and combined with cellulose acetate extracted from waste cigarette butts. [3], [4]. UV-Vis analysis confirmed AgNP formation at ~ 420 nm, while FTIR identified phytochemical capping groups. DLS revealed particle sizes of 25 to 100 nm with a zeta potential of -21.9 to -17.0 mV, and XRD confirmed FCC silver and semi-crystalline CA. TEM showed spherical AgNPs with uniform dispersion, whereas SEM revealed the porous surface morphology of the AgNP–CA composite. TGA indicated enhanced stability with ~18% residue at 600 °C, and BET analysis showed a surface area of ~45 m^2/g. The composite achieved 92% removal efficiency, retained >80% efficiency after five cycles, and exhibited minimal Ag leaching (~0.12 mg/L, ~1.5%).

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Lucky Moagi Mpshe

Lucky Moagi Mpshe is an emerging chemist and nanoscientist with a strong interdisciplinary background in botany, analytical chemistry, and nanomaterials. He holds a BSc in Botany and Chemistry and a BSc Honours in Chemistry from the University of Johannesburg, where his Honours research focused on the quality control, efficacy, and safety of commercial herbal medicines, with a specific emphasis on cannabis-based products. This work reflected a unique integration of phytochemistry to evaluate the scientific credibility and safety of plant-based therapeutics.

Currently pursuing an MSc in Nanoscience (Chemistry major) at the University of Johannesburg, Moagi's research centres on the green synthesis of silver nanoparticles (AgNPs) and their functionalization with cellulose acetate (CA) for the removal of neonicotinoid insecticides (NNI's) from wastewater. His work aligns with the principles of green chemistry and environmental sustainability, with applications in advanced water treatment technologies.

He is passionate about sustainable innovation at the interface of natural products chemistry, materials science, and environmental remediation. His competencies include nanoparticle synthesis and characterization, green extraction techniques, analytical method development, and environmental pollutant monitoring.

P-WW-06

Comparative Study of $ZnCo_2O_4$ and $ZnNb_2O_4$ Spinel Nanocomposites for Electrochemical Detection of Chloramphenicol in Environmental and Biological Matrices

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Presenting Author: Ms. Kgwadu Percy Mulaudji

Abstract

Accurate quantification of antibiotic concentrations is essential for the treatment of serious infections and antimicrobial control. The rising demand for innovative treatments has driven extensive research dedicated to examining the behaviour and impact of antibiotics within the human body. This includes their mechanism of action, targeted biological sites, potential side effects and residual trace elements. Chloramphenicol (CAP), a broad-spectrum antibiotic, has gained significant attention due to its link with drug-resistant bacterial strains [1-3]. Its dual role as a therapeutic saviour and potential toxin emphasizes its complex pharmacological profile which makes it ineffective against certain pathogens while remaining active against others, this makes it a compelling subject for further investigation [1-7]. Recent detection technologies have led to the development of highly selective and sensitive electrochemical sensing platforms for CAP monitoring in clinical and environmental samples. However, notable gaps remain, particularly in integrating the sensing materials that can detect CAP in a pico-Molar range and employing a cost-effective electrochemical sensor platform. The appropriate CAP dosage depends on the disease condition, as careful administration is essential to avoid its toxicity. Spinel materials possess multiple cationic ions, abundant oxygen vacancies, and high reactivity, which are beneficial for sensor applications [8;9]. This study compares the electrochemical performance of $ZnCo_2O_4$ and $ZnNb_2O_4$ spinel nanocomposites for CAP detection. $ZnCo_2O_4$ achieved a detection limit of 0.15 µM, while $ZnNb_2O_4$ is currently under evaluation [9].

Key words: chloramphenicol, $ZnCo_2O_4$ and $ZnNb_2O_4$ spinel nanocomposites, electrochemical sensing, mechanism of action

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Ms Kgwadu Percy Mulaudji

Ms. Kgwadu Percy Mulaudji is a postgraduate researcher at the University of the Western Cape, specializing in electrochemical sensor development for environmental and biomedical applications. Her current research focuses on nanostructured materials for the detection of emerging contaminants in water and biological systems, with a keen interest in sustainable sensing technologies tailored for resource-limited settings.

TREATMENT OF LEACHATE USING CELLULOSE BIOFLOCCULANT

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Keywords: leachate, bioflocculant, cellulose, turbidity

Wastewater management and improvement in environmental water quality are crucial for ensuring the safety of end users, therefore achieving SDG 6. However, discharge of the landfill leachate continues to be a threat to land, aquatic life and groundwater. Herein, cellulose-based bioflocculant derived from agricultural waste is investigated as an environmentally friendly and long-term sustainable solution to the pre-treatment of leachate, with successive post treatment using membrane distillation. The current chemical flocculants used to treat leachate are not only costly but also produce harmful and non-biodegradable sludge, requiring careful handling and disposal. The study commenced with the extraction of cellulose from selected agricultural waste followed by characterisation using FTIR, XRD and SEM-EDS. Jar test experiments were conducted to test the efficacy of the bioflocculant yielding remarkable turbidity and COD reductions of 89% and 57%, respectively. These findings highlight the potential of cellulose-based bioflocculant as a sustainable pre-treatment method for leachate.

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Ms Makhamathi Sello

Ms Makhamathi Sello is an MSc in chemistry candidate at the University of the Witwatersrand. She has a Bachelor of Science degree in biology and chemistry from the National University of Lesotho and an honors degree in chemistry from the University of the Witwatersrand. She has co-supervised two honors research projects and is currently assisting in undergraduate labs as a lab demonstrator. She is passionate about sustainable development solutions and current research focuses on the use of an agricultural waste-based bioflocculant for the pre-treatment of leachate and membrane distillation technique as a post-treatment method.

Impregnation of wood-derived activated carbon with metal-based nanoparticles

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The degradation and pollution of the natural environment is a global problem. The advancements in development and rapid growth of the population cause stress on freshwater systems. Addressing this issue requires the development of economical and ecologically friendly materials. In this study, wattle bark derived activated charcoal was produced via physical activation. Furthermore, nanoparticles of silver, copper oxide and iron (III) oxide were successfully synthesized using aloe vera extract as a reducing and stabilizing agent. FTIR, PXRD, DLS/Zeta potential, BET, SEM/EDS, and TEM were used to verify the synthesis and characterize the structural and morphological properties of the nanoparticles. The nanoparticles were then impregnated on the activated charcoal. This study combined the magnetic, antibacterial, and antimicrobial properties of the nanoparticles with the adsorption ability of activated charcoal to eliminate phosphates and microbial contaminants from water.

Keywords: Activated charcoal, phosphates, bacteria, silver nanoparticles, copper oxide nanoparticles, iron (III) oxide nanoparticles.

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D Speek

MSc Nanoscience (Chemistry) candidate specializing in waste beneficiation and the synthesis of nanoparticles and their applications in environmental remediation.

Synthesis and Characterisation of Ag/Cu Chitosan nanoparticles for the adsorption emerging contaminants from wastewater effluent.

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Abstract

Recent advancements in cost-effective methods for contaminant remediation have made bimetallic nanoparticles particularly suitable for removing emerging contaminants from waste water owing to their unique chemical and physical properties.

Bimetallic nanoparticles have gained significant attention due to their distinctive catalytic, electronic, optical, and magnetic properties [1]. These nanoparticles, composed of two metals, exhibit enhanced catalytic, electronic, optical, and magnetic characteristics due to synergistic effects. The choice of metal combinations and synthesis techniques significantly influences pollutant removal efficacy [2].

The research focuses the synthesis of a bimetallic Ag/Cu nanoparticles in a chitosan aqueous solution for application in the removal of emerging contaminants from wastewater effluent.

The study presents results on the chemical, physical, and morphological properties of the nanoparticles, analysed through techniques such as X-ray diffraction (XRD), Fourier Transform Infrared (FT-IR) spectroscopy, Ultraviolet-Visible (UV-Vis) spectroscopy, scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS), transmission electron microscopy (TEM), and thermogravimetric analysis (TGA).

Key words: Chitosan; Silver; Copper; Nanomaterials; Morphology; Adsorption

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Synthesis and application of gadolinium tungstate photocatalyst integrated with pineapple leaf biomass for enhanced wastewater treatment

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Abstract

Water is a vital resource for numerous sectors including municipal, industrial, and agriculture, but rapid urbanization and industrial growth have magnified water demand, creating significant challenges in water management and sustainability. A key concern is water pollution, particularly contamination of water by heavy metals and organic pollutants. These pollutants not only threaten aquatic ecosystems but also pose a serious health risks to communities, especially in underserved regions. This project explores the sustainable application of nanotechnology for water remediation, focusing on the synthesis and use of a rare-earth based photocatalyst i.e., gadolinium tungstate for advanced wastewater treatment. The photocatalyst is integrated with an eco-friendly adsorbent derived from pineapple leaf biomass, a widely available agricultural residue in many African regions. The resulting nanocomposite is thoroughly characterized to evaluate its structural, morphological, and optical properties. Its performance is assessed based on the adsorption of heavy metals in wastewater, and the possibility of reusing the spent adsorbent in the photocatalytic degradation of organic pollutants such as organic dyes, aiming to demonstrate enhanced degradation efficiency. Furthermore, the synergistic mechanisms between photo-adsorption—are investigated to gain insight into the interfacial dynamics between the photocatalyst and biomass matrix. This work highlights a green, low-cost solution for addressing water pollution in line with circular economy principles.

Keywords: Advanced oxidation processes, Heavy metals, Hybrid treatment technology, Rare-earth nanoparticles, Water pollution.

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Sinethemba Kaba

I was born in small township known as Dimbaza just outside of King Williams Town. I pursued my Bachelor of science degree at Fort Hare, where i graduated with cum laude, i then went to do BSc honors in chemistry (Nelson Mandela), Masters Nanoscience (University of Western Cape), and currently I am in my second academic year as a PhD candidate.

P-WW-11

Synthesis of chitosan nanocomposite materials grafted with MWCNTs for removal of tetracycline pharmaceutical from water samples

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Amid varieties of water organic pollutants, pharmaceuticals are the most abundant class of pollutants showing toxic effect to human health [1,2]. This study developed chitosan nanocomposites by incorporating functionalised and nitrogen-doped multi-walled carbon nanotubes (FMWCNTs and NMWCNTs) for the removal of tetracycline pharmaceutical contaminants from water. The composites were characterised with FTIR, SEM, EDS, XRD, BET, UV-vis, and TGA under various conditions (pH, adsorbent dosage, concentration, contact time, and temperature). Optimal tetracycline removal (85%) was achieved at pH 6, 2 g/L adsorbent dose, 10 ppm concentration and 30 minute contact time. FMWCNT-chitosan could be recycled 5 times with an adsorption loss of only 2%and it also showed good adsorption efficiency of 82% in the presence of counter ions and 70% in a binary system. The adsorption process followed the Langmuir isotherm (263 mg/g), indicative of monolayer adsorption and pseudo-second order kinetics.

Keywords: Pharmaceuticals, Nanocomposites, Adsorption, Tetracycline

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Professor Lutendo Evelyn Macevele

Prof Lutendo Evelyn Macevele is a researcher and Associate Professor of Chemistry at the University of Limpopo. Her research focuses on the development of advanced nanocomposite materials for water treatment, particularly polymer-based membranes enhanced with carbon nanotubes, metal oxides, and silver nanoparticles. She applies techniques such as SEM, XRD, FTIR, BET, and TGA to characterize materials and evaluate their performance in removing heavy metals and pharmaceutical contaminants from wastewater. Prof Macevele has published in peer-reviewed journals and supervises postgraduate research in nanotechnology and materials chemistry.

P-WW-12

Simultaneous wastewater treatment and hydrogen generation using electrospun titania nanofibers

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Abstract

The photocatalytic activity of titania based catalysts, which is based on their ability to generate electron–hole pairs upon photoillumination, is limited due to its wide band gap and lack of efficient retrievability post-application. Herein, heterogenous photocatalysts based on electrospun fibers composed of polyvinylpyrrolidone and titanium propoxide were prepared and heated at 500, 750 and 950 °C to obtain anatase and rutile fibers. The fibers were then decorated with Pd and Co nanoparticles. The fibrous materials obtained have a paper-like macroscopic appearance allowing for easy handling and separation. The photocatalytic activities of the materials were evaluated for the generation of hydrogen in polluted water upon UV (368 nm) or visible (630 nm) light excitation. Depending on the heat treatment or the post-synthetic decoration method, the materials show higher, or similar, activity compared to the commercially available P25-TiO_2, with superior ease of separation, making them ideal for flow applications.

Keywords: Electrospinning, titanium dioxide, photocatalysis

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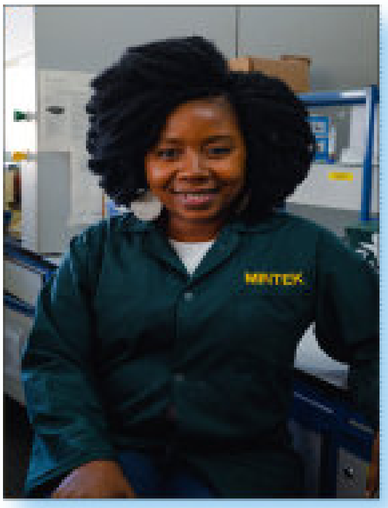
Dr Sivuyisiwe Mapukata



Dr Sivuyisiwe Mapukata holds a PhD in Chemistry from Rhodes University wherein she specialized in Nanotechnology. She is currently a Scientist in the Nanotechnology Innovation Center, at Mintek's Advanced Materials Division. With a niche for environmental remediation and sustainability, her research experience interests are mainly on wastewater remediation and energy generation.

P-WW-13

Development of a Chitosan containing Iron polymer for the electroanalysis of alprazolam

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Abstract

Chitosan, a biocompatible and multifunctional material derived from chitin, has become a promising material for the development of electrochemical sensors for pharmaceutical detection due to its unique properties [1].

It is also easy to modify and functionalise chitosan, which makes the material ideal for application in electrochemical sensor development. When chitosan is combined with other nanomaterials, it enhances the electrochemical sensors' sensitivity, selectivity, and stability [2].

The current study has explored the development of a chitosan-based electrochemical sensor containing metallic iron for the detection of alprazolam, a widely prescribed benzodiazepine pharmaceutical used to treat anxiety and panic disorders.

The chemical properties of the nanocomposite were studied using chemical and morphological properties obtained by conducting X-ray diffraction (XRD), Fourier Transform Infra-Red (FT-IR) spectroscopy, Ultraviolet-Visible Spectroscopy (UV–Vis), scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS) and transmission electron microscopy (TEM) analysis.

Keywords: Chitosan; Iron; Nanomaterials; Morphology; Electroanalysis; Pharmaceuticals

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P-WW-14

Optimized Synthesis of AgI Nanoparticles for Enhanced Cloud Seeding: A Novel Approach to Address Water Scarcity

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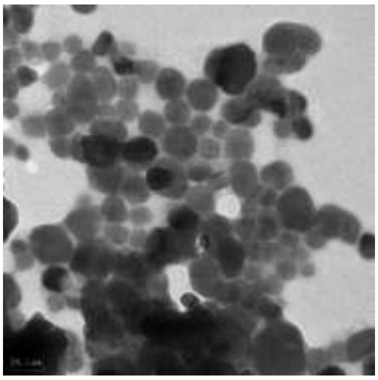
Abstract

Water scarcity is an increasing global challenge requiring innovative solutions. Cloud seeding with ice nucleating agents, particularly silver iodide (AgI) nanoparticles, offers a promising approach. Due to their high surface-to-volume ratio, nanoscale AgI particles exhibit superior ice nucleation efficiency compared to conventional micro-sized agents. In this study, AgI colloidal suspensions were synthesized using pulsed laser ablation in liquid (PLAL), a clean and eco-friendly method. The work focused on optimizing nanoparticle properties, especially size, to enhance ice nucleation capability. Optical and structural characterizations, including UV-Vis, SEM, TEM, Raman, and FTIR, confirmed morphology and composition, with an average particle size of 23 nm determined by TEM (Fig.1) and zetasizer analysis. Laboratory ice nucleation experiments revealed significantly improved ice formation efficiency using these nanoparticles. The results highlight AgI nanoparticles as a scalable and sustainable solution to advance cloud seeding and help mitigate water scarcity.

Keywords: Nanoparticle, Colloidal suspensions, Cloud Seeding, Ice Nucleation, AgI, Environmental Sustainability, Water Shortage Problem



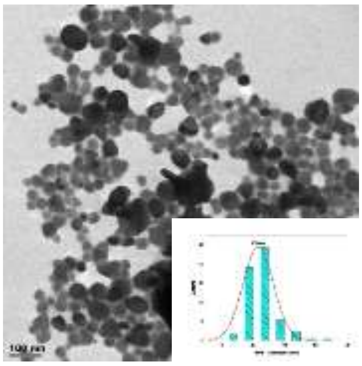


Fig. 1: Transmission electron microscopy (TEM) imaging of Pulsed laser ablated AgI nanoparticles.

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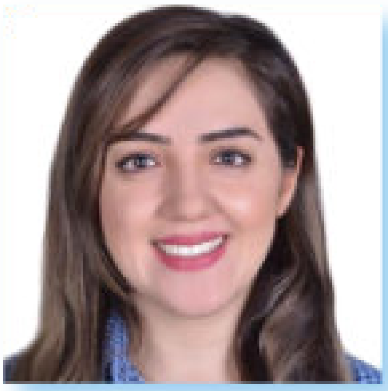
Shiva Shafiei



Shiva Shafiei is a Ph.D. student in the University of South Africa, Department of Electrical and Smart Systems Engineering. She is doing her Ph.D. within framework of UNESCO-UNISA Africa chair in Nanoscience & Nanotechnology under supervision of professor Malik Maaza. Her research focuses on the synthesis and application of nanomaterials for environmental solutions, with a particular emphasis on eco-friendly cloud seeding technologies.

P-WW-15

Green Biosynthesis of Allium sativum–Mediated Copper Sulfide Nanostructures for Sustainable Degradation of Synthetic Dyes

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Abstract

Synthetic dyes are widely used in textile, plastic, and cosmetic industries, yet their persistence and chemical stability make them major environmental pollutants. In this study, a sustainable and non-toxic synthesis approach was developed for producing metal-based nanostructures using *Allium sativum* (garlic) as a natural reducing and stabilizing agent. The bio-synthesized nanostructures were comprehensively characterized by X-ray Photoelectron Spectroscopy (XPS), Scanning Electron Microscopy (SEM), and Energy Dispersive Spectroscopy (EDS), confirming the successful formation of uniform, crystalline surfaces enriched with sulfur and organic functional groups derived from garlic metabolites. Their photocatalytic efficiency was assessed against model synthetic dyes such as methylene blue under visible light irradiation. Remarkably, the *A. sativum*-mediated nanostructures exhibited rapid and high degradation rates, demonstrating their strong catalytic potential and photoreactivity. This green route eliminates hazardous reagents, lowers synthesis costs, and introduces a scalable, environmentally responsible pathway for wastewater treatment. The findings highlight the promise of phyto-mediated nanotechnology in addressing dye contamination and advancing the next generation of sustainable environmental remediation materials.

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Aylar Shams Khameneh

Aylar Shams Khameneh is a PhD Fellow at the UNESCO–UNISA–iTLABS/NRF Africa Chair in Nanoscience and Nanotechnologies (U2ACN2), University of South Africa. Her research focuses on the green synthesis and characterization of bioengineered metal sulfide nanostructures for sustainable water purification and environmental remediation. She holds a Master's degree in Organic Chemistry and a Bachelor's degree in Pure Chemistry from Islamic Azad University, Iran. Aylar has published in the fields of green nanotechnology and organic synthesis, with a strong interest in bridging nanoscience, environmental chemistry, and renewable technologies. Her current work explores sulfurbased phytochemical reactions from Allium sativum for fabricating multifunctional Cu_2S nanomaterials with catalytic and optical selectivity. She is passionate about advancing eco-conscious nanomaterials and inspiring the next generation of scientists dedicated to sustainability and innovation.

P-WW-16

Synthesis and Characterisation of a Chitosan containing Manganese polymer for Electroanalysis of Pharmaceuticals

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Abstract

The naturally occurring biopolymer, chitosan (CS), has received a lot of attention in applications in the last decade. Properties of this biopolymer includes inherent biocompatibility, biodegradability, and minimal toxicity [1].

Chitosan has applications in various research areas that include electrochemical sensors, catalysis, energy storage, and environmental applications [2].

Applying nanoscience and nanotechnology, new nanomaterials have been synthesised with metal ions incorporated into the nanomaterials. Utilising manganese, this metal is found to be of low cost, environmentally friendly, non-toxic, have relative high energy density, with high activity in alkaline media [3].

The research describes the incorporation of manganese into chitosan to form a nanocomposite that is applied in chemical sensor research for electroanalysis of pharmaceutical compounds in wastewater samples.

The results presented include the chemical and morphological properties obtained by conducting X-ray diffraction, Fourier Transform Infra-Red, Ultraviolet-Visible Spectroscopy spectroscopy, scanning electron microscopy, energy dispersive X-ray spectroscopy and transmission electron microscopy analysis.

Key words: Chitosan; Manganese; Nanomaterials; Morphology; Electroanalysis

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Vernon Somerset

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Vernon Somerset obtained his PhD in Electro-analytical Chemistry in 2007 at the University of the Western Cape, Bellville, Cape Town. With more than 20+ years of experience in Environmental Chemistry research, he has worked on various projects focusing on the sources, transport pathways and fates of the inorganic and organic pollutants in the environment. Since joining the CSIR, he has been involved in research activities investigating different aspects of improving the analytical techniques for the quantification of the different pollutants in water, sediment and biota samples. This further includes the determination of bioaccumulation of organic and inorganic pollutants in sediment and invertebrates, in order to assess the eco-toxicity of these compounds and the threat to human health in aquatic ecosystems. Vernon continues to supervise Doctoral and Master's degree students on various environmental projects in collaboration with Proffs. E. Iwuoha, P. Baker and other researchers of the SensorLab Research Group, Chemistry Department at the University of the Western Cape.

In 2016, Vernon joined the Cape Peninsula University of Technology (CPUT) and set-up his research laboratory in 2017 to continue his research activities and train Masters and Doctoral students. As the project leader of the Environmental Chemistry Research Group, Vernon has been working with other researchers and students in the Chemistry Department, CPUT, Bellville campus, Bellville. The focus remains on inorganic and organic contaminants in the aquatic environment.

Fabrication of Bi-doped WO_3/CFA nanocomposite for efficient photocatalytic degradation of ciprofloxacin (CIP) under visible light.

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ABSTRACT

The persistent presence of ciprofloxacin (CIP) in aquatic ecosystems poses significant environmental and health risks due to its resistance to conventional wastewater purification methods. This study explores the synthesis, characterization and application of bismuth-doped tungsten oxide supported on coal fly ash (Bi-doped WO_3/CFA) as a novel photocatalyst for CIP degradation under visible light. The nanocomposite was synthesized via a hydrothermal method & hydrothermal conditions were optimized to anchor Bi-doped WO_3 NPs onto the CFA surface [1]. Characterization techniques used for this study include Fourier-transform infrared spectroscopy (FTIR) for functional groups, Brunauer-Emmett-Teller (BET) for surface area and porosity, x-ray diffraction (XRD) for crystal phase and doping effects, lastly, scanning electron microscopy (SEM), EDS elemental mapping and transmission electron microscopy (TEM) for morphology and elemental distribution [2]. This work highlights the potential of waste obtained material in sustainable environmental remediation, offering a dual benefit of pollutant removal and industrial waste valorization. [3].

Keywords: Ciprofloxacin, bismuth doping, hydrothermal synthesis, coal fly ash, visible light.

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Palesa Diako

My name is Palesa Diako, I am 26 years old. I was born and bred in Kwathema (a small township in Gauteng). I am a 3x graduate from the University of Johannesburg. My first qualification is a Diploma in Analytical Chemistry, second being an Advanced Diploma in Analytical Chemistry and the third one is a BSc honours in Chemistry. I am currently doing my second-year Master’s in Nanoscience (majoring in advanced nanochemistry) with a research focus on water treatment.

Synergetic Effect of Rare-Earth (Ce) Doped on Gas Sensing Properties of Cobalt Nickel Ferrites Nanoparticles.

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Department of Physics, University of Johannesburg, 55 Beit St, Doornfontein, Johannesburg, 2028, South Africa.

Abstract

We present the effect of cerium (Ce^{3+}) at various concentrations ranging from 1-3 wt%, doped in $CoNiFe_2O_4$ for the detection of LPG and H_2S, prepared by the sol-gel method. X-ray Diffraction confirms the cubic phase of all the samples, and no impurities were detected with a crystallite size range of 8 to 11 nm. Scanning Electron Microscopy (SEM) and Electron Dispersive X-ray Spectroscopy (EDS) depict that undoped and doped ferrite are spherical with only a few areas having non-flake-like. The gas response of undoped and doped Ce^{3+} was investigated in the 225-275 °C temperature range. Undoped $CoNiFe_2O_4$ showed a low response. In contrast, samples doped with Ce^{3+} had an improved response to LPG and H_2S gases. Increasing the Ce^{3+} amount in $CoNiFe_2O_4$ is promising for making better sensors to detect gases.

Keywords: $CoNiFe_2O_4$, Sol-gel, Cerium, Gas sensor.

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P-WW-19

Fabrication of zinc oxide-functionalised graphene oxide nanocomposites for bacterial disinfection

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Abstract

Wastewater treatment plants (WWTPs) in South Africa play a critical role in maintaining water quality. However, persistent microbiological and chemical non-compliance, particularly in KwaZulu-Natal (KZN), has led to significant environmental and public health risks [1]. The release of inadequately treated effluent has contributed to elevated *Escherichia coli* (*E. coli*) levels in surface waters, notably in the Umgeni River, which is a vital raw water source that flows into the Indian Ocean and is potentially exacerbating coastal contamination [2]. Traditional disinfection methods, such as chlorination, ozonation, and UV radiation, present limitations, including the formation of harmful disinfection by-products (DBPs)[1]. The ZnO@APTES-functionalised GO nanocomposites have been successfully synthesised and characterised using techniques such as SEM-EDX, FTIR, Raman and XRD. Current work is on optimising the nanocomposite for bacterial disinfection against *E. coli* and *Enterococcus faecalis (E. faecalis)* and incorporating it into a polymer membrane for wastewater treatment.

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Masego Mogale

Masego Mogale is a Master's candidate in the Department of Chemical Sciences at the University of Johannesburg, South Africa. Her research focuses on the development of antifouling and antimicrobial ultrafiltration membranes by incorporating nanocomposites into polymeric materials, aimed at mitigating biofouling and improving disinfection in wastewater treatment plants. She holds a BSc (Hons) in Chemistry and is passionate about sustainable water treatment solutions, with a particular focus on addressing water quality challenges in the KwaZulu-Natal region. Masego has presented her work at national conferences and is committed to advancing innovative materials for environmental applications.

Waste PET derived Nanocomposite: Fluorescence Sensing of Environmental Pollutant, Tributyltin in aqueous medium.

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Abstract

Waste-derived nanomaterials have garnered a lot of attention in various applications including environmental remediation and monitoring [1, 2]. In this study, waste polyethylene terephthalate (PET) was upcycled, and depolymerised to yield terephthalic acid (TPA), serving as an organic linker and a carbon precursor. The synthesized materials where hydrothermally composited to obtain photoluminescent PET derived nanocomposite. The nanocomposite was comprehensively characterised and applied for the rapid detection of tributyltin (TBT) in aqueous medium. TBT is an organotin compound that is highly toxic and poses significant thread to human health and aquatic environment [3]. The sensor's performance was further validated using high performance liquid chromatography (HLPC). This green and inexpensive approach offers alternative non-evasive real time monitoring tool. Furthermore, the study highlights the dual benefits of circular economy and sustainability by leveraging waste into functional nanomaterials.

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Tumelo Nortica Mashoene

Tumelo Nortica Mashoene is a PhD candidate in chemistry at the University of Johannesburg under the supervision of Prof. P.N Nomngongo. Her research focuses on the development of sustainable nanomaterials derived from recycled waste polyethylene terephthalate for fluorescence and electrochemical sensing of organic pollutants. By incorporating green chemistry and material science, her research aims to provide inexpensive, non-toxic, on site, and real time environmental monitoring solutions.

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