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UNIVERSITÉ IBNOU ZOHR

Proceeding

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Faculty of Medicine and Pharmacy - Agadir - Morocco

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MOT DU COMITE D'ORGANISATION

Au début du 3ème millénaire, notre planète se trouve confrontée à de nombreux défis écologiques. D'une part, l'accroissement rapide de la population mondiale s'accompagne d'une augmentation de la consommation des ressources mais aussi de la détérioration de notre environnement qui menace la vie sur terre. D'autre part, le choix d'un matériau est généralement fondé sur des critères extra-environnementaux (performance, coût, disponibilité, fonctionnalité, esthétique…) mais prend rarement en compte les impacts sur l'environnement et la santé humaine. L'utilisation de matériaux respectueux de l'environnement s'avère une nécessité incontournable pour résoudre ce fléau.

C'est dans ce contexte que le Laboratoire Matériaux et Environnement (LME) et l'Association Ibn Zohr pour l'Environnement et les Sciences des Matériaux (AIZESMA) organisent, du 22 au 23 avril 2026, le Congrès International : Matériaux Appliqués à l'Environnement CIMAE-2026 sous le slogan « S'engager et Agir ensemble pour protéger notre planète ».

Cette manifestation scientifique est une opportunité de rencontres entre acteurs nationaux et internationaux spécialistes des domaines liés aux matériaux et à l'environnement. C'est une occasion de mettre en exergue les thématiques fortes, depuis l'étude des Surfaces et Interfaces passant par le Traitement et la Valorisation des déchets solides jusqu'aux applications innovantes des matériaux pour la détection et traitement de la pollution.

Nous témoignons notre gratitude à Monsieur le Président de l'Université Ibn Zohr et à Monsieur le Doyen de la Faculté des Sciences d'Agadir pour avoir cru en notre initiative et d'être engagés pour que ce congrès International soit une réussite.

Nous exprimons nos remerciements au Comité Scientifique pour son aide et sa collaboration dans l'expertise et la sélection des résumés. Les conférenciers nous ont honorés pour avoir accepté notre invitation, qu'ils en soient bien remerciés.

Nous saluons l'engagement des différents sponsors à nos côtés ; nous les remercions pour leur appui et soutien financier et pour l'intérêt qu'ils portent à cette manifestation.

Le Comité d'Organisation vous réitère ses sincères remerciements pour votre présence, marque de votre intérêt et de votre engagement pour notre initiative. Merci pour votre présence et votre soutien à cette manifestation.

Ensemble pour la protection de notre planète ; faisons des éditions CIMAEE, une grande fête scientifique des matériaux et de l'environnement.

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Water resources between climate change and human pressure: Insight from Morocco

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Abstract

The impact of climate change and human activities on water resources is clearly highlighted throughout the world. The consequences are more alarming in semi-arid and arid areas where drought continues to negatively unbalance hydrological storage at the scale of hydrological basins.

This quantitative degradation is accompanied by a qualitative degradation of various origins (salinity, various waste discharges, fertilizations, etc.). Managing the resource in the face of these major issues is a real challenge for decision-makers, politicians and scientists. The main objective of this presentation is to ask the relevant questions and discuss the major issues and alternative solutions through some examples in Morocco and Souss-Massa in particular. What contribution can scientific research through new technologies and the participatory approach make to integrated water resource management to tackle climate change and human pressure?

Keywords: Water resources, waste management, degradation

Les (macro-micro-nano-) plastiques dans l'environnement : inventaire, impacts et solutions.

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Abstract

INVENTAIRE. La pollution par les matières plastiques constitue un défi mondial en raison de sa persistance dans l'environnement et de son impact négatif sur les écosystèmes et les sociétés humaines. La production annuelle de plastique a plus que doublé en vingt ans pour atteindre 460 millions de tonnes, et elle pourrait tripler d'ici à 2060 si on continue ainsi. Plus de 52 millions de tonnes de plastique (hors microplastiques) sont rejetées dans l'environnement chaque année. 265 000 tonnes de plastique sont véhiculées chaque année jusqu'à la mer par les principaux fleuves et rivières du monde entier. Environ 70% des déchets plastiques atteignant les océans semblent « disparaitre ». En réalité, ils se fragmentent en particules de taille micrométrique et nanométrique dont le parcours exact est difficile à suivre. Une partie se retrouve par exemple incorporé dans le corail qui, résultat très inquiétant, représenterait un puits pouvant séquestrer le plastique pendant des centaines d'années.

IMPACTS. Les connaissances actuelles sur les effets du plastique sur la santé des animaux (cancers, problèmes de fertilité, d'immunité, de mémoire et d'apprentissage), ainsi que des études sur les cellules humaines en laboratoire (effet de stress oxydatif) révèlent une aggravation des quantités retrouvées dans les organismes, dû à une exposition plus grande, à travers l'eau, l'air et l'alimentation. Ces fragments plastiques abritent toute une communauté de micro-organismes qui transitent par les mers et rivières, tels que sur un radeau, provoquant entre autres une diminution spectaculaire de l'oxygène dans certains fleuves, comme cela a été démontré sur le Mékong (Asie du Sud Est). Ainsi, ces changements ont un impact sur la santé des cours d'eau et sur leur capacité à soutenir la biodiversité au sein de leurs écosystèmes.

SOLUTIONS. Alors, quelles solutions s'offrent à nous pour faire face aux défis de collecter ce qui est déjà dans l'environnement, de recycler ce qui aura été collecté, de moins produire de plastiques? L'une des solutions pourrait être d'utiliser des oxydes semi-conducteurs photosensibles pour réaliser l'oxydation avancée des plastiques micro et nanoparticulaire présents après épuration des eaux usées, évitant ainsi leur rejet en mer.

Keywords: pollution, plastique, environnement

Photocatalysis for Hydrogen Production

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Abstract:

The transition toward sustainable energy systems necessitates the development of efficient technologies for clean hydrogen generation. Photocatalytic hydrogen production represents a promising approach, relying either on the direct photodecomposition of water (water splitting) or on hydrogen evolution reactions involving sacrificial agents. This presentation will address the fundamental mechanisms underlying both reaction types, with particular emphasis on the role of photocatalyst composition, structure, and surface properties. Water splitting over single photocatalysts and composite materials, as well as, advantages and disadvantages of sacrificial agents' application will be discussed. Various reactor configurations and photoreactor designs applied in photocatalytic H_2 evolution studies will also be analyzed. The author's recent research findings will be presented in the broader context of international progress in the field of photocatalytic hydrogen production. Own research will include H_2 generation over TiO_2-X@$Cs_3Bi_2X_9$, NH_2-MIL-125(Ti/Co), Cu-NH_2-MIL-125(Ti) protected by PVDF, $CuInS_2$ quantum dot-modified COFs and $SrTiO_3$ modified by Pt-Ag Janus nanoparticles.

Keyword: hydrogen production, photocatalysis, photodecomposition

Electrochemical (bio)sensors for sensitive and selective environmental monitoring.

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Abstract:

Electrochemical (bio)sensors have the potential of levering the environmental monitoring by providing fast and cost-effective analysis. These sensors integrate selective recognition elements with electrochemical transducers to detect target analytes. Their reduced size allows on-site analysis, and the use of nanomaterials can enhance the sensor's sensitivity.

This makes them promising for real-life applications. Join this lecture to dive into the latest advancements in electrochemical sensors for the analysis of emerging contaminants (specifically pharmaceuticals) in environmental samples.

Keyword: detection, environmental monitoring, biosensors, nanomaterials

The Operational Realities and Future Challenges of Lithium-Ion Batteries as a Bottleneck in the Energy Transition

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Abstract:

The global shift from fossil fuels to renewables like wind and solar is creating an unprecedented demand for large-scale energy storage. While several technologies exist, Lithium-ion Batteries have emerged as the leading contender due to their high density and efficiency.
Yet, significant challenges in cost, safety, and performance remain. This presentation will outline our research at UM6P to overcome these hurdles by developing next-generation components, with a special focus on valorizing African mineral resources to build a more sustainable battery future.

Keywords: Lithium-ion Batteries; Electrode materials; Phosphates, African Resources

Acknowledgements: The author gratefully acknowledges OCP for its financial support. Special appreciation goes to the PhDs and Postdocs at the Energy Storage and Conversion Division within ACER department for their valuable contribution.

Closing the loop: Waste-derived materials for sustainable water treatment

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Abstract:

The increasing demand for clean water, combined with the growing volume of waste, calls for integrated and sustainable treatment strategies. The work that have been done in my research group explores the potential of waste-derived materials as efficient, low-cost alternatives to conventional water treatment media. Agricultural residues, industrial byproducts, and biomass wastes can be transformed into coagulantes and adsorbents capable of removing a wide range of contaminants, including heavy metals, metalloids and dyes. By adopting a circular approach, waste valorization and water purification can be coupled to minimize resource consumption and environmental impact.

Water treatment plants commonly use conventional coagulants such as aluminum and ferric salts and synthetic polymers. However, these chemicals have drawbacks, including being derived from non-renewable resources, high costs, pH sensitivity, toxic sludge, and potential health risks like Alzheimer's (aluminum-based coagulants). Natural coagulants and flocculants have emerged as viable substitutes for chemical coagulants. Tannins can be obtained by simple extraction with hot water from vegetable residues, as chestnut shells and tree bark, such as stone pine and eucalyptus, waste products that exist in large quantities in Portugal. Tannins cationised through a derivatisation reaction produce bio-coagulants that are effective in removing colour and turbidity from surface water and textile and aquaculture wastewaters. The solid residue obtained from tannins extraction, after surface modification with iron, was highly efficient as adsorbent in removing color from textile effluents, producing treated water suitable for reintroduction into the dyeing process. Other successful tested biosorption processes, including cork residues from the cork industry are:

- Absorption of oil from wastewater in the food industry;
- Arsenic removal from groundwater, by iron-modified cork, for the production of drinking water;
- Production of magnesium-modified biochar to adsorb phosphate from wastewater, resulting in an efficient fertilizer.

- To close the loop, all solid waste resulting from the coagulation and sorption processes can be incorporated into cement tiles, resulting in a material with adequate resistance and no leaching of pollutants with water.
- Challenges such as process scalability, material variability, and environmental footprint must be addressed. Life-cycle and techno-economic analyses has already been done for some processes with good results. Nevertheless, transforming wastes into treatment resources represents a key step toward circular water systems. This approaches not only mitigates pollution and waste generation but also supports a sustainable transition to resource-efficient water manage.

- **Keywords**: water treatment, adsorption, natural coagulants

PRESENTATIONS ORALES

Thème 1 : Matériaux innovants et développement durable

The elaboration of red clay mud based ceramic membranes for microfiltration

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Abstract

Ceramic membranes play a crucial role in many industrial applications, such as water treatment, gas separation, and catalytic reactions. They stand out for their mechanical strength, chemical and thermal resistance, and longer lifespan compared to polymeric membranes [1-3]. However, their high manufacturing cost limits their large-scale use, particularly in developing countries. This situation has led research efforts to focus on the development of low-cost ceramic membranes [4-6].

In our research, converting red clay mud into ceramic membranes was successfully realized. A mixture of red clay mud combined with porosity and reinforcement additives was prepared. The ceramic membranes were shaped using hydraulic press followed by a thermal treatment at 1000 °C. Phase identification and microstructure were investigated using X-ray diffraction (XRD) and scanning electron microscopy (SEM). Physical and mechanical properties such as porosity, water absorption and flexural strength were evaluated. The results confirm that red clay mud represents a promising and sustainable alternative to ceramic raw materials.

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Enhancing the thermophysical properties of aerated concrete using ecological additives with chemical treatment.

Malika Atigui[1*], Youssef Maaloufa[1,2,3], Asma Souidi[1], Mina Amazal[1], Slimane Oubeddou[1], Hassan Demrati[1], Soumia Mounir[1,2,3], Ahmed Aharoune[1]

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Abstract

In this study, we have decided to develop a composite material which is included in the list of building materials that would meet the requirements of thermal insulation while at the same time helping to protect the environment. To do this, we used waste from the olive oil extraction industry as a replacement for sand in non-autoclaved aerated concrete, we developed two types of mix, the first one by using olive pomace sand (OPU) with proportions of (0%, 10% , 20% ,30% and 40% by mass) and the other using the same proportions of olive pomace treated (OPT) with NaOH treatment, to study the effect of chemical treatment on the physical and thermal properties of this waste. The results obtained show that chemical treatment gives better physical properties and that this treatment improves thermal conductivity with gains of 0.64% and 2.93% for 30% and 40% respectively, and it is also found that it reduces the rate of water absorption and porosity for the 10% replacement percentage and shows a reduction rate of 31.2% and 23.5% respectively for untreated specimens and 34.4% and 24.5% for treated specimens.

Keywords: Aerated concrete; durability; olive pomace; thermophysical properties; chemical treatment; thermal conductivity.

Biosourced activated carbon: synthesis, characterization and adsorption performance of pharmaceutical products

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Abstract

The removal of pharmaceuticals from water has become a major issue in environmental remediation. In this study, activated carbon prepared from bio-based material appears as a promising adsorbent for the removal of organic pollutants. A comparative study was conducted to identify the most effective activating agent between KOH and H_3PO_4, using different mass ratios. The results showed that KOH activation, with a mass ratio of (1:3), led to the best adsorbent performance. The properties of the resulting activated carbon were highlighted using various characterization techniques (XRD, FTIR, SEM/EDX, BET, and Boehm titration). Furthermore, a centered composite design of experiments (CCD) was used to study the combined influence of four operating parameters on the adsorption of sulfamethoxazole (SMX) by synthesized activated carbon. Under optimal conditions, an SMX removal efficiency of 97% to 99% was achieved. The kinetic data were accurately described by the pseudo-second-order model, while the Langmuir isotherm showed good fit to the equilibrium data, with a maximum adsorption capacity of 98 mg/g. We also used density functional theory (DFT) calculations and Monte Carlo simulations to figure out the best places for adsorbing SMX molecule, which gave us a better understanding of how this pollutant is removed through the prepared AC surface.

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Manufacture of activated carbons from bio-waste: Adsorption of Diclofenac.

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Abstract

Water pollution has become a major global environmental challenge due to increasing industrialization, urbanization, and population growth. Among emerging contaminants, pharmaceutical compounds are of particular concern because of their continuous release into aquatic environments, persistence, and potential adverse effects on ecosystems and human health. Conventional wastewater treatment processes are often ineffective at completely removing these micro-pollutants, highlighting the urgent need for efficient and sustainable remediation strategies.

This work investigates the synthesis and application of nanostructured carbons (NCs) derived from bio-waste as efficient materials for wastewater purification. The NCs were prepared from flaxseed waste using a two-step process involving hydrothermal carbonization followed by chemical activation with phosphoric acid (H_3PO_4), aiming to enhance their porosity and surface chemical functionality. The resulting materials were evaluated for the adsorption of diclofenac sodium (DCF), a widely used pharmaceutical compound frequently detected in aquatic environments. A comprehensive physicochemical characterization was carried out using scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy (SEM-EDX), X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), nitrogen adsorption–desorption isotherms (N_2 -sorption), thermogravimetric analysis (TGA/DTG), and Raman spectroscopy. The characterization results revealed that the synthesized NCs exhibit a highly developed porous structure, abundant oxygen-containing surface functional groups, and well-defined morphologies. These properties contribute significantly to their adsorption performance, demonstrating that the prepared nanostructured carbons are promising and sustainable adsorbents for the effective removal of pharmaceutical contaminants from wastewater.

Bio-Based Coagulants from Pine Bark for Continuous Textile Wastewater Treatment and Circular Sludge Valorisation

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Abstract

Agroforestry residues represent an important resource for the development of sustainable materials for water and waste management [1]. In this study, tannins extracted from pine bark (*Pinus pinaster*) were chemically modified via a Mannich reaction to produce a cationic, bio-based coagulant for textile wastewater treatment [2,3]. The synthesized pine bark coagulant was applied to real textile effluent under continuous-flow coagulation–flocculation conditions in order to evaluate its performance under operationally relevant conditions [4]. The continuous system, comprising of rapid mixing, slow mixing, and sedimentation units, was operated at an initial pH of 5 and a coagulant dosage of 170 mg L^{-1}. Stable operation was rapidly achieved, resulting in an average color removal of approximately 78%, representing an improvement of nearly 10% compared to batch treatment under equivalent conditions. Turbidity remained consistently below 1 NTU and conductivity showed negligible variation, confirming effective clarification, while the observed slight increase in organic carbon was attributed to the organic nature of the tannin-based coagulant at higher dosages. In parallel, the sludge generated during continuous coagulation was assessed for valorization through incorporation into cement-based tiles as a partial replacement of sand. Sludge incorporation levels of 2%, 5%, 10%, and 20% (w/w) were investigated. Tiles containing 10% and 20% sludge exhibited excessive porosity and poor mechanical integrity, whereas tiles with 2% and 5% sludge showed good structural stability and surface quality. Mechanical testing demonstrated that 2% sludge incorporation increased compressive resistance relative to the control, while 5% incorporation maintained comparable strength with enhanced ductility. These results demonstrate that pine bark-derived coagulants can be effectively applied in continuous textile wastewater treatment and that the resulting sludge can be successfully valorized in construction materials, supporting integrated waste minimization and circular economy strategies:

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Sustainable cement mortars incorporating shell waste and coconut fibres to improve environmental and thermal performance

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Abstract

The reuse of shellfish residues in construction materials represents an effective and sustainable approach to waste recovery while significantly reducing the associated environmental impact. By incorporating these residues into construction products, it is possible to limit waste accumulation and reduce the exploitation of natural resources. In this study, shell waste is examined as a partial substitute for natural sand in cement mortar formulations, with the aim of assessing its feasibility and potential contribution to the development of more environmentally friendly building materials. Simultaneously, natural coconut fibres were incorporated in order to assess their influence on the mortar mixture containing shell aggregates. Natural sand was replaced by shell sand at three substitution levels (15%, 25% and 45% by mass), while coconut fibres were incorporated at volume fractions of 0%, 8% and 16%. Several key characteristics of the material were evaluated, including its mechanical performance and thermal response. The results indicate that the incorporation of shell sand and coconut fibres improves the thermal performance of the mortar. The incorporation of shell waste to substitute 45% of the sand is anticipated to increase the thermal insulation efficiency of the material of 22 % and 24 % for CM450 and CM4516 respectively (with CM is Cement Mortar). This replacement has a negative effect on mechanical strength, with the reduction in compressive strength ranging from 20 % for CM450 to 31 % for CM4516. However, replacing 8% of the coconut fibres gives flexural strength values close to those of the reference mortar. In terms of capillarity, shell aggregates have a tendency to reduce the capillarity coefficient of mortars reaching a rate of 58 % for CM450, but the fibres react in the opposite way.

Keywords: Cement mortars, shell sand, coconut fibres, mechanical properties, thermal properties, waste valorization

Valorisation of Pine Bark Residues as Tailored Biosorbents for Textile Wastewater Treatment

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Abstract

The valorisation of agro-industrial by-products for wastewater treatment offers a sustainable solution to mitigate the environmental impact of textile effluents. In this study, pine bark from Pinus pinaster was evaluated as a biosorbent for textile wastewater decolorization [1,2], with performance assessed through real colour measurements expressed in Pt–Co units (absorbance at 400 nm). Biosorbents were prepared by high-pressure impregnation with zinc chloride ($ZnCl_2$) and calcium chloride ($CaCl_2$) at 75 and 150 MPa for 10 min, followed by thermal treatments under N_2, $N_2 + CO_2$, and $N_2 + H_2$ atmospheres. The impregnating salt and thermal treatment significantly influenced colour removal. $ZnCl_2$-impregnated biosorbents showed moderate performance, with residual real colour values above 95 Pt–Co units when compared with 227 Pt-Co from the effluent without treatment. In contrast, $CaCl_2$ - modified pine bark exhibited superior decolorization, particularly after $N_2 + CO_2$ and $N_2 + H_2$ treatments, achieving residual real colour values of approximately 63–79 Pt–Co units at an adsorbent concentration of 5 g/L. Increasing the adsorbent dosage to 7.5 and 10 g/L further enhanced performance, reducing residual real colour to as low as 22–35 Pt–Co units. These results demonstrate that adsorbent concentration plays a critical role in maximizing colour removal, while impregnation pressure had a comparatively minor effect. Overall, calcium-modified pine bark prepared by high-pressure impregnation and optimized thermal activation shows strong potential as a low-cost and sustainable biosorbent for textile wastewater treatment.

Table 1. Average real color (Pt-Co) achieved after 24 h of adsorption treatments.

$CaCl_2$	**$N_2 + CO_2$**			**$N_2 + H_2$**		
	5g/L	**7.5 g/L**	**10 g/L**	**5 g/L**	**7.5 g/L**	**10 g/L**
75 MPa	67 ± 2	41 ± 1	34 ± 2	80 ± 4	46 ± 3	34 ± 2
150MPa	66 ± 1	37 ± 2	22 ± 2	64 ± 3	35 ± 1	25 ± 2

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Effect of fibre addition on the thermophysical, mechanical, and durability performance of unfired earthen composites

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Abstract

This study investigates the effect of fibre addition on the thermophysical, mechanical, and durability performance of unfired earthen composites intended for building applications. The composites were produced by incorporating different fibre volume fractions (20%, 40%, and 60%) into a clay-based matrix. The raw materials were comprehensively characterised through physical, chemical, thermal, geotechnical, and mineralogical analyses. Thermophysical properties were determined using the Hot Disk transient plane source method, while mechanical performance was evaluated by compressive and flexural strength tests. Durability was assessed by means of capillary water absorption tests to examine the influence of fibre content on water-related behaviour. The results indicate that increasing fibre content significantly improves the thermal performance of the composites, with reductions in thermal conductivity, thermal effusivity, and thermal diffusivity of up to 49.07%, 34.65%, and 39.26%, respectively, along with an increase of 16.34% in specific heat capacity at the highest fibre content. However, fibre addition led to a progressive decrease in compressive and flexural strengths. Durability assessment further revealed enhanced water resistance with increasing fibre content. Overall, the findings demonstrate that fibre addition represents an effective strategy for improving the thermal efficiency and durability of unfired earthen composites, highlighting their potential for sustainable construction applications.

Keywords: Earthen composites; Fibre reinforcement; Thermophysical properties; Mechanical performance; Durability.

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AI-Driven Cheminformatics for the Design of Sustainable and Innovative Materials

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Abstract

The design of innovative materials for sustainable applications is a major challenge in modern science. This study employs cheminformatics, machine learning (ML), and artificial intelligence (AI) to accelerate the discovery and optimization of environmentally friendly materials. Molecular descriptors and structural features of candidate compounds were analyzed to predict key properties, such as thermal stability, mechanical strength, and biodegradability. Machine learning models, including Random Forest and neural networks, were trained and validated to identify promising candidates with optimal performance and minimal environmental impact. Principal component analysis (PCA) and clustering techniques were used to explore chemical space, revealing structural motifs associated with enhanced sustainability metrics. The integration of AI-driven predictions with cheminformatics analyses enabled rapid screening of large compound libraries, significantly reducing experimental costs and time. The study demonstrates that combining computational intelligence and cheminformatics provides a powerful strategy for designing next-generation materials that meet both functional and environmental criteria, paving the way for sustainable innovation in material science.

KEYWORDS: Innovative materials; cheminformatics; machine learning; AI.

Recycling and use of saturated adsorbents as a filler for geopolymer materials: application in construction materials

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Abstract

Geopolymer-based adsorbents have demonstrated strong potential for removing organic dyes from water; however, the end-of-life management of used adsorbents remains a critical bottleneck for truly sustainable implementation. In this work, a circular-economy pathway is proposed in which a geopolymer saturated with methylene blue is recovered after adsorption and subsequently valorized as a secondary raw material for construction-oriented products.

In this work, the geopolymer generated by adsorption process was prepared through alkaline activation of Fly Ash and the porosity was created by adding of H_2O_2 as a foaming agent. The saturation of the adsorbent sites was ensured by adding a concentrated solution of methylene blue to adsorbent powder. The recycling material was prepared by alkaline activation of mixture of generated geopolymer adsorbent with different proportions of calcined natural clay that is kaolinite rich. The structure and morphology of prepared materials were characterized using several analytical techniques, including X-ray Diffraction (XRD)**,** Fourier Transform Infrared Spectroscopy (FTIR) and Scanning Electron Microscopy (SEM) coupled with Energy-Dispersive X-ray Spectroscopy (EDS/EDX). -

In addition, the compressive strength results obtained for the prepared specimen shows a good agreement for its use in the construction materials field.

Keywords: Geopolymer; Fly Ash; alkaline activation; methylene blue; recycling; calcined natural kaolinite; compressive strength.

Towards a sustainable computational approach for the valorisation of traditional geometric materials: the case of the moroccan zellige

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Abstract

The Moroccan Zellige embodies an emblematic expression of the Arab-Islamic architectural heritage, where the ornamental aesthetics are articulated with a remarkable geometric rigor [1]. These compositions, based on the principles of symmetry, proportion and periodic tiling, follow a structural logic close to crystallographic symmetry groups [2,3]. For a long time transmitted orally by the Maalems, this refined craft retains a cultural authenticity, but makes it difficult to explicitly access its mathematical foundations [4]. With a view to sustainable preservation and material innovation, this study proposes a computational framework inspired by crystallography methods to analyze, reconstruct and digitally generate traditional geometric patterns. By modeling isometric transformations and tiling operations, we identify the underlying logic that governs the organization of patterns [5]. The algorithmic tool developed not only makes it possible to faithfully reproduce documented diagrams, but also to explore new configurations respectful of the classic aesthetic canons of the Zellige [6]. This approach, part of a sustainable development perspective, paves the way for the integration of this traditional knowledge in the design of innovative decorative materials, with low environmental impact and high cultural value [7].

Keywords: Moroccan zellige; Islamic architectural heritage; The algorithmic tool; crystallographic symmetry groups; decorative materials.

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Comparative analysis of waste valorization using different composting techniques

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Abstract

The rapid growth of agro-industrial activities has generated massive amounts of organic wastes, raising significant environmental and management challenges. Composting represents a sustainable and cost-effective strategy for the valorization of these residues by converting them into organic amendments with added value. The purpose of this study is to conduct a comparative analysis of several composting techniques applied for agro-industrial waste, such as controlled composting in bioreactors, vermicomposting, and conventional aerobic composting. These composting methods will be used to characterize and process agro-industrial residues in order to evaluate their performance in terms of degradation efficiency, process kinetics, and quality of the final compost. Throughout the composting process, physico-chemical and biological parameters will be monitored, including temperature evolution, moisture content, pH, C/N ratio, organic material stabilization, nutrient content, and microbial activity. The maturity and agronomic value of the resulting composts will be assessed using stability indices and phytotoxicity tests. The comparative approach will allow the identification of the advantages and limitations of each composting method, considering factors such as processing time, operational complexity, cost, and environmental impacts. It is anticipated that the results will provide valuable insights into the selection of appropriate composting strategies for specific types of agro-industrial waste.

Keywords: Organic wastes, valorization, several composting techniques.

Impurity reduction and mineral recovery from phosphate waste: a simple treatment for industrial reuse

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Abstract

Large quantities of phosphate waste are generated during beneficiation processes in Morocco and are generally stockpiled near washing plants, leading to significant environmental pressures and the loss of valuable mineral resources [1]. This study proposes a simple and effective treatment route to valorize this waste while minimizing its impurity load, particularly cadmium, while preserving the main mineral phases.

The process involves sequential washing, drying, and sieving, which enable the isolation of a coarse fraction with markedly reduced contaminant levels. Physicochemical characterization using XRD, XRF, FTIR, ICP-AES, and SEM-EDX provides clear evidence of the mineral and chemical upgrading achieved through the applied treatment. XRD confirm that the treated waste contains calcite, fluorapatite, quartz, and dolomite. XRF analysis reveals a substantial increase in CaO content and an appreciable amount of P_2O_5. FTIR spectra further support these findings by showing enhanced vibrational bands corresponding to (CO_3^{2-}) groups of calcite and (PO_4^{3-}) groups of fluorapatite, with a marked attenuation of bands linked to Al-bearing phase. ICP-AES measurements indicate a pronounced decrease in cadmium, magnesium, and aluminum concentrations in the treated fraction. SEM-EDX microanalyses reveal a more homogeneous mineral surface, with elemental mappings showing stronger Ca and P signals and significantly reduced distributions of Cd, Mg, and Al.

The treatment achieved an 86% reduction in cadmium (from 200 to 28 mg/kg) while maintaining high recovery rates of CaO and P_2O_5 in the coarse fraction. Beyond impurity removal, the CaO-rich fraction exhibits chemical properties suitable for phosphoric acid desulfation, further supporting its integration into phosphate processing. Overall, this approach provides a cost-effective and scalable strategy for waste minimization, metal decontamination, and circular resource utilization.

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Dual Valorization of Landfill Leachate and Digestate: Hydrochar Assisted Co-Digestion Optimized by Box–Behnken Design

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Abstract

The growing need for efficient waste-to-energy strategies has directed attention toward the anaerobic co-digestion of unconventional and challenging substrates. In this study, a comprehensive evaluation was conducted on the co-digestion of landfill leachate with various organic residues namely poultry by-products (PBP), sewage sludge, and vegetable waste to identify synergistic substrate combinations for enhanced biomethane recovery. Among the tested mixtures, leachate-PBP co-digestion demonstrated the highest methane yield, revealing a strong synergistic interaction. Building upon this, a targeted optimization was performed using a Box–Behnken Design (BBD) coupled with Response Surface Methodology (RSM) to investigate the effects of key process variables: leachate proportion (25-75%), substrate-to-inoculum (S/I) ratio (0.5-1.5), and digestate-derived hydrochar dosage (5-15 g/L). The optimal conditions (73.38% leachate, S/I 0.50, 11.15 g/L hydrochar) resulted in a maximum biomethane potential (BMP) of 243.45 L CH_4 /kg VS, marking a 93.01% improvement over the central points. The RSM model exhibited high reliability (desirability = 1). To enhance predictive capabilities and model performance, an Artificial Neural Network (ANN) was employed in parallel. Comparative analysis showed that the ANN model outperformed RSM, achieving superior predictive accuracy ($R^2 = 0.9999$, RMSE = 4.98 vs. $R^2 = 0.989$, RMSE = 5.53). These findings highlight the potential of combining leachate with carbon-rich PBP, supplemented by hydrochar, as a promising strategy to boost methane production. Furthermore, the integration of experimental design and machine learning offers a powerful and scalable tool for optimizing anaerobic digestion systems targeting high-strength waste streams.

Keywords: Anaerobic co-digestion, Landfill leachate, Poultry by-products, Biomethane, Digestate-based hydrochar, Box–Behnken Design.

Synthesis, optical characterization, and electrical properties of layered ferroelectric ceramics

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Abstract

Aurivillius phases are a form of perovskite represented by the general formulae is $(Bi_2O_2)(A_{n-1}B_nO_{3n+1})$ (where A is a large 12 co-ordinate cation, and B is a small 6 co-ordinate cation) [1]. In this study, praseodymium (Pr)-doped $SrBi_2Nb_2O_9$ ceramics were synthesized via solid-state reaction using carbonate, oxide, and nitrate precursors dissolved in a citric acid and ethylene glycol solution. Structural characterization by X-ray diffraction confirmed that the samples exhibited orthorhombic symmetry characteristic of the $SrBi_2Nb_2O_9$ structure, with a decreasing unit cell volume following Pr incorporation into the crystal lattice. FTIR analysis highlighted the vibration of the NbO_6 octahedron, while the presence of Pr^{3+} ions was confirmed by photoluminescence. UV-Vis spectroscopy revealed a direct band gap dependent on the doping level. The Curie temperature, constant across frequencies, confirms that the ceramics are normal ferroelectrics, with the ferroelectric transition more influenced by the Pr substitution site than by its valence, showing no linear correlation with Pr^{3+} concentration. At room temperature, doping does not improve dielectric loss, whereas at high temperature, electrical conduction is dominated by doubly ionized oxygen vacancies and a hopping mechanism [2].

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High-Performance MOF-Based Composites for Ciprofloxacin Elimination in Water Treatment

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Abstract:

Water contamination by emerging pollutants, such as pharmaceutical residues, dyes, and agricultural chemicals, poses a growing environmental challenge. Among these contaminants, antibiotics like ciprofloxacin are of particular concern due to their persistence, toxicity, and contribution to antimicrobial resistance [1]. Recent developments in materials science have identified Metal Organic Frameworks (MOFs) as promising materials for advanced water treatment applications. Owing to their high surface area, tunable porosity, and chemical versatility, MOFs demonstrate excellent adsorption and catalytic performance toward the removal of organic and inorganic pollutants [2]. This contribution highlights recent advances in MOF synthesis, structural design, and functional performance for water purification. Special emphasis is placed on MOF-based composites and their integration with photocatalytic systems to enhance the degradation of persistent pharmaceutical contaminants. In addition, green synthesis approaches using bio-based organic linkers, such as gallic acid, are discussed as sustainable alternatives aligned with circular economy principles. These findings underline the strong potential of MOFs as efficient and sustainable materials for next-generation water treatment technologies.

Keywords: Metal–Organic Frameworks, Water Treatment, Photocatalysis, Environmental Remediation, Green Chemistry

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Enhancing biogas digestate into Co-polymerized, highly activated biochar for efficient Orange G removal and industrial wastewater treatment applications

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Abstract

This study explores the simultaneous solution of two critical challenges: waste valorisation and water treatment, by transforming biogas residues into highly effective materials for environmental remediation. In particular, biogas residue, known as digestate, is converted into biochar, which is then activated with potassium hydroxide (KOH) and functionalized through copolymerization with two conducting polymers; polyaniline (PANI) and polypyrrole (PPy). Four different ratios of ABC@PANI@PPy were synthesized, and their structural and surface characteristics were extensively analyzed using techniques such as XPS, XRD, BET, FTIR, SEM/EDX, TGA/TDA, and zeta potential analysis. Among the various ratios synthesized, ABC@PANI@PPy (4:1) demonstrated the highest adsorption capacity, achieving an Orange G (OG) removal of 301.70 mg/g under optimal conditions (natural pH, adsorbent dose = 0.5 g/L). A comprehensive sorption mechanism was identified, involving electrostatic interactions between OG and HN+, CN+, and =N+ groups, ion exchange between doped Cl− ions and OG, hydrogen bonding, and π-π interactions between the aromatic C of the biochar and the π system of the OG molecule. Furthermore, reusability tests showed that ABC@PANI@PPy maintained over 88% of its removal efficiency after five cycles. The material also performed exceptionally well in industrial wastewater treatment, achieving over 95.45% removal efficiency. This study underscores the significant potential of digestate-derived biochar functionalized with conducting polymers for efficient and sustainable wastewater treatment applications.

Structural, electrical, and antibacterial evaluation of polypyrrole-assisted copper metallization of acrylonitrile butadiene-styrene

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Abstract

The metallization of polymer substrates such as acrylonitrile–butadiene–styrene (ABS) is essential for producing lightweight, conductive, and functional components, yet conventional pretreatment processes rely on hazardous chemistries and provide limited control over surface properties. This work investigates a polypyrrole (PPy) interlayer, chemically synthesized on etched ABS, as an alternative conductive route to enable copper electroplating while enhancing surface functionality. ABS substrates underwent sequential polishing, chemical etching, PPy deposition, and copper metallization. The resulting surfaces were characterized by SEM, XRD, Raman spectroscopy, profilometry, XPS, electrical conductivity measurements, and contact angle analysis. Wettability tests revealed a strong hydrophilization after chemical etching and a decrease in contact angle for PPy/ABS, highlighting the role of dopant ions (Cl^-) and polymer chain rearrangement in promoting interfacial adhesion. The PPy interlayer enabled homogeneous copper deposition and resulted in significantly improved electrical conductivity. Antibacterial assays demonstrated that silver-modified coatings inhibited *Escherichia coli* in diffusion assays, and copper-coated ABS fully prevented *Staphylococcus epidermidis* biofilm formation.

The novelty of this work is the integrated assessment correlating surface chemistry, morphology and conductivity with antibacterial responses of PPy-mediated metallized ABS, providing guidance for the design of functional metallized ABS surfaces suitable for biomedical and hygienic applications.

Keywords : ABS, polypyrrole, metallization, wettability, antibacterian, copper, conductivity.

Acknowledgments

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A Novel Synthesis Process and Characterization of Double Salt Fertilizers X2Ca(SO4)2.H2O (X = NH4 or K) Using Phosphogypsum as a Precursor

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Abstract

The sustainable management of industrial by-products such as phosphogypsum (PG) is a major environmental challenge. In this study, an integrated process guided by phase diagrams was developed to convert the PG onto valuable fertilizers compounds.

As starting reagent rich in calcium and sulfates, PG was used to synthesize ammonium sulfate ($(NH_4)_2SO_4$) and potassium sulfate via simple reaction using NH_4OH and KOH respectively. The fertilizers $X_2Ca(SO_4)_2 \cdot H_2O$ (X= NH_4 or K) were synthesized based on the ternary phase diagram of the system Ca^{2+}- NH_4^+ // SO_4^{2-} -H_2O or Ca^{2+}- K^+ // SO_4^{2-} -H_2O at room temperature. The synthesized products were characterized using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), thermogravimetric analysis coupled with differential thermal analysis (TGA-DTA), and scanning electron microscopy coupled with energy dispersive spectroscopy (SEM-EDS). The results confirmed the formation of crystalline phases and demonstrated the efficiency of the process in converting phosphogypsum waste into valuable fertilizer materials. This work proposes a circular and sustainable approach to waste assessment and resource recovery.

Keywords phosphogypsum, waste management, phase diagram, fertilizer.

ZIF-67@Digestate Derived Co,N-Doped Biochar Membranes for Sulfamethoxazole Removal through Peroxydisulfate Activation

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Abstract

The ubiquitous presence of sulfamethoxazole (SMX) within aquatic ecosystems coupled with the increasing production of sewage sludge digestate (SSD) has emerged as a critical environmental challenge. This necessitates the development of efficient decontamination strategies and sustainable waste management approaches. Herein, magnetic Co_x-NBC composites were synthesized by integrating ZIF-67 and nitrogen-rich biochar (NBC) through ball milling and thermal treatment. These elaborated materials were comprehensively characterized and demonstrated exceptional performance as metal-doped carbocatalysts, exhibiting synergistic capabilities in both the adsorption and catalytic degradation of sulfamethoxazole (SMX) through efficient activation of peroxydisulfate (PDS). The results indicate that the biochar matrix plays a pivotal role in facilitating the uniform dispersion of ZIF-67 particles, effectively suppressing their aggregation, enhancing structural stability, and providing additional adsorption sites for sulfamethoxazole (SMX). A comprehensive investigation of key operational parameters was conducted within the Co_x-NBC/PDS system, including the initial pH of the SMX solution, catalyst dosage, PDS concentration, and the presence of inorganic ions and humic substances. Furthermore, the dominant reactive oxygen species (ROS) involved in SMX degradation were systematically identified through quenching experiments, offering critical insight into the underlying catalytic mechanisms.

Keywords: Biochar, ZIF-67, Enhanced functionalities, Peroxydisulfate activation, Sulfamethoxazole degradation

Valorization of Wool and Wood Sawdust Waste in the Formulation of Stabilized and Compacted Earth Bricks

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Abstract

The building and construction sector is considered to be one of the most energy-intensive sectors in the world. It accounts for 36% of the world's energy consumption [1]. It also accounts for 25% of Morocco's total share of the market [2]. On a national scale, these sectors are growing steadily. According to World Bank forecasts, an increase of 30% is expected [3]. This study evaluates the effect of natural additives (sawdust and wool fibers) on CEB mechanical and thermal performance. The bricks were stabilized with 6% cement and 1% sawdust, while wool fibers were added in varying proportions (0-1.5%). Mechanical strength, thermal conductivity and water absorption were measured. Compressive strength improved by 15% and thermal conductivity reduced by 20% with the addition of 0.75% wool fibers. These results suggest that the incorporation of natural additives can improve the performance of CEBs and support their use in sustainable building practices.

Keywords: Compressed Stabilized Earth Bricks (CEB), Sawdust, Wool fibers, Mechanical properties, Thermal conductivity, Eco-friendly materials.

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Adsorptive Performance of an Apiaceae Derived Biomaterial for Methylene Blue Removal from Water

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Abstract

This study assesses the potential of a low-cost biomaterial derived from a locally available plant (Apiaceae family) for the removal of methylene blue (MB) from aqueous solutions. The biosorbent was prepared by simple physical treatment and characterized by a pHpzc around 7.0, with FTIR and SEM analyses confirming the presence of active functional groups and a porous surface structure morphology that becomes more compact after adsorption, suggesting effective interaction with the dye molecules. Batch experiments revealed rapid adsorption kinetics, with equilibrium reached within 5 minutes. The removal efficiency increased with adsorbent dosage (78.65–96.78%) and remained high over a pH range of 5–9. A slight decrease in adsorption at higher temperatures suggested an exothermic process. The material also maintained good performance at higher dye concentrations (up to 86% removal at 30 mg/L). Kinetic and isotherm studies showed that the process follows a pseudo-second-order model with a $R^2 = 0.999$ and is best described by the Temkin isotherm, with a maximum adsorption capacity of 49.75 mg/g (predicted by Langmuir model. The biosorbent exhibited good reusability, retaining about 91% efficiency after three cycles.

Overall, this biomaterial represents a promising, sustainable, and cost-effective solution for dye-contaminated wastewater treatment.

Keywords:

Adsorption; Methylene blue; Apiaceae biomaterial; Kinetics; Isotherms; Wastewater treatment.

PRESENTATIONS ORALES

Thème 2 : Innovations pour la Détection et la Protection de l'Environnement

Recovery and recycling of brine water discharged from desalination plants.

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Abstract

Desalination plants have expanded considerably over the last decade, as the need for drinking water increases with population growth. Disposal or management of desalination brine (concentrate) presents major environmental challenges for most plants, and is becoming increasingly expensive. The release of brine water directly has the power to destabilize local seawater conditions, such that salinity poses a significant threat to marine life. It is therefore necessary to find a way of recovering this brine before it is disposed of, in order to reduce its harmful impact on the environment, on the other hand to benefit some commercial chemical products. Indeed, the present work has been divided on two approaches, the first one will be oriented to valorize rejected brine water (RBW) discharged from desalination plant, to produce some of useful chemical products such as calcium carbonate ($CaCO_3$), Na_2CO_3 …, also to reduce water salinity which in turn helps to protect the aquatic ecosystem. The second approach consists of reusing and recycling the calcium carbonate recovered in the first step for osmosis water remineralisation (permeate) inside the desalination plant. As results, Our first study shows that valorization of reject brine water (RBW) by adding lime $Ca(OH)_2$ and carbon dioxide CO_2 led to $CaCO_3$ precipitation; the mass obtained increases as the two added reagents increase. The high flow rates of CO_2 lead to a remarkable reduction in the salinity of the brines discharged. The produced salt $CaCO_3$ was charged in pilot calcite bed on the laboratory scale to release the second step of our study. The results show that remineralisation using recovered $CaCO_3$ could correct to osmosis water its calco-carbonic balance, to achieve the drinking water standard; but that is linked to many parameters such as the flow rate and speed of the permeate (osmosis water); also the thickness of bed has an effect on the process.

Key Features :

- Recovery of 17g of $CaCO_3$ from 10g of lime with a flow rate of 1L/min of CO_2.
- The salinity of the rejected brine water (RBW) was reduced from 42000 ppm to 35200 ppm (17% reduction).
- Remineralisation using recovered $CaCO_3$ in calcite bed is more effective than hydrated lime method used in desalination plants.

Keywords : Recovery, management, brines, $CaCO_3$ precipitation, lime, carbon dioxide, remineralisation

Graphic Abstract

Sustainable Clay Bricks from Recycled Wood Ash and Pottery Waste: A Green Alternative for Construction

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ABSTRACT

Clay, one of the oldest construction materials known to humanity, has been used for millennia to build dwellings around the world. In recent decades, however, the expansion of urbanization and the influence of Western construction practices have led to the widespread adoption of cement-based materials, resulting in higher building costs and increased energy consumption for thermal comfort.

In light of growing environmental concerns, there is renewed interest in sustainable construction methods. In Morocco—particularly in mountainous areas like the village of Tighmi—local artisans continue to rely on traditional materials.

Additionally, more affluent individuals are increasingly embracing natural materials such as clay, earth, and wood. Recycling waste within the construction sector also offers a viable solution to environmental challenges, especially regarding waste management. For instance, wood ash is being explored for its potential reuse.

This study investigates the incorporation of wood ash and crushed pottery waste into the production of eco-friendly bricks. Laboratory tests were conducted by varying the proportions of these additives in clay mixtures to identify optimal compositions that enhance thermal and mechanical performance. The prepared samples were shaped into bricks and cylindrical specimens for testing.

The results indicate that adding 20% wood ash significantly improves thermal performance. In contrast, crushed pottery waste increases water absorption, with maximum mechanical strength achieved at a 5% substitution level. Therefore, replacing 20% of clay with wood ash or 5% with crushed pottery waste allows for the production of environmentally friendly blocks with thermal resistance comparable to that of conventional construction materials.

Key words : ***Eco-friendly construction, Clay, Waste recycling, Thermal resistance.***

Valorisation of rose distillation waste as a biofertilizer: impacts on soil health and floral yield of *Rosa damascene*

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ABSTRACT

Rose distillation waste (RDW), a major byproduct of essential oil extraction, accumulates in large quantities near distillation facilities, posing significant environmental challenges. However, this underutilized biomass represents a promising and sustainable resource for agricultural applications. This study evaluates the potential of rose distillation waste (RDW) as a biofertilizer for *Rosa damascena*, with particular emphasis on its effects on soil health and floral yield. A field experiment was conducted at Kelaât M'Gouna (southeastern Morocco) during the 2023 growing year, encompassing two consecutive flowering seasons. The trial was laid out in a randomized complete block design with three treatments: an untreated control, RDW applied alone, and RDW combined with microbial inoculation. Each treatment was replicated within blocks to account for field variability. Soil physicochemical and biological properties, along with floral yield parameters, were monitored to assess the agronomic effectiveness of RDW-based amendments under field conditions. The application of RDW alone significantly improved key soil physicochemical and biological properties, including water-holding capacity (+14.09%), enhanced nutrient cycling, as evidenced by a significant improvement in the soil carbon-to-nitrogen (C/N) ratio (+7.31%), and increased microbial activity. Notably, when RDW was combined with microbial inoculants, a strong synergistic effect was observed, leading to marked increases in dehydrogenase (2.75 µg TPF·g^{-1} dry weight·24 h^{-1}) and β-glucosidase (71.39 µg PNG·g^{-1} dry weight·h^{-1}) activities, which are critical indicators of microbially mediated organic matter decomposition. These improvements in soil health translated into a significant increase in floral yield, reaching 6.67 t·ha^{-1}. Overall, our findings demonstrate that RDW should not be considered waste, but rather a valuable bioresource with proven agronomic benefits. Furthermore, inoculating RDW with beneficial microbes further increased its beneficial effects, offering an innovative and sustainable strategy to improve soil health and crop productivity.

Keywords: *Rosa damascena*, rose distillation waste, soil microbial activity, soil amendment, sustainable agriculture.

Visible-Light assisted Electro-Fenton Mineralization of Pesticide Imidacloprid using $MnFe_2O_4$/g-C_3N_4 Nanocomposite: DFT calculations, Mechanism pathway and Toxicity analysis

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Abstract

$MnFe_2O_4$/g-C_3N_4 nanocomposites were developed as efficient catalysts for a visible-light-assisted heterogeneous electro-Fenton (HPEF) process aimed at the mineralization of imidacloprid (IMD) in wastewater. The structural, morphological, and surface properties of the synthesized materials were comprehensively characterized using XRD, FTIR, Raman spectroscopy, N_2 adsorption–desorption, SEM-EDS, TEM, and XPS analyses, confirming the successful integration of $MnFe_2O_4$ nanoparticles within the g-C_3N_4 matrix. The photo-assisted electrochemical performance of the $MnFe_2O_4$/g-C_3N_4 catalyst was evaluated under visible light irradiation in an electrochemical system, demonstrating high efficiency toward IMD degradation and mineralization with improved energy performance. The main operational parameters, including current intensity, catalyst dosage, and initial pH, were systematically optimized using response surface methodology based on central composite design RSM-CCD, allowing the identification of optimal conditions for maximum removal efficiency.

Mechanistic investigations, supported by radical scavenging experiments, revealed that hydroxyl radicals (•OH) are the predominant reactive oxygen species responsible for IMD degradation. Density Functional Theory (DFT) calculations further provided insights into the electronic structure, charge distribution, and active sites of the $MnFe_2O_4$/g-C_3N_4 composite, supporting the experimental observations. Transformation products were identified using LC-MS analysis, and subsequent toxicity assessment demonstrated a significant reduction in the toxicity of IMD and its intermediates during the HPEF process. In addition, the catalyst exhibited excellent stability and reusability over multiple cycles, as confirmed by post-reaction characterization.

Keywords: Imidacloprid, Heterogeneous electro-Fenton, $MnFe_2O_4$/g-C_3N_4, visible light, DFT calculations, toxicity analysis, wastewater treatment.

$Zn_3(PO_4)_2/Cu_2O$ heterojunction as an efficient photoelectrocatalyst for organic pollutant degradation

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Abstract

This study reports the synthesis of a $Zn_3(PO_4)_2/Cu_2O$ photoanode prepared via an electrodeposition approach. The as-fabricated material was comprehensively characterised using X-ray diffraction (XRD), which confirmed the orthorhombic crystal structure of $Zn_3(PO_4)_2$ and the cubic phase of Cu_2O [1], while scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy (SEM–EDX) revealed the surface morphology and elemental composition of the composite. UV–visible diffuse reflectance spectroscopy (UV–Vis DRS) was employed to evaluate the optical properties and estimate the bandgap energies of both semiconductors. Electrochemical properties were investigated using linear sweep voltammetry (LSV), electrochemical impedance spectroscopy (EIS), and Mott-Schottky (MS) analysis. The photoanode was subsequently applied to the electrochemical degradation of Reactive Black 5, where key operational parameters including current density, initial dye concentration, and supporting electrolyte concentration were optimized using a central composite design combined with response surface methodology (CCD–RSM). Under optimal conditions, a degradation efficiency of 98% was achieved within 15 min. Moreover, the $Zn_3(PO_4)_2/Cu_2O$ photoanode exhibited good stability, maintaining its performance over six consecutive degradation cycles.

Keywords: Electrodeposition,Thin films, $Zn_3(PO_4)_2/Cu_2O$, Electrocatalysis Photoelectrocatalysis, CCD-RSM Environmental treatment

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V_2O_5-enabled heterojunction photocatalysts for visible-light driven degradation of organic dyes

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Abstract

This work presents a V_2O_5-based heterojunction photocatalyst constructed using co-precipitation and solid-solid mixing techniques to improve its performance in photocatalytic activity under visible light. V_2O_5 was synthesized by co-precipitation, after which a Z-scheme heterojunction was formed through solid–solid mixing with $Bi_{24}O_{31}Cl_{10}$ [1,2]. X-ray diffraction (XRD) confirmed the successful integration of the two components, and scanning electron microscopy (SEM) revealed homogeneous distribution and the morphological structure of the materials. Diffuse reflectance spectroscopy (DRS) showed enhanced visible-light absorption and a reduced band gap of 2.86 eV for the composite. The resulting composite exhibited excellent photocatalytic performance in the degradation of organic dyes, with Rhodamine B used as a model compound. Up to 98% removal was achieved within 60 min under visible-light irradiation. Reactive species trapping experiments identified photogenerated holes (h^+) and superoxide radicals ($O_2^{\cdot -}$) as the dominant active species. This supports an efficient Z-scheme charge transfer mechanism that suppresses charge recombination. Furthermore, the photocatalyst demonstrated excellent stability and reusability over five consecutive cycles, highlighting its potential for sustainable water purification applications under visible light.

Keywords:
Photocatalysis; $(1\text{-}x)Bi_{24}O_{31}Cl_{10}/xV_2O_5$ composites; RhB photodegradation; visible-light irradiation

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Z-Scheme-Driven Photoelectrocatalytic Degradation of Tetracycline over $(1-x)Cu_3(PO_4)_2/xBi_2O_3$ Composites under Visible Light

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Abstract

$(1-x)Cu_3(PO_4)_2/xBi_2O_3$ composites were synthesized via a solid-state route and systematically characterized to evaluate their structural, optical, and photoelectrochemical properties. XRD, FT-IR, and SEM analyses confirmed the successful formation of a well-integrated heterostructure with intimate interfacial contact between $Cu_3(PO_4)_2$ and Bi_2O_3 phases. UV–Vis diffuse reflectance spectroscopy revealed enhanced visible-light absorption, with band gap energies of 3.20 eV for $Cu_3(PO_4)_2$ and 2.84 eV for Bi_2O_3. Among the investigated compositions, the x = 0.8 composite exhibited the best performance toward tetracycline degradation under visible-light irradiation. Electrochemical analyses, including OCP, EIS, and Mott–Schottky measurements, demonstrated improved charge separation and interfacial charge transfer, supporting the formation of a direct Z-scheme heterojunction between n-type $Cu_3(PO_4)_2$ and p-type Bi_2O_3. Under optimized conditions, the x = 0.8 composite achieved 82% photocatalytic degradation within 90 min and complete removal within 15 min in the photoelectrocatalytic mode. Radical scavenging experiments identified holes (h^+) and superoxide radicals ($\bullet O_2^-$) as the dominant reactive species, explaining the superior photoelectrocatalytic activity of the heterostructure.

Keywords: Solid-state; Bi_2O_3; $Cu_3(PO_4)_2$; Photocatalysis; Photoelectrocatalysis; Z-Scheme; Tetracycline.

ZIF-67@Digestate Derived Co,N-Doped Biochar Membranes for Sulfamethoxazole Removal through Peroxydisulfate Activation

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Abstract

The ubiquitous presence of sulfamethoxazole (SMX) within aquatic ecosystems coupled with the increasing production of sewage sludge digestate (SSD) has emerged as a critical environmental challenge. This necessitates the development of efficient decontamination strategies and sustainable waste management approaches. Herein, magnetic Co_x-NBC composites were synthesized by integrating ZIF-67 and nitrogen-rich biochar (NBC) through ball milling and thermal treatment. These elaborated materials were comprehensively characterized and demonstrated exceptional performance as metal-doped carbocatalysts, exhibiting synergistic capabilities in both the adsorption and catalytic degradation of sulfamethoxazole (SMX) through efficient activation of peroxydisulfate (PDS). The results indicate that the biochar matrix plays a pivotal role in facilitating the uniform dispersion of ZIF-67 particles, effectively suppressing their aggregation, enhancing structural stability, and providing additional adsorption sites for sulfamethoxazole (SMX). A comprehensive investigation of key operational parameters was conducted within the Co_x-NBC/PDS system, including the initial pH of the SMX solution, catalyst dosage, PDS concentration, and the presence of inorganic ions and humic substances. Furthermore, the dominant reactive oxygen species (ROS) involved in SMX degradation were systematically identified through quenching experiments, offering critical insight into the underlying catalytic mechanisms.

Keywords: Biochar, ZIF-67, Enhanced functionalities, Peroxydisulfate activation, Sulfamethoxazole degradation

Utilizing Quartz Sand Contaminated with Organic Pollutants as a Composite for Construction Materials

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Abstract

The management of quartz sand contaminated by organic pollutants presents a growing environmental challenge, exacerbated by the intensification of industrial activities and urbanization. The disposal of these wastes leads to land use issues and the risk of leaching pollutants into water resources. In a context of dwindling natural resources and the promotion of a circular economy, repurposing this sand as a matrix for construction materials emerges as a promising alternative. However, the incorporation of organic pollutants can alter the physicochemical properties of the materials, affecting their strength and durability. Therefore, it is crucial to rigorously assess the impact of these pollutants and establish acceptable concentration thresholds. Additionally, a life cycle assessment (LCA) is essential to evaluate the environmental footprint of this approach compared to traditional solutions. The economic viability of this repurposing, including the costs of collection and treatment, must also be examined

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The synthesis of a magnetic polymer @ZnO nanocomposite is a facile process, and it exhibits visible-light photocatalytic degradation of organic dyes.

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Abstract

Wather pollution caused by organic dyes remais a critcal global challenge. In response, photocatalytic treatement has been widely implemented as an effective approach to improve water quality. In the present study. The nanocomposite magnetic polymer @ ZnO was synthesized a simple Mechanochemical. The photocatalyst was characterized using X-Ray Diffraction (XRD), Scanning Electron Microscopy combined with Energy Dispersive X-ray Spectoscopy (SEM/EDX), and Diffuse Reflectance Spectroscopy (DRS). The results of these studies demonstrated the succeful formation of the photocatalyst. The photodegradation was tested by methylene blue (MB) dye under visible light irradiation resulting in photodegradation efficiency of 95% after 180 min of irradiation using 1g.L^{-1} of nanocomposite in an aqueous solution of MB at 12 mg.L^{-1}.

Keywords: Photocatalysis – Degradation – Dye – Visible light – Magnetic polymer @ ZnO

Évaluation de la qualité des sols d'une ancienne mine d'amas sulfurés volcanogènes (Kettara, Jebilet Centrales, Maroc) et identification d'un substrat adapté à la phytostabilisation

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Résumé

La zone de l'ancienne mine de Kettara (Jebilet, Marrakech-Safi), exploitée pour ses sulfures massifs (VMS), présente aujourd'hui une dégradation avancée des sols liée à l'oxydation de minéraux sulfurés tels que la pyrite, la chalcopyrite et la sphalérite. Cette étude vise à évaluer la qualité, la fertilité et le niveau de contamination des sols environnants afin d'orienter des stratégies de réhabilitation. Quatre types de sols représentatifs (jaune, rouge, sulfurisé, mélangé) ont été prélevés, préparés et analysés au sein des laboratoires Agro Bio Val et du Centre d'Analyse et de Caractérisation de la FSSM.

Les analyses physico-chimiques (pH, CE, carbone total, phosphore total), granulométriques, azotées (NTK) et métalliques (Pb, Cd, Cu, Zn par AAS) révèlent une acidité extrême (pH 2–3) attribuée au drainage minier acide. Malgré cette acidité, les concentrations en métaux lourds demeurent faibles à modérées, suggérant une fixation partielle ou une dispersion naturelle. Les sols présentent des niveaux de fertilité contrastés : le sol rouge montre les teneurs les plus élevées en phosphore et en azote, traduisant son potentiel agronomique, tandis que le sol jaune apparaît le plus dégradé, avec un azote très faible et un carbone non humifié.

Les résultats mettent en évidence une forte influence de l'héritage minier sur la qualité des sols, combinant acidité, variabilité nutritive et risque de mobilisation métallique. Parmi les sols étudiés, le sol rouge a été identifié comme le plus favorable à une stratégie de phytostabilisation. Cette étude fournit des éléments clés pour la réhabilitation écologique des environnements miniers sulfurés dans le contexte semi-aride marocain.

Optimization of the Leaching Process for the Pretreatment of Phosphate Rare Earth Element Concentrates using the Taguchi Methodology

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Abstract

Each year, a significant amount of mining waste is produced in Morocco. Improper disposal of this waste can lead to serious environmental and social issues. This study aims to optimize the leaching conditions for the recovery of rare earth elements from solid mining waste. The effects of several parameters were examined, including the type of acid (nitric, phosphoric, and hydrochloric), acid concentration, reaction time, and solid-to/liquid ratio[1][2]. The sample was analyzed using X-ray diffraction (XRD) to identify its mineral composition, and the results were confirmed by X-ray fluorescence (XRF). The morphology of the sample was observed using scanning electron microscopy (SEM). Inductively coupled plasma atomic emission spectroscopy (ICP-MS) showed that the sample contained 424.87 ppm of rare earth elements. A Taguchi experimental design (L9) was used to determine the optimal leaching conditions. The acid concentrations ranged from 4.1 M to 10 M, the solid/liquid ratios from 1/12 to 1/5, the temperatures from 28°C to 69°C, and the reaction time was fixed at 60 minutes. The best recovery of rare earth elements was obtained using hydrochloric acid at a concentration of 4.1 M, a temperature of 28°C, a solid-to-liquid ratio of 1/5, and a leaching time of 60 minutes.

Keywords: Acid Leaching, Taguchi method, rare earth, phosphate mine waste

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Corrosion inhibition of mild steel in acidic medium using newly synthesized heterocyclic organic compound Cl-PRZ

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Abstract

The inhibition of Mild Steel (MS) corrosion in 1M HCl solution by Cl-PRZ compound has been examined using electrochemical impedance spectroscopy and potentiodynamic polarization (PDP) at different temperatures. The results indicate that the inhibition efficiency increases with the concentration of Cl-PRZ reaching maximum values of 86% at the optimal concentration (1mM) according to PDP analysis. The obtained results suggest that the tested inhibitor act as a mixed-type inhibitor, which hinders anodic and cathodic processes. Furthermore, the inhibitor follows the Langmuir adsorption isotherm for a monolayer adsorption. Scanning electron microscopy analysis of the MS sample has also been conducted and discussed. Theoretical calculations based on the density functional theory calculations and Monte Carlo simulations coupled to simulated annealing algorithm demonstrated a good agreement with the experimental findings.

Keywords: Organic Inhibitor, EIS, Polarization, Langmuir, Mild Steel.

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Nanomaterials for Environmental Protection: Iron-Doped Biochar for Advanced Wastewater Depollution

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Abstract

The presence of persistent organic pollutants in wastewater, particularly textile dyes, represents a serious environmental challenge due to their toxicity, stability, and resistance to conventional treatment processes. Sulfate radical–based advanced oxidation processes (SR-AOPs) have emerged as promising alternatives because of their high oxidation potential and selectivity. In this study, an efficient and sustainable SR-AOP system was developed through the heterogeneous activation of persulfate using iron-doped biochar (Fe-BC) synthesized from olive pomace, an abundant agricultural by-product.

Fe-BC simultaneously acted as an adsorbent and a catalyst, promoting persulfate activation and the generation of sulfate ($SO_4^{\bullet-}$) and hydroxyl ($OH^{\bullet}$) radicals. The process was evaluated using methylene blue as a model organic pollutant. The effects of operational parameters such as reaction time, persulfate concentration, catalyst dosage, pH, and temperature were investigated to determine optimal conditions. Under neutral pH and room temperature, a degradation efficiency exceeding 98% was achieved within 15 minutes, following pseudo-first-order kinetics.

The stability and recyclability of Fe-BC were also confirmed over multiple reuse cycles, showing minimal loss of catalytic activity. Furthermore, the applicability of the Fe-BC/persulfate system was successfully demonstrated using real wastewater from a municipal treatment plant, achieving significant reductions in chemical oxygen demand (COD), biochemical oxygen demand (BOD_5), and turbidity.

These results highlight the potential of iron-doped biochar–mediated persulfate activation as a green, cost-effective, and scalable solution for the treatment of dye-contaminated and organic-polluted wastewaters, offering high efficiency under environmentally friendly conditions.

Keywords: Biochar; Iron; Advanced persulphate oxidation process; Methylene Blue; Wastewater treatment.

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Projected Impacts of Climate Change on Water Resources in the Upstream Tassaoute Watershed Using Rainfall–Runoff Modeling

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Abstract

Climate change has a significant impact on the water resources of the upstream Tassaoute watershed. For this reason, a study was conducted to characterize and quantify water resources in this region. By using rainfall-runoff models such as GR2M and Thornthwaite, as well as projections from regional climate models, it was found that stream flows will decrease significantly. Indeed, the stream flows are expected to experience a decrease ranging from - 40% to -60% depending on the model and scenarios used. These findings are consistent with other studies conducted at the national and Mediterranean scales, which highlight a decrease in precipitation and water resources. These observations emphasize the urgency of adopting effective adaptation and management measures to cope with the increasing scarcity of water in the upstream Tassaoute watershed. Key words: Climate change – Hydrological models – GR2M – Thornthwaite – Climate models – Morocco.

Electrodeposition of high-entropy oxide-carbide composites in organic solvent and application as oxygen evolution electrode in water splitting

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Abstract

High-entropy oxides are promising catalysts for the oxygen evolution reaction in water splitting. In this study, coatings of oxide-carbide composites containing transition elements such as Cr, Mn, Fe, Co, Ni, Mo, or W were electrodeposited in a C_3H_7NO(DMF)-CH_3CN or C_2H_6SO (DMSO)-based chloride solution. X-ray diffraction (XRD) and transmission electron microscopy (TEM) analyses showed an amorphous structure in the coatings, whereas X-ray photoelectron spectroscopy (XPS) confirmed the presence of carbides, oxides, and oxygen vacancies. Oxides and carbides were produced via the reduction of hydrated water and organic molecules for the aqua- and chloro-complexes of metal ions. The coating exhibited high catalytic activity for the oxygen evolution reaction in water splitting and achieved overpotentials of less than 300 mV in an alkaline solution, corresponding to a current density of 10 mA cm^{-2}. Long-term stability was also investigated, and stable overpotentials and minor surface dissolution were confirmed. The catalytic activity is discussed using the density functional theory. The unsaturated oxidation number of the metal atoms depicted the relationship between the binding state and the overpotential of the active sites.

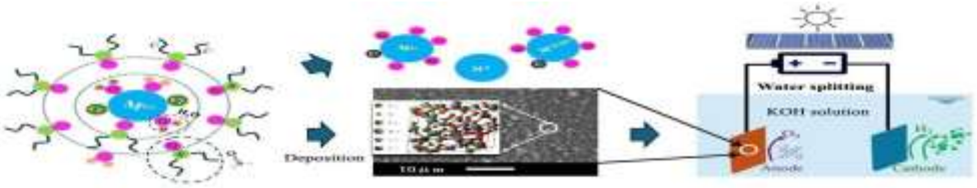

Figure 1. Electrodeposition mechanism and application as OER electrode

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CaCO3 recovery by reacting rejected brine water (RBW) with both Ca(OH)2 and CO2 : its recycling (CaCO3) in desalination post-treatment and in water salinity reduction

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Abstract

This study adopts a two-fold approach. The first focuses on the valorization of rejected brine water (RBW) from desalination plants by producing useful chemicals, such as calcium carbonate ($CaCO_3$), while simultaneously reducing brine salinity, thus helping protect aquatic ecosystems. The second approach involves reusing and recycling the recovered chemicals, particularly calcium carbonate, for the remineralization of the reverse osmosis permeate within the desalination facility as part of post-treatment.

Preliminary results show that adding calcium hydroxide ($Ca(OH)_2$) and carbon dioxide (CO_2) to RBW leads to the precipitation of $CaCO_3$ and a decrease in water salinity. The mass of precipitated $CaCO_3$ increases with higher doses of both reactants. Furthermore, high CO_2 flow rates significantly reduce the salinity of the discharged brine. The produced $CaCO_3$ was loaded into a pilot-scale calcite bed for use in the second stage of the study. Results indicate that remineralization using the recovered $CaCO_3$ can effectively restore the calco-carbonic equilibrium of the permeate, bringing it to potable water standards. However, this process is highly dependent on several parameters, including CO_2 flow rate, permeate flow velocity, and bed thickness, which all significantly impact the overall efficiency.

Keywors : Reject brine water (RBW), Desalination, CaCO3 precipitation, Remineralization

Effect of Alkali-Treated Doum Palm Fibers on the Properties of Geopolymer Composites

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Abstract

With increasing global concern over environmental sustainability, geopolymers have attracted significant interest as eco-friendly alternatives to conventional cementitious materials. However, their practical application is often limited by inherent brittleness and low flexibility. This study investigates the development of lightweight geopolymer composites (LWGCs) reinforced with alkali-treated short-leaf date palm fibers (SLDPFs), using copper mine waste (CMW) as the primary aluminosilicate source. The effects of fiber treatment and content (1–5 wt.%) on the mechanical and physical properties of the composites were systematically evaluated. The results showed that fiber incorporation significantly enhanced the modulus of rupture (MOR), modulus of elasticity (MOE), and compressive strength, with optimal performance observed at 2–3 wt.% fiber content. Excessive fiber addition led to decreased mechanical performance due to agglomeration and increased porosity. FTIR and SEM analyses revealed improved fiber–matrix interfacial bonding and changes in the geopolymer gel structure after fiber treatment. Water absorption and thickness swelling increased with higher fiber content but remained within acceptable limits at moderate dosages. These findings demonstrate that alkali-treated date palm fibers, when used at optimal concentrations, can markedly improve the mechanical performance and durability of sustainable geopolymer composites. This work highlights the potential for valorizing agricultural and mining wastes in the production of high-performance, eco-friendly building materials.

***Keywords**:* Geopolymer, alkali treated fibers, palm doum fibers, ecofriendly composites, mechanical, physical properties.

An Integrated Physics-Based and Data-Driven Framework for Predicting Membrane Degradation and Remaining Useful Life in PEM Fuel Cells

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Abstract

Polymer electrolyte membrane fuel cells (PEMFCs) convert hydrogen and oxygen into electricity, with water and heat as the main by-products at the point of use.

Their large-scale environmental impact therefore depends strongly on the durability of their core materials—especially the polymer electrolyte membrane—whose hydration and water management govern both performance and degradation.

In line with the CIMAEE-2026 focus on the conception/functionalization of materials and innovative applications for environmental protection and clean energy, this work presents an operationally practical, physics-informed framework to track membrane health and forecast remaining useful life (RUL) using signals typically logged in PEMFC stacks.

A quasi-static model links reactant crossover to membrane state, while a damage law accumulates operating-condition effects over time to deliver an online health indicator and RUL estimate. Under baseline operation near 60 °C with stable hydration, hydrogen/oxygen crossover remained nearly constant (median $j_{cross,H}^{2}$ ≈ 1.61 µA.cm^{-2}; $j_{cross,O2}$ ≈ 0.126 µA.cm^{-2}) with low accumulated damage after 1000 h ($D \approx 0.042$), yielding a long projected lifetime ($RUL \approx 2.36\times10^{4}$ h) if conditions persist. A subsequent step to higher temperature and humidity (80 °C, high RH) coincided with an increase in median hydrogen crossover (~j_{cross,H2} ≈ 2.63 µA·cm^{-2}) and an inferred through-thickness defect (effective radius $r_{eq} \approx 1.37$ µm), indicating accelerated material degradation and reduced RUL. The proposed approach supports durability-oriented material selection and condition management for cleaner energy systems consistent with water-and-environment congress priorities.

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Optimization of precipitation conditions for enhanced textural properties and surface reactivity of SDS-assisted mesoporous γ-alumina

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Abstract

The synthesis of mesoporous γ-alumina using soft template is widely utilized in adsorption of pollutants and greenhouse gas due to its advantageous textural properties and chemical stability **[1]**. However, the simultaneous influence of synthesis parameters, particularly surfactant concentration and pH, on its surface free energy remains underexplored **[2]**. This study presents the controlled synthesis of mesoporous γ-alumina via an anionic sodium dodecyl sulfate (SDS)-assisted precipitation method using aluminum nitrate as precursor. The effects of pH, SDS concentration, calcination temperature, and SDS addition sequence on the physicochemical properties and surface reactivity of γ-Al_2O_3 were systematically investigated. Characterization techniques including XRD, FTIR, nitrogen adsorption–desorption (BET), TGA, and contact angle measurements revealed strong dependencies of surface chemistry and mesostructure on synthesis conditions. The optimal sample synthesized at pH 10 with 0.025 M SDS and calcined at 500 °C, with SDS added before-precipitation, exhibited a highly ordered mesoporous framework, a specific surface area of ~183 m^2/g, and an average pore size of ~7 nm. Notably, surface polarity increased markedly from ~12% for pristine γ-alumina to ~54% under optimal conditions, indicating enhanced hydrophilicity attributed to effective micelle templating. Overall, this study provides a simple, economical, and environmentally friendly route for tailoring mesoporous γ-alumina with controlled polarity and improved textural properties. The findings highlight the strong interplay between synthesis conditions and surface reactivity, offering a robust strategy for designing γ-alumina materials with enhanced performance in adsorption and catalytic applications.

Keywords: Mesoporous γ-Alumina, Precipitation, SDS concentration, pH effect, Surface free energy, Textural properties.

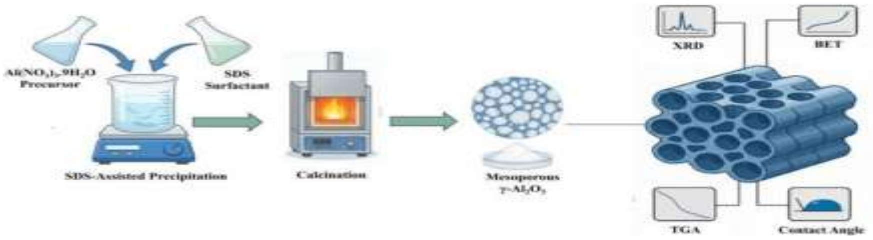

Figure 1. Schematic illustrating the synthesis procedure of mesoporous γ-alumina via SDS-assisted precipitation.

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Amine-Functionalized SDS-Templated Mesoporous γ-Alumina for Efficient CO_2 Capture

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Abstract

The continuous rise in CO_2 emissions is a major contributor to climate change, underscoring the urgent need for efficient and scalable capture technologies. Among the available approaches, amine-functionalized solid sorbents have emerged as promising candidates due to their high CO_2 selectivity, and excellent regeneration performance **[1]**. In this study, mesoporous γ-alumina was first synthesized via a soft-template precipitation method using the anionic surfactant sodium dodecyl sulfate (SDS), which enables the formation of well-defined mesoporosity and high surface area suitable for functionalization **[2]**. To enhance its affinity toward CO_2, the γ-alumina surface was modified through a two-step strategy. First, phosphorylation was carried out to introduce negatively charged phosphate groups, enhancing the anchoring and dispersion of amine functionalities. The phosphorylated alumina was then functionalized with polyethylenimine (PEI) by physical impregnation. Structural and chemical characterizations confirmed the success of each modification step. FTIR spectra revealed the appearance of characteristic N–H, C–H and C–N bands associated with PEI, indicating effective adsorption of the polymer through non-covalent interactions. XRD analysis showed that the γ-alumina crystalline phase was preserved after modification, while additional features associated with phosphate species confirmed successful surface phosphorylation. Overall, this work demonstrates that combining SDS-derived mesoporous γ-alumina, surface phosphorylation, and PEI impregnation leads to the formation of amine-functionalized sorbents with improved interaction sites for CO_2 capture, offering a promising approach for the development of efficient and durable solid sorbents for CO_2 capture applications.

Keywords: Mesoporous γ-Alumina, Soft-template precipitation, SDS-assisted synthesis, Polyethylenimine (PEI) functionalization, CO_2 capture.

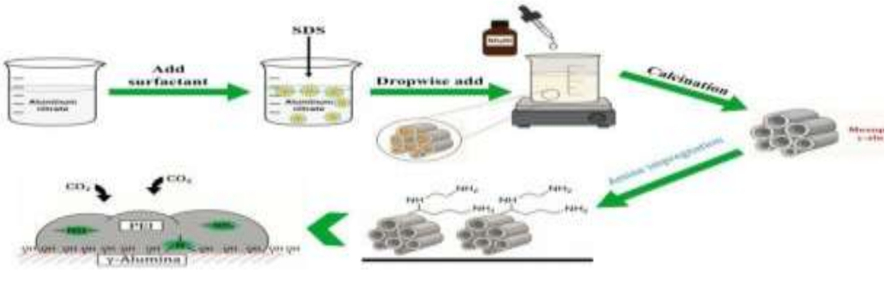

Figure 1: Synthesis Process of Mesoporous γ-Alumina and Its Surface Modification for Enhanced CO_2 Capture

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Effect of Annealing Temperature on the Structural and Morphological Properties of Kesterite (CZTS) Solar Cells

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Abstract

Kesterite (Cu_2 $ZnSnS_4$, CZTS) solar cells are promising absorber materials for thin-film photovoltaics due to their composition of earth-abundant elements and their high theoretical efficiency compared to the similarly structured chalcopyrite $Cu(In,Ga)Se_2$ (CIGS). This work aims to investigate the influence of annealing temperature on the structural, morphological, and optical properties of the kesterite solar cells. CZTS thin films were prepared using a sol–gel method via spin coating. The precursor solutions were deposited onto soda-lime glass substrates, followed by preheating on a hot plate for 5 minutes and cooling for 15 minutes to obtain a film thickness of approximately 1 µm. The films were then annealed in a tube furnace at different temperatures (480, 520, and 550 °C) to optimize phase formation and crystallinity. Structural and morphological characterizations were carried out using X-ray diffraction (XRD), Raman spectroscopy (RS), and scanning electron microscopy (SEM).

Structural characterization using X-ray diffraction and Raman spectroscopy confirms the formation of the kesterite phase in all samples, with the film annealed at 520°C exhibiting the highest intense peak corresponding to (112) orientation, indicating higher crystallinity and reduced secondary phases. Morphological analysis using scanning electron microscopy (SEM) reveals a significant increase in grain size and improved surface compactness at 520 °C compared to films annealed at 480 and 550 °C. These results identify that an annealing temperature of 520 °C is optimal for obtaining high-quality CZTS thin films.

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Cryoconcentration as a green and sustainable strategy for the treatment and valorization of aromatic plant distillation wastewater

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Abstract

The extraction of essential oils generates effluents heavily loaded with organic matter. We used the hydrodistillation waters of an aromatic plant to evaluate *Cryoconcentration* as a treatment process. After freezing at –24 °C and controlled sweating, five fractions (F1–F5) were collected. Physicochemical analyzes show a clear concentration of polyphenols in the early fractions. F1 exhibits the highest concentration indices (≈ 3.11 for MO and 3.17 for MM) as well as the highest levels of flavonoids and tannins, with a gradual decrease until F5. UV-Visible and ATR-FTIR spectroscopic analyzes confirm the presence of characteristic signatures of phenolic compounds in all fractions.

An analysis by UHPLC/ESI-MS was conducted and allowed for the identification of the main phenolic compounds - potentially bioactive - in raw waters and enriched fractions. The examination of antioxidant activity, evaluated by DPPH, TBARS, and conjugated dienes methods, reveals a significantly higher antioxidant power in the most concentrated fractions. The antimicrobial activity, evaluated by disk diffusion and minimum inhibitory concentration (MIC) methods, was tested against *Candida albicans, Escherichia coli, Pseudomonas aeruginosa*, and *Staphylococcus aureus*. The results obtained demonstrate the effectiveness of cryoconcentration in concentrating and enhancing the bioactive compounds of hydrodistillation waters, while also providing a sustainable approach to reducing the environmental impact of the essential oil sector.

Keywords : Cryoconcentration, Hydrodistillation, Wastewater, Polyphenols, ATR-FTIR, UHPLC/ESI-MS, DPPH, Antioxidant activity, antimicrobial activity

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Synthesis of zeolite from red clay mud

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Abstract

Zeolites, aluminosilicates with 3D framework, that are mostly applied as catalysts, ion exchangers, and adsorbents, are one of the crucial materials with several industrial applications ranging from water purification to gas separation and heterogeneous catalysis [1-2]. Industrial/mining wastes and natural clays provide sustainable and low-cost sources of aluminosilicates precursors for the production of synthetic zeolites [3].

Red clay mud, an unexploitable sterile layer removed during mining operations prior to reach iron-bearing ore, is rich in silica and aluminum oxides was used as the main raw material for zeolite synthesis. An alkaline activation with a specific Si/Na ratio followed by hydrothermal treatment was done. The obtained powder was characterized by different techniques. X-ray diffraction confirmed the formation of crystalline zeolite phase type P1. Morphology was observed using scanning electron microscopy that revealed the defined zeolite crystals. Textural analysis demonstrated a significant increase in specific surface area. Our study presents a significant method to transform red clay mud into framework zeolite. Further studies are planned to investigate the functionality of the synthesized zeolite.

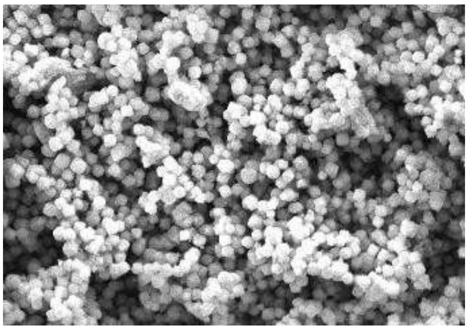

Figure 1. SEM image of synthesized zeolite.

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Bio-Based Packaging Materials: Formulation and Properties for Environmentally Friendly Applications

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Abstract

In response to the environmental challenges associated with plastic pollution and waste management, the development of bio-based packaging materials represents a strategic alternative for reducing the environmental footprint of food packaging. Derived from renewable resources such as polysaccharides (starch, cellulose, chitosan*), proteins (gelatin, plant proteins), or lipids, these biomaterials enable the design of biodegradable and/or compostable films that meet current requirements for sustainability and the preservation of aquatic ecosystems. They also offer a promising pathway for meeting the ambitious objectives of the European PPWR regulation, which by 2030 aims to drastically reduce conventional plastics and accelerate the transition toward circular, recyclable, or bio-based packaging solutions.

The formulation of such films relies on the optimization of several parameters: selection of the biopolymer, incorporation of plasticizers to adjust flexibility, and addition of natural additives capable of providing specific functionalities (antimicrobial activity, antioxidant properties, or improved barrier performance). Processing techniques such as solution casting and extrusion are implemented within low-energy approaches compatible with sustainable production.

The final properties of the films, including mechanical strength, barrier performance, morphology, and water sensitivity, depend strongly on the formulation and internal structuring of the material. While moisture sensitivity remains a major challenge for their use in food packaging, recent advances in the physico-chemical modification of bio-based matrices are opening new possibilities for increasingly high-performance solutions aligned with current regulatory and environmental expectations.

In this study, new bio-based films are currently being developed. Expected outcomes include improvements in mechanical properties, morphological organization, structural and functional stability, and the ability to extend the shelf life of fresh fruits and vegetables. These films aim to provide enhanced resistance and added functionality, enabling realistic applications within food supply chains while reducing the overall environmental impact.

This work therefore contributes to a deeper understanding of formulation mechanisms in bio-based materials and supports the development of innovative, sustainable packaging solutions compatible with European targets for reducing conventional plastics.

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Advanced study of parameters influencing clogging in polyethylene drippers: a combined polymer materials–numerical simulation–irrigation approach

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Abstract

Clogging of polyethylene (PE) emitters is a major bottleneck for the long-term performance of drip irrigation systems, especially when non-conventional waters (hard groundwater, treated wastewater) are used. This work is part of an ongoing PhD study that develops an integrated approach to understand and mitigate clogging by combining: (i) a parametric analysis of hydraulic conditions and water quality, (ii) the evaluation of polymer materials for emitters and laterals, and (iii) a multiphysics numerical modelling of clogging.

A closed-loop test bench was built with commercial PE emitters supplied by a model water reproducing typical characteristics of groundwater from the Béni Mellal region (high hardness, Ca^{2+} /Mg^{2+} , HCO_3^{-} , Fe) with controlled suspended solids (50–200 $mg \cdot L^{-1}$). PE and surface-modified PE coupons were characterised (contact angle, roughness) to assess the influence of surface properties on deposit adhesion. A 3D model was developed in COMSOL Multiphysics, coupling laminar flow and particle transport with first-order wall adsorption for different emitter geometries.

Preliminary results show that increasing suspended solids and adding iron significantly accelerate clogging, with mean discharge loss rising from about 7% to more than 25% under the most severe conditions. A moderate increase in operating pressure reduces the simulated clogging index by roughly 20–30% by shrinking low-velocity recirculation zones, while the combination of an optimised internal labyrinth and surface-modified PE lowers the global clogging index by nearly 50% and delays the time to a critical clogging threshold. The agreement between numerically predicted high-risk zones and observed deposit patterns confirms the relevance of coupling polymer surface engineering and numerical simulation to design clogging-resistant emitters for agricultural irrigation.

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Hydrological modeling of the oued amzaz watershed in morocco using gis and hec-hms

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Abstract

This study investigates hydrological flood risks in the Oued Amzaz watershed, located upstream of the Sebou basin in Morocco, a region frequently affected by intense hydrometeorological events. Due to its physiographic characteristics and rainfall variability, the watershed is highly susceptible to flooding.

The proposed methodology integrates Geographic Information Systems (GIS) and hydrological modeling using the HEC-HMS model. Hydrological and topographic data were collected, processed, and analyzed to extract the main morphometric and hydrological parameters of the basin. A representative hydrological model was developed and calibrated to simulate runoff processes.

The results allow a better understanding of the hydrological behavior of the watershed and highlight its sensitivity to extreme precipitation events. This work provides a useful decision-support tool for flood risk assessment and contributes to improving watershed management and mitigation strategies in vulnerable regions.

Keywords: Flood risk, Hydrological modeling, GIS, HEC-HMS, Watershed

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Tannin-Based Coagulants Performance in Starch-Rich Industrial Wastewater Treatment

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Abstract

The increasing demand for high-quality water has intensified due to the pollution-driven degradation of clean water sources. Coagulation is a key process in wastewater treatment, enabling the removal of suspended particles and dissolved contaminants [1]. Conventional coagulants based on aluminum and ferric salts are widely used; however, their application is associated with several drawbacks, including the generation of toxic sludge and potential links to neurodegenerative diseases [2]. As a safer and more sustainable alternative, tannin-based coagulants have emerged as promising renewable materials [2]. These coagulants are typically produced via the Mannich reaction, which converts the naturally anionic tannin structure into a cationic form through the reaction of an aldehyde, commonly formaldehyde, with an amine [1]. In this study, tannin-based coagulants were evaluated for the treatment of industrial wastewater generated by a Portuguese company, characterized by high starch content and elevated turbidity levels. Due to these characteristics, the effluent requires an effective coagulation process to ensure adequate treatment. Two biocoagulants- a commercial tannin-based coagulant (Tanfloc) and a chestnut-derived tannin-based coagulant--were investigated and compared with a conventional coagulant, aluminum sulfate. Chestnut tannins were extracted using distilled water at 90 °C for 10 min, resulting in an extraction yield of 20.3 ± 0.8%. The extracted material presented a total phenolic content of 333 ± 23 $\mathrm{mg_{GAE}/g_{Extract}}$ and a condensed tannin content of 152 ± 68 $\mathrm{mg_{CE}/g_{Extract}}$. Preliminary studies showed that the original wastewater turbidity, after filtration, was 15 ± 0.3 NTU. Coagulation performance was assessed through measurements of pH, conductivity, natural organic matter, color, and turbidity removal. The traditional coagulant, at an optimal concentration of 15 mg/L, was able to remove about 64% of turbidity. *Tanfloc* achieved a turbidity removal efficiency of 63% at a dosage of 2 mg/L under the original effluent pH (6.65). In comparison, the chestnut-derived tannin coagulant reached a turbidity removal of 47% at a concentration of 20 mg/L and pH 6. None of the tested coagulants significantly alter the conductivity and pH of the wastewater. Overall, these results highlight the potential of tannin-based coagulants as environmentally friendly alternatives for industrial wastewater treatment.

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A Low-Energy and Circular-Economy Approach for Recovering Cobalt and Lithium from Spent Li-ion Batteries

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Abstract

Over the years, the demand for lithium-ion batteries has continued to increase due to the growing use of electric vehicles, smartphones, laptops, and other electronic devices. It is estimated that 200,000 tons of cathode materials for lithium-ion batteries (LIBs) are produced each year, and production is expected to reach 6.8 million tons by 2035 [1]. However, such widespread use also leads to the generation of large amounts of electronic waste. By 2030, more than 11 million tons of spent LIBs are expected to be generated [2]. This has significant economic and environmental impacts, as it increases the consumption of natural metal resources such as nickel, cobalt, and lithium, while improperly treated waste batteries can contaminate soil and water systems. Battery recycling can help minimize environmental pollution and reduce production costs, making spent batteries a secondary source of high-value raw materials**.** The most common processes used to recycle spent LIBs include pyrometallurgical, hydrometallurgical, and biometallurgical methods**.**

In our work, we developed a hydrometallurgical process to recycle spent Li-ion batteries taken from a Huawei phone. This process is based on the use of phosphoric acid as a leaching agent, which is a Moroccan product manufactured by OCP. The metal recovery method used is precipitation, allowing the recovery of cobalt in a form that can be directly valorized in an energy-storage application, specifically supercapacitors. This technology is suitable for applications requiring high power density rather than high energy density, and is also characterized by its long cycle life. The second recovery step concerns lithium precipitation, a highly valuable and expensive metal with limited natural resources. This process shows high recovery efficiencies, achieving 99% for cobalt and 97% for lithium, while ensuring a high purity of the final products.

In the context of circular economy and sustainability, our process presents significant advantages: it consumes little energy and allows the recovery of strategic and expensive metals at a lower cost compared to extraction from natural sources.

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Catalytic Oxidation of Ethanol as a VOC over $LaPO_4$ -Based Catalysts Prepared by Co-precipitation

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Abstract

Volatile organic compounds (VOCs), including alcohols, aldehydes, and aromatic compounds, are major atmospheric pollutants that contribute to air quality degradation and adverse health effects. Ethanol, widely used as an oxygenated fuel additive due to its high octane number and renewable origin, exhibits cleaner combustion compared to conventional additives. However, its incomplete oxidation leads to the formation of toxic by-products such as acetaldehyde and formaldehyde, which are harmful to both human health and the environment. Therefore, the development of efficient catalysts capable of promoting the complete oxidation of ethanol into CO_2 and H_2O is of great importance.

In this study, $LaPO_4$ -based catalysts prepared by the co-precipitation method were investigated for the total oxidation of ethanol. The $LaPO_4$ support was synthesized by controlled co-precipitation of lanthanum nitrate and diammonium hydrogen phosphate, followed by aging, drying, and calcination. Subsequently, 10 wt.% of different active phases (Ni, Co, Cu, Ce, and Mg) were deposited onto the $LaPO_4$ support by wet impregnation to enhance the redox properties and catalytic efficiency.

The catalytic activity was evaluated through light-off experiments for ethanol oxidation in a fixed-bed quartz reactor under atmospheric pressure. Ethanol conversion, CO_2 yield, and product selectivity were monitored using FT-IR gas analysis over a temperature range of 100–500 °C. The results demonstrate that metal-doped $LaPO_4$ catalysts significantly enhance ethanol conversion while suppressing the formation of partial oxidation by-products such as acetaldehyde and formaldehyde. This improvement is attributed to the synergistic interaction between the active phases and the $LaPO_4$ support, which promotes oxygen activation and favors complete oxidation pathways.

These findings highlight the potential of $LaPO_4$ -based catalysts prepared by co-precipitation as efficient and environmentally friendly materials for the catalytic abatement of VOCs, particularly in applications related to alcohol-containing fuel emissions.

Keywords : VOCs, Ethanol oxidation, $LaPO_4$, Co-precipitation, Catalytic combustion, Air pollution control.

Acknowledgment: This work was conducted as part of the *PhD-Associate Scholarship – PASS* program, **Theme7: Economie verte et Economie bleue** (2025–2027), funded by the Ministry of Higher Education, Scientific Research and Innovation, in collaboration with CNRST.

Catalyst-free grafting of caprolactone for hydrophobic, thermally stable, and reactive lignocellulosic fibers: a green approach

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Abstract

This study investigates the catalyst-free modification of lignocellulosic fibers via the ring-opening polymerization of ε-caprolactone (PCL). The proposed method, which is both simple and environmentally friendly, enables efficient grafting of PCL onto the surface of Kraft cellulose fibers (PCL-g-PK). Successful functionalization was confirmed using multiple characterization techniques, including Fourier-transform infrared spectroscopy (FTIR), solid-state ^{13}C nuclear magnetic resonance (^{13}C CP/MAS NMR), scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy (SEM-EDX), X-ray diffraction (XRD), differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), contact angle measurements, and fiber quality analysis (FQA). The results demonstrated a significant increase in fiber hydrophobicity, clear chemical evidence of ester bond formation, a slight decrease in initial thermal stability counterbalanced by an increase in maximum degradation temperature, and preservation of the original crystalline structure. These hydrophobic yet hydroxyl-functionalized fibers (PCL-g-PK) exhibit strong potential for industrial applications, particularly in composite materials.

KEYWORDS : Kraft pulp; cellulose grafting; poly(ε-caprolactone); catalyst-free ring-opening polymerization; hydrophobicity; thermal stability.

$LaPO_4$ -Based Catalysts Synthesized by Sol–Gel Method for Ethanol Oxidation

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ABSTRACT

The catalytic elimination of volatile organic compounds (VOCs) remains a major challenge in air pollution control, particularly for oxygenated species such as ethanol. Although ethanol is considered a cleaner fuel additive, its oxidation often generates harmful intermediates, making catalyst design a critical factor for efficient emission treatment.

In this work, $LaPO_4$ -supported catalysts were synthesized via a **sol–gel** route in order to improve structural homogeneity and surface properties. Lanthanum phosphate was obtained from nitrate and phosphate precursors under controlled pH conditions, followed by drying and calcination. Different metals (Ni, Co, Cu, Ce, and Mg) were then added in a fixed amount (10 wt.%) by wet impregnation to improve the catalytic performance.

The catalytic behavior of the prepared materials was investigated in the total oxidation of ethanol using a fixed-bed reactor under atmospheric pressure. Gas-phase products were analyzed by FT-IR spectroscopy over a wide temperature range. Compared to the undoped support, metal-modified $LaPO_4$ catalysts exhibited improved activity toward ethanol conversion and a higher tendency for complete oxidation, with reduced formation of oxygenated by-products.

The improved performance is attributed to the combined effect of the sol–gel synthesis method and metal incorporation, which promotes better dispersion of active sites and facilitates oxidation reactions. These results demonstrate that sol–gel derived $LaPO_4$ -based catalysts are promising candidates for VOC abatement applications related to alcohol-containing emissions.

Keywords: VOCs, Ethanol oxidation, $LaPO_4$, Sol–gel synthesis, Metal-supported catalysts, Environmental catalysis.

Acknowledgment:

This work was conducted as part of the *PhD-Associate Scholarship – PASS* program, **Theme7: Economie verte et Economie bleue** (2025–2027), funded by the Ministry of Higher Education, Scientific Research and Innovation, in collaboration with CNRST.

Machine learning-based forest cover mapping using sentinel-2 multispectral and spectral index features

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Abstract

Accurate and timely mapping of forest cover is essential for environmental monitoring, land management, and climate change studies. Recent advances in Earth observation and machine learning have enabled improved land cover classification at high spatial and temporal resolutions. This study investigates the potential of Sentinel-2 multispectral imagery for forest and non-forest mapping using supervised machine learning techniques. Surface reflectance data from Sentinel-2 products were used to extract spectral bands and vegetation indices, including the Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), and Normalized Difference Water Index (NDWI). 400 points for forest and non-forest classes were obtained from Global forest cover version 2 (GFC2020 v2) and divided into training, testing and validation sets. Several machine learning classifiers, including Random Forest and Support Vector Machine, were trained and evaluated using overall accuracy and Kappa index. The results demonstrate that machine learning models can effectively discriminate forest from non-forest areas, achieving an overall accuracy exceeding 90% and a high kappa index for the forest class. Feature importance analysis indicates the near-infrared and red-edge bands, together with vegetation indices, play a significant role in classification performance. The proposed approach highlights the effectiveness of Sentinel-2 imagery combined with machine learning for reliable forest cover mapping and provides a scalable framework for operational forest monitoring at regional scales.

Keywords: Sentinel-2, Machine Learning, forest cover, mapping, spectral index

One-Step Combustion Synthesis of $NiMn_2O_4$ Nanoparticles Using Urea: A Cost-Effective Route to Enhanced Photocatalytic Activity

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Abstract

Water and air contamination pose major concerns for public health and the environment. Nowadays, industrial activities release significant amounts of organic pollutants. However, conventional treatment processes often prove insufficient for completely removing these compounds, leading to their release into the environment and disruption of ecosystem functions. Therefore, developing innovative technologies and advanced processes is crucial to ensure the effective degradation and elimination of these pollutants.

Among promising approaches, heterogeneous photocatalysis has emerged as an efficient solution for converting organic compounds into harmless species. This physicochemical process relies on activating a semiconductor photocatalyst under light irradiation. The photocatalyst itself remains undegraded while facilitating the decomposition of organic molecules into less toxic products.

Nickel manganese oxide ($NiMn_2O_4$) belongs to the spinel oxide family and features a distinct crystal structure with varied properties. As a mixed-metal oxide, $NiMn_2O_4$ exhibits intriguing magnetic, electrical, and catalytic properties, making it an attractive candidate for various applications. Its spinel structure provides numerous active sites for surface interactions, while the presence of transition metal ions enables tunable electronic and magnetic characteristics.

In this study, $NiMn_2O_4$ nanoparticles were successfully synthesized using a simple sol-gel combustion method, which aligns with green chemistry principles and suits large-scale production. The physicochemical and optical properties of the $NiMn_2O_4$ nanomaterials were thoroughly characterized using various techniques, including X-ray diffraction (XRD), scanning electron microscopy (SEM), UV-Vis diffuse reflectance spectroscopy (UV-Vis DRS), Fourier-transform infrared spectroscopy (FTIR), and surface charge analysis.

The photocatalytic performance of the synthesized materials was evaluated through the degradation of rhodamine B (RhB) at 5 ppm under UV irradiation, monitored spectroscopically.

Matériaux hybrides à base d'argile pour des applications durables

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Resumé

Les matériaux hybrides à base d'argile constituent une classe de matériaux organiques–inorganiques qui suscite un intérêt croissant dans la recherche scientifique et industrielle. Les argiles naturelles, telles que la montmorillonite, la bentonite, la saponite ou la sépiolite, sont des minéraux abondants, peu coûteux et respectueux de l'environnement. Leur structure lamellaire, leur grande surface spécifique, leur capacité d'échange cationique élevée et leur stabilité chimique en font des supports particulièrement attractifs pour l'élaboration de matériaux hybrides aux propriétés améliorées.

L'association des argiles avec des matrices organiques, polymériques ou inorganiques permet de concevoir des matériaux présentant des performances supérieures à celles des matériaux conventionnels. En particulier, les matériaux hybrides à base d'argile offrent une amélioration significative des propriétés mécaniques, thermiques et barrières, ainsi qu'une meilleure résistance au vieillissement et aux agents chimiques. Ces avantages sont étroitement liés à la dispersion des feuillets argileux et aux interactions physico-chimiques établies entre les phases constitutives du matériau hybride.

Grâce à leur caractère multifonctionnel, les matériaux hybrides à base d'argile trouvent des applications potentielles dans de nombreux domaines, notamment l'emballage avancé, les revêtements, les matériaux de construction, le traitement des eaux, l'adsorption des polluants, le confinement des déchets dangereux, ainsi que dans des secteurs émergents tels que l'électronique flexible, le stockage de l'énergie et la biomédecine.

L'intérêt croissant pour ces matériaux s'explique également par leur contribution au développement de matériaux durables, répondant aux exigences actuelles de performance, de réduction des coûts et de respect de l'environnement. Les matériaux hybrides à base d'argile apparaissent ainsi comme des candidats prometteurs pour le développement de matériaux innovants et multifonctionnels, en accord avec les enjeux technologiques et environnementaux contemporains.

AI-Driven Green Finance and Its Implications for Environmental Sustainability: A Systematic Review

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Abstract

As the challenges of climate change and environmental degradation continue growing, there is a pressing need for more sustainable financial solutions. In this context, Artificial Intelligence (AI) has emerged as a catalyst for green finance, providing better tools for risk assessment, sustainability evaluation, and smart green investment decision-making.

This study aims to provide a synthesis of the academic literature on the intersection between Artificial Intelligence and green finance, with a focus on environmental sustainability, energy transition, and climate-related financial decisions.

A Systematic Literature Review (SLR) was conducted following the PRISMA methodology. The analysis is based on a structured search of the Web of Science database using the keywords "Artificial Intelligence" and "Green Finance" for the period 2015–2026. After applying strict inclusion and exclusion criteria, a final sample of 43 articles was retained.

The results highlight three main findings. First, AI is widely used to improve environmental and climate risk assessment, particularly through predictive modeling of carbon emissions and energy efficiency. Second, AI-based tools enhance ESG measurement and sustainability evaluation, contributing to greater transparency in green finance. Third, AI supports the optimization of green financial decisions, including sustainable investment strategies and energy transition financing. Nevertheless, the review reveals persistent gaps, notably the limited attention to emerging economies and the weak integration of policy considerations.

This review offers a structured overview of the nexus between AI and green finance nexus and charts future research directions to enhance the role of intelligent financial systems in environmental sustainability.

Key words: Artificial Intelligence; Green Finance; Environmental Sustainability; Systematic Literature Review.

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Controlling Pore Structure and Surface Charge of UiO-66-NH_2 @HTC for Improved Water Remediation

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Abstract

Metal–organic frameworks (MOFs) are advanced porous materials known for their high surface areas, tunable pore structures, and adjustable surface chemistry, making them attractive for environmental applications. Among them, zirconium-based MOFs, particularly UiO-66, exhibit outstanding chemical and thermal stability due to their robust Zr_6 O_4 $(OH)_4$ clusters and highly connected framework. However, their adsorption performance strongly depends on synthesis conditions, precursor selection, and post-synthetic treatments.

In this work, UiO-66-NH_2 composites were synthesized using two different zirconium precursors, zirconium tetrachloride and zirconium oxychloride octahydrate, to investigate their influence on crystallinity, pore structure, and surface properties. Both acidic and basic activation methods were applied to tailor surface charge and enhance adsorption efficiency. In addition, hydrothermal carbon was incorporated into the UiO-66-NH_2 framework to improve textural properties and introduce additional functional sites.

The resulting UiO-66-NH_2 @HTC composites exhibited enhanced mesoporosity, improved crystallinity, and superior adsorption performance toward both cationic and anionic dyes, namely methylene blue and Congo red. The improved adsorption behavior is attributed to optimized pore architecture, electrostatic interactions, and hydrogen bonding. Furthermore, the composites demonstrated good stability and reusability, highlighting their potential for practical wastewater treatment applications.

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Efficient BV@ZT photocatalyst for efficient degradation of organic pollutants: synthesis and characterization

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Abstract

Water quality and availability are definitely some of the most important issues facing our century. Due to the strong growth of industrial activities and the repercussions of climate change, organic pollutants such as pharmaceutical products, pesticides, and dyes accumulate in our water in large quantities and have a harmful effect on ecosystems and human health. To degrade these pollutants, sustainable treatment solutions such as advanced oxidation processes are being explored, particularly photocatalysis using semiconductors under solar energy.

A novel BV@ZT Z-scheme heterojunction photocatalyst was successfully designed and synthesized to boost visible-light driven degradation of organic pollutants. BV, prepared by solid-state process, and ZT, prepared by a hydrothermal method, were used as precursors to synthesize BV@ZT composite via a solid-state reaction. In order to correlate the photocatalytic efficiency of the photocatalysts with their structural, microstructural, vibrational, and optical properties, the samples were characterized and analyzed using various techniques. Under visible light irradiation, the optimal photocatalyst from the (1-x)BV@xZT series achieved complete degradation of Rhodamine B (RhB) with excellent cyclic stability. This superior photocatalytic performance is attributed to the BV@ZT heterojunction, which promotes efficient charge carrier separation. Trapping tests showed the role and predominance of $HO^{\cdot}$ and h^{+} charge carriers in the degradation reaction mechanism.

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Sustainable Biopolymer-Based Materials for Water Treatment Applications

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Abstract

An eco-friendly method was developed to enhance a natural biopolymer through phosphorylation using phosphoric acid and urea via a green esterification process. Comprehensive characterization by FTIR, XRD, SEM, EDX, solid-state NMR, TGA, and potentiometric titration confirmed the successful grafting of phosphate and nitrogen functional groups onto the biopolymer backbone, achieving high degrees of substitution (DSP = 4.13; DSN = 3.25). The modified biopolymer remained readily soluble in water while being insoluble in most organic solvents, confirming its strongly hydrophilic nature. The phosphorylation process converted the biopolymer into a polyanionic material, providing a high density of negatively charged sites. As a result, the phosphorylated biopolymer was effectively used as an adsorbent for the removal of cationic organic dyes from aqueous solutions, with methylene blue employed as a model pollutant. The adsorption performance is mainly governed by electrostatic interactions between the polyanionic surface and cationic dye molecules, highlighting the strong potential of this material as a sustainable and environmentally friendly adsorbent for water purification applications.

Key words:

biopolymers; Green modification; Adsorption; Eco-friendly materials

A new zinc(II) coordination complex based on 2,5-bis(4-pyridyl)-1,3,4-oxadiazole and selenocyanate as a co-ligand: Synthesis, spectroscopy, crystal structure and Hirshfeld surface analysis

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Abstract

In recent decades, significant research efforts have been focused on synthesizing coordination complexes using N-heterocyclic ligands. These complexes play an important role in understanding inorganic structures and have diverse applications, including biological [1], magnetic, and catalytic properties [2]. The synthesis of coordination networks is influenced by various factors, such as solvent choice, metal ions, anions, reaction conditions, and reagent ratios. The wide range of metals and their coordination spheres impact the topology of coordination networks, offering architectural flexibility and diverse properties. The focus on N-heterocyclic ligands, especially those with electron donor atoms like nitrogen, sulfur, or oxygen, has attracted attention in creating new materials. Recent research has emphasized the development of coordination polymers using N-heterocyclic ligands and pseudohalides. The selenocyanate anion ($SeCN^{-)}$ has been of particular interest due to its versatility in forming various complexes, including monomers, dimers, and coordination polymers [3]. On the other hand, the chemistry of d^{10} metal ions, specifically Cd^{2+}, $Hg^{2+}$and Zn^{2+}, has garnered attention for constructing polymeric complexes with diverse properties applicable in energy storage, photocatalyst, drug delivery systems, and sensors for biological analyses.

In this work, we report the synthesis of a new zinc (II) complex based on 2,5-bis(4-pyridyl)-1,3,4-oxadiazole(4-bpo) in the presence of selenocyanate as a co-ligand, with the formula $[Zn(4\text{-bpo})_2(SeCN)_2(H_2O)_2]$). The complex was obtained are characterized by elemental analysis, FT-IR spectroscopy, UV-vis spectroscopy, and single-crystal X-ray diffraction. Themost striking feature of this complex resides in the formation of a three-dimensionalsupramolecular network sustained by hydrogen bonding and π–πstacking interactions.Hirshfeld surface analysis was employed to investigate intermolecular interactions and packing effects within the coordination network.

Keywords: N-Heterocyclic, selenocyanate, energy storage, photocatalyst, crystal structure, Hirshfeld surface analysis.

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Effect of thermomechanical treatment on healing response of cold recycled asphalt pavements

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Abstract

Cold recycled asphalt pavements have recently attracted increasing interest for their potential to recover mechanical performance through induced-healing techniques such as induction and microwave heating. However, heating alone is often insufficient to restore the initial strength of damaged mixtures. To address this limitation, this study evaluates a thermomechanical treatment applied to cold recycled reclaimed asphalt mixtures produced with RAP and different contents of black steel mill slags. Healing Rates (%HR) were quantified using repeated indirect tensile strength tests, evaluating the influence of heating duration and slags content on induced-healing potential. The results showed that the highest healing rate had been achieved, demonstrating complete recovery of the initial ITS and highlighting the effectiveness of thermomechanical treatment in restoring the mechanical integrity of the mixture.

Chemical and mineralogical analyses indicated that the slag contains iron-oxide-rich phases with favorable dielectric properties, leading to improved microwave absorption and higher heating efficiency compared with the reference mixture. Although slag incorporation increased air void content due to its angularity and porosity, all mixtures satisfied the required ITS thresholds, indicating adequate structural integrity. Overall, these findings highlight the potential of microwave-induced healing, combined with re-compaction, as a sustainable and cost-effective approach to prolong pavement lifespan, reduce maintenance costs, and promote environmentally friendly road rehabilitation.

Keywords:

Cold asphalt concretes; Microwave heating; Healing capacity; Sustainable pavements

Enhanced electrical, dielectric, optical, and mechanical properties of innovative biocomposites based on Agar-Agar and Potassium Dihydrogen Phosphate

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Résumé

Biocomposite films based on agar-agar as biopolymer and potassium dihydrogen phosphate (KDP) particles as reinforcing material were prepared by the solution casting method, with KDP contents varying from 0 to 15%. X-ray diffraction and infrared spectroscopy characterization revealed a strong interaction and perfect biocompatibility between agar-agar and KDP. The study of optical properties showed that when the biofilm was reinforced with phosphate particles, its reflectance, refractive index and optical conductivity increased. The addition of inorganic particles also increased the dielectric constant and improved the electrical performance of the biofilms, which exhibited quasi-stable values over a wide frequency range. In addition, the incorporation of 3% to 15% KDP into the agar-agar matrix significantly improved the Young's modulus of the synthesized films. Water solubility tests showed that the more the biofilms were reinforced with KDP particles, the less soluble they became. This work paves the way for the development of environmentally friendly and durable biofilms with low cost that can be used as semi-conductive and light reflective materials.

Figure 1. Shem of the preparation of KDP/AGAR biocomposite films

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Study, characterization, and influence of sand used in The infiltration-percolation process for wastewater treatment

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Abstract

This work consists of a study, using a column approach, of the influence of filter media characteristics on purification performance through the infiltration percolation process. The latter is a wastewater purification system most widely used for environmental preservation and the recovery of a large quantity of water for reuse in agriculture or green spaces. This process involves filtering previously treated domestic or industrial wastewater (after decantation) onto sand beds. The sand used is that of Oued Souss (region of Agadir, Morocco) and is characterized by an effective diameter (D10) and a uniformity coefficient (CU), which are respectively 0.15 and 1.46. Monitoring of the purification performance of this massif has enabled the achievement of very satisfactory results in terms of purification: a reduction of 93 to 98% of biological oxygen demand (BOD5), 80 to 92% of chemical oxygen demand (COD), and 85 to 98% of suspended matter (MES). The quality of the water purified by this process depends on the characteristics of the sand used (particle size and composition), the different types of pollutants present in the raw wastewater, and climatic conditions.

Keywords: Wastewater; Sand; BOD5; COD; MES; Infiltration-percolation

In situ synthesis and characterization of a PANI@AP hybrid composite applied to Orange G dye adsorption

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Abstract

The increasing pollution of water by organic substances highlights the urgent need to develop effective, sustainable, and accessible decontamination methods. Polyaniline (PANI)-based composites have recently attracted considerable interest in the field of wastewater treatment. In this study, a novel PANI@AP hybrid composite was synthesized via in situ oxidative polymerization. Its morphology and structure were thoroughly characterized using scanning electron microscopy coupled with EDS spectroscopy, X-ray diffraction, as well as FTIR and Raman spectroscopy. For the first time, this composite was evaluated as an adsorbent for the removal of Orange G dye from aqueous solutions. The influence of various experimental parameters on the adsorption process, including adsorbent mass, contact time, pH, and initial dye concentration, was investigated. The kinetic results indicate that the adsorption process follows a pseudo-second-order model, while isotherm analysis reveals that the Langmuir model provides the best description of OG adsorption and the maximum adsorption capacity was estimated to be 26.67 mg/g. highlighting the strong potential of PANI@AP for the purification of water contaminated with organic dyes.

Keywords: Polyaniline, PANI@AP composite, Adsorption, Orange G dye, Water treatment, Langmuir isotherm.

Computational Investigation of Solid Organic Residues as Potential Inhibitors for Iron Corrosion in Acidic Media

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Abstract

Solid organic residues formed during routine qualitative chemical tests are commonly treated as analytical waste and rarely considered for functional applications. Nevertheless, their molecular composition, often characterized by polar functional groups, conjugated frameworks, and heteroatom-rich domains, suggests a potential ability to interact with metallic surfaces exposed to aggressive environments. In this work, a theoretical study is carried out to explore the corrosion inhibition potential of selected solid organic residues with respect to iron degradation in acidic media[1].

The investigation is based on a combination of quantum chemical calculations and molecular simulations, enabling an atomic-scale analysis of electronic properties and metal–inhibitor interactions. Frontier orbital features, global reactivity descriptors, and molecular flexibility are examined to assess the tendency of the investigated residues to adsorb on the iron surface. Adsorption simulations provide insight into stable interfacial configurations and reveal distinct behaviors depending on the chemical nature of the residues[2]. The results indicate that molecular regions enriched with electron-donating atoms, particularly nitrogen- and oxygen-containing sites, play a decisive role in anchoring the residues onto the iron surface. The adsorption process appears to be governed by a mixed mechanism involving both electrostatic interactions and donor–acceptor electronic exchanges between electron-rich molecular sites and vacant metal orbitals. Overall, these findings suggest that solid organic residues originating from qualitative chemical processes may constitute a viable alternative for iron corrosion mitigation in acidic environments, while offering new perspectives for the valorization of analytical by-products.

Keywords

Iron corrosion; solid organic residues; corrosion inhibition; adsorption; molecular modeling; density functional theory.

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Microplastic pollution in Morocco's High Atlas: First evidence and selective impact on soil microbiome across an elevational gradient

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Abstract

Microplastics (MPs) are emerging contaminants in terrestrial ecosystems, yet their distribution and ecological impacts in remote mountain soils remain poorly understood. This study investigated MP contamination along an elevational gradient on Mount Toubkal (500–4167 m), the highest peak in North Africa. Soil samples were collected from nine elevations and analyzed for MP abundance, morphology, size, color, and polymer composition. MPs were quantified via density separation and stereomicroscopy, with polymer confirmation by FTIR and surface analysis using SEM-EDX. DNA was extracted from each sample and sequenced (Illumina MiSeq) targeting bacterial 16S rRNA and fungal ITS regions. MPs were found across all sites, with 1693 particles identified and an average concentration of 23.2 MP/kg of soil. Fibers dominated, especially at higher altitudes, while smaller particles (<500 µm) and lighter polymers (e.g., polystyrene, cellulose acetate) increased with elevation. Surface degradation features confirmed environmental weathering. Correlation analyses linked MPs traits to microbial composition: bacterial communities showed no significant response, but fungal richness and diversity declined with increasing abundance of fibrous MPs, PVC, and small particles. At the phylum level, fungal groups responded selectively to MPs' traits, suggesting that MPs act as environmental filters. These findings reveal the widespread presence of MPs in alpine soils and their trait-specific impacts on fungal communities, emphasizing the need to account for MP heterogeneity in ecological risk assessments.

Microplastics detected from 500 to 4167 m show altitude-dependent traits and microbial associations

Keywords: Microplastics, Mountain soils, Microbiome, Elevational gradient, Polymer degradation.

Shrimp shell-derived chito-protein nanocomposites for sustainable dye effluent remediation: efficiency, reusability, and environmental safety

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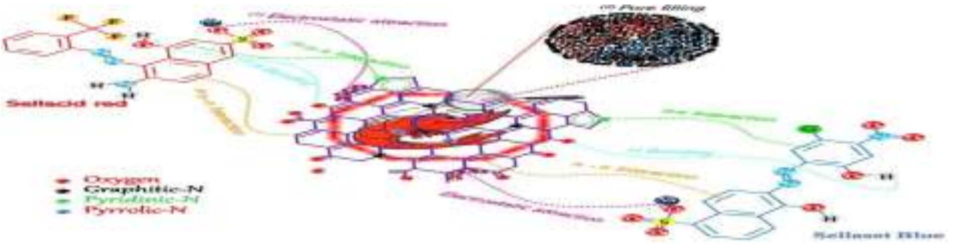
Abstract

The transformation of seafood processing residues into advanced functional materials offers a dual solution to environmental pollution: mitigating waste streams while addressing water contamination. In this study, shrimp exoskeletons were valorized into a chitin–protein composite (SE-CP) through acid demineralization and thermal activation and evaluated as a biosorbent for the removal of anionic textile dyes Sellacid Red (SR) and Sellaset Blue (SB).

The material was characterized using SEM, EDX, FTIR, XRD, BET, DLS, XPS, and PZC analyses, confirming a mesoporous structure (specific surface area = 51.4914 m2 g^{-1}) enriched with amino and hydroxyl groups that favor electrostatic and hydrogen-bonding interactions. Batch adsorption studies showed maximum removal efficiencies of 99.2% for SR at pH = 3 and 98.7% for SB at pH = 4 both around 20 °C and an initial dye concentration of 100 mg L^{-1}. Kinetic data fitted the pseudo-second-order model (R2 > 0.96), and equilibrium was best described by the Freundlich isotherm, with adsorption capacities of 158.43 mg g^{-1} (SR) and 63.81 mg g^{-1} (SB). SE-CP retained over 76% of its adsorption capacity after five regeneration cycles, indicating strong stability and reusability. This work demonstrates a low-cost and sustainable biosorbent derived from shrimp waste, with high efficiency, reusability, and green synthesis, positioning SE-CP as a promising candidate for industrial dye wastewater treatment within circular economy principles.



Keywords: shrimp shell valorization, chitin-protein nanocomposite, functional biopolymers, advanced sorbents, sustainable separations.

In Situ Polymerized Polyaniline Grafted onto a Biosourced Biomass as an Efficient Adsorbent for Orange G Dye Removal

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Abstract

The development of efficient and low-cost adsorbents based on polymer-biomass composites has attracted increasing interest for wastewater treatment. In this study, a polyaniline-biomass composite was synthesized via *in situ* oxidative polymerization in order to develop an efficient and durable material for the removal of aqueous pollutants. Polyaniline was deposited onto a biosourced support, resulting in a functional composite with enhanced surface characteristics. The prepared composite was characterized by FTIR, XRD, and SEM/EDS to analyze its chemical structure, crystallinity, and morphology. The results confirmed the successful incorporation of the polymer and revealed a heterogeneous and porous morphology, favorable for adsorption. The adsorption performance of the composite was evaluated by studying the effects of contact time, solution pH, adsorbent dose, and initial dye concentration. Kinetic and isotherm models adequately described the adsorption mechanism and showed good agreement with the experimental data. Overall, this work highlights the potential of polymer–biomass composites as promising candidates for environmental applications, offering a simple synthesis route and encouraging adsorption performance.

Keywords:
Polymer-based composites; Polyaniline; Biomass; Adsorption; Environmental applications

Poly(Brilliant Cresyl Blue)–Graphene Oxide Electrodes and Poloxamer-Coated Polycaprolactone Nanoparticles for Electrochemical Investigation of Fludarabine–Albumin Interaction and Stability in Blood Cancer Therapy

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Abstract

Fludarabine phosphate (FLU) is a key chemotherapeutic agent used in treating hematologic malignancies, but its clinical efficacy is limited by rapid degradation and strong binding to serum proteins, which reduce its bioavailability. Understanding and controlling the interaction between FLU and human serum albumin (HSA) is therefore essential for optimizing its pharmacokinetics and therapeutic performance. This study presents an electrochemical investigation of the FLU-HSA interaction using a poly(brilliant cresyl blue)-graphene oxide (PBCB-GO) composite-modified glassy carbon electrode (GCE). The PBCB-GO composite was electrochemically synthesized and characterized using cyclic voltammetry (CV), electrochemical impedance spectroscopy (EIS), Raman spectroscopy, and scanning electron microscopy (SEM), revealing enhanced conductivity and stability for sensing applications. Electrochemical studies using the $K_3Fe(CN)_6/K_4Fe(CN)_6$ redox system showed that the presence of FLU and HSA decreased the peak current, increased peak-to-peak separation (ΔEp), and shifted the formal potential, indicating slower electron transfer due to complex formation. Differential pulse voltammetry (DPV) was used to calculate the binding constant (Ka) between FLU and HSA, yielding a value of $2.06\ 10^3\ M^{-1}$. Time-dependent studies indicated that complex formation stabilizes after 30 minutes. Additionally, the interaction between HSA and nanoparticle-encapsulated FLU was investigated, with Poloxamer-coated nanoparticles, particularly Poloxamer 407, showing the weakest interaction with HSA. These findings demonstrate the potential of the PBCB-GO/GCE platform for studying drug-protein interactions and highlight the role of polymer coatings in enhancing drug bioavailability by reducing opsonization in circulation.

MWCNT-PMB Modified Electrode for Enhanced Detection of Methiocarb Insecticide

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Abstract

A glassy carbon electrode modified with multi-walled carbon nanotubes poly (methylene blue) (MWCNT-PMB/GCE) was developed as a promising electrode for the electrochemical sensing of Methiocarb (MTC). The electrode was prepared by synthesizing a PMB layer using cyclic voltammetry at an optimized cycle number of 30, followed by the deposition of MWCNT on the surface. The resulting MWCNT-PMB film has been characterized using scanning electron microscopy, electrochemical impedance spectroscopy, and cyclic voltammetry. The results show enhanced electrochemical properties, including an increased active surface area (1.35 mm^2) and improved conductivity ($Rct = 15\ \Omega$). These features contributed to improved sensitivity, selectivity, and a lower oxidation potential for detecting MTC. The electrochemical detection of MTC was carried out in Britton Robinson buffer at an optimized pH of 5, using the differential pulse voltammetry method. The calibration plot exhibited linearity between 10 and 100 μM(R^2=0.99) in the standard solution. The detection limit for MTC was determined to be 2.72 μM. Furthermore, the fabricated sensor was successfully applied to quantify MTC in human serum within the concentration range of 10–70 μM(R^2 = 0.97), with a detection limit of 9.98 μM. The sensor demonstrated reliable performance with acceptable recovery results.

A bibliometric analysis on surface water quality assessment: health risks for children in southern Morocco

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Abstract

Waterborne childhood diseases are a major public health problem, resulting from the interaction between microbiological contamination of water, the physiological vulnerability of children, and inadequate sanitation systems, particularly in regions subject to high environmental pressures. This study aims to analyze trends, citation patterns, and collaborations in the field of research related to the assessment of surface water quality in relation to its health risks to children and to analytical methods over the past few years in order to provide an in-depth understanding of the development of methods in scientific research and to highlight gaps in research that could represent opportunities for future development. Bibliometric analysis is a widely used technique for analyzing large volumes of scientific data. For this study, 188 documents published between 2000 and 2025 were collected from the renowned Scopus database. The data was analyzed using the "Bibliometrics" package and visualized using the “Vosviewer” software. The study revealed that the productivity of water quality research in relation to waterborne childhood diseases has increased over time especially in 2024. The article will help researchers identify countries, institutions, and authors engaged in research on the assessment of surface water quality related to risks to children's health.

Keywords: Bibliometric analysis- Surface water quality - children's health.

DFT and Simulation Study of a Novel Salt as an Efficient Corrosion Inhibitor

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Abstract

This study focuses on synthetizing and characterizing an organic corrosion inhibitor with the aim of providing robust protection for mild steel in environments containing hydrochloric acid. A simplified and efficient synthesis method is described, providing a thorough analysis of the organic's chemical structure using methodologies such as X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), and nuclear magnetic resonance spectroscopy (NMR). To evaluate the corrosion inhibition efficacy, tests were conducted at varying concentrations of the hybrid in a 1 M hydrochloric acid solution for mild steel, employing techniques like potentiodynamic polarization and electrochemical measurements. The results indicated a correlation between inhibitor concentration and inhibition efficiency, leading to a simultaneous reduction in corrosion current density. Particularly, the inhibitor demonstrated its highest effectiveness at a concentration of 400 ppm, with an inhibition efficiency of 94%, This revealing that the prepared inhibitor acts as a mixed-type inhibitor. The influence of temperature on the inhibition efficiency was discussed over a range of 298 to

328 K. This methodology integrates efficient synthesis, in-depth characterization, and performance assessments, highlighting the potential of this organic inhibitor for effective corrosion protection of mild steel in corrosive environments.[1]

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Molecular detection and global environmental occurrence of enteric viruses: A literature driven assessment within a One Health framework

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Abstract

Enteric viruses, particularly Hepatitis A Virus (HAV) and Norovirus, are globally recognized as major contributors to waterborne and foodborne outbreaks. International studies conducted between 2000 and 2025 across Europe, North America, Asia, and Africa consistently demonstrate their high environmental persistence, resistance to conventional water treatment processes, and ability to remain infectious at very low doses. Reviews report detection frequencies ranging from 10% to more than 60% in wastewater, surface waters, irrigation systems, and even groundwater, underscoring their role as reliable indicators of fecal contamination. Despite this global evidence, viral monitoring remains seldom included in routine water-quality assessment frameworks, which continue to rely predominantly on bacterial indicators that do not reflect viral risks. Molecular techniques such as RT-qPCR are widely recommended in the literature for sensitive and specific detection, yet their deployment is uneven across regions, revealing a persistent gap in international surveillance systems. Building on these global findings, the present work integrates international evidence to highlight the critical need for environmentally based viral detection approaches in support of the One Health paradigm. The review synthesizes data on viral persistence in diverse aquatic environments, pathways of transmission through irrigation and recreational waters, and associations with environmental parameters such as turbidity, temperature, rainfall patterns, and land-use gradients. Studies from Spain, Brazil, China, and the United States demonstrate clear correlations between viral loads and wastewater discharge levels, agricultural runoff, and seasonal dynamics. Moreover, the literature emphasizes the emergence of genomic surveillance tools that enable the tracking of viral variants and improve early warning capabilities for public health protection.

Facile Synthesis of a Novel Nanocomposite with High Adsorption Performance toward Anionic Dye Removal

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Abstract

Wastewater that is polluted with synthetic dyes presents a major environmental problem and treatment by conventional methods usually does not lead to full elimination of the dyes. The industry desperately looks for eco-friendly solutions that involve the use of photocatalysts that can efficiently remove toxic organic dyes from water. In this work, a new novel material was successfully synthesized through a simple coprecipitation method. The composite was thoroughly characterized using FTIR, XRD, BET surface analysis, SEM morphology, and thermal analyses (DTA/TGA), confirming the successful formation of the material.

The adsorption performance of the novel material as-prepared toward Orange G (OG) dye removal from aqueous solutions was systematically investigated under batch adsorption conditions experiments were systematically conducted to investigate the effects of contact time, initial dye concentration, temperature, solution pH, and adsorbent dosage. The highest adsorption efficiency was achieved at an optimal pH of 5 using an adsorbent mass of 12.5 mg. Experimental results show that the kinetic model of pseudo-second-order (PSO) and Freundlich isotherm provided a good fitting of the whole experimental data suggesting monolayer adsorption on a homogeneous surface with a maximum adsorption capacity (Q_{max}) of 271mg.g^{-1}. Thermodynamic parameters confirmed that the adsorption process was spontaneous and endothermic.

Furthermore, regeneration and stability studies revealed that the adsorbent retained excellent performance after several adsorption–desorption cycles, highlighting its strong potential for large-scale wastewater treatment applications.[1]

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Chemical shaping of Metal Organic Frameworks for enhanced CO_2 uptake

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Abstract

While metal-organic frameworks (MOFs) are well-known for being highly crystalline materials with record porosity (up to 7000 m^2g^{-1}), their shaping difficulties and low stability still restrict their transition from laboratory to large-scale applications [1]. Thus, the mixing of MOFs with other substrates like polysaccharides, is a recent strategy adopted to overcome these limitations and obtain composites in various forms, such as monoliths, films, or microspheres [2]. On the other hand, combining MOFs with secondary materials like graphene oxide (GO) is suggested as a solution to mitigate the effects of humidity on MOFs' stability [3].

Instead of the direct-mixing of MOFs with a polymer matrix, we recently developed a novel approach based on the in-situ growth of MOFs within chitosan beads. This strategy leads to shaped hybrid materials with homogeneous MOF particles dispersion, enhanced interactions, and preserved open porosity. Herein, this strategy has been further refined to prepare HKUST-1-based binary and ternary composites with high specific surface areas (up to 923 m^2g^{-1}) and improved hydrolytic stability at room temperature [4]. Notably, to demonstrate the versatility of this strategy, we prepared CPO-27-based composites for the first time using this in-situ method, resulting in robust CS@CPO-27 beads with high crystallinity (Figure. 1c) and specific surface areas exceeding 500 m^2g^{-1} [5]. The as-prepared CS@HKUST-1 and CS@CPO-27-Co (Figure. 1a and 1b) were tested for CO_2 capture ((Figure. 1d), demonstrating adsorption capacities of 2.60 and 3.16 $mmol.g^{-1}$, respectively, at 298 K, making them among the leading candidates for CO_2 adsorption.

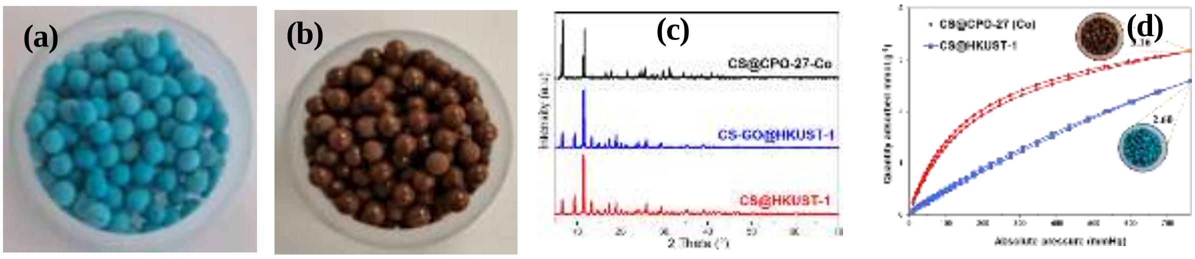

Figure 1. The as-prepared CS@HKUST-1 (a), and CS@CPO-27 (b) beads, and their corresponding PXRD patterns (c) and test in CO_2 adsorption at 298 K (d).

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Electrochemical Study of Iron Phosphate–Based Cathode Materials in Aqueous Electrolytes

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Abstract

The growing demand for energy due to population growth has led to an energy crisis. To address this situation, research is underway to explore materials capable of safely storing energy. Studies mainly focus on the electrochemical performance of these materials in an aqueous environment, due to their potential advantages such as high ionic conductivity, increased safety, and potentially lower costs. However, it is important to note that batteries using aqueous media may have a lower voltage limit and lower energy density than batteries using organic media.

The chosen material, based on iron and phosphate, possesses several remarkable properties. Its olivine-type crystalline structure provides it with chemical stability. Furthermore, its high density allows it to store more energy per unit volume. It is also low in solubility, ensuring its stability and durability as an electrode. In terms of electrochemical performance, it is commonly used as a positive electrode material in lithium-ion and sodium-ion batteries due to its high operating voltage, cyclic stability, and low toxicity. Iron phosphate-based materials are particularly promising due to their low cost, non-toxicity, and the abundance of their components (iron and phosphate) in nature. However, these materials exhibit limited ionic conductivity, which can be a disadvantage. Doping techniques or structural modification can be employed to improve this conductivity. Additionally, the material has a high diffusion coefficient, facilitating the rapid transport of sodium ions, and a remarkable specific capacity, thereby increasing the amount of stored energy.

Keywords: batteries, energy storage, lithium-ion, performance, sodium-ion.

Controlled Synthesis of Phosphate-Based Materials ($M_x(PO_4)_y$): Impact on Charge Transfer and Photocatalytic Degradation Efficiency

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Abstract

Currently, water is heavily polluted by industrial activities, where it is contaminated by recalcitrant organic pollutants such as pesticides, pharmaceuticals, phenolic compounds, heavy metals, and dyes. These pollutants pose a major problem for the environment and human health. Photocatalytic phosphate-based materials offer an effective solution for degrading these pollutants. Thanks to their structural, microstructural, and optical properties, they enable both wastewater purification and clean energy production. Their effectiveness depends on their composition, microstructure, and ability to absorb light.

In this work, we used phosphate materials with the general formula $M_x(PO_4)_y$ that were synthesized by various methods such as co-precipitation, sol-gel, and solid-solid reaction in order to study the influence of the synthesis method on their properties and photocatalytic activity. The materials were characterized by XRD, SEM, Raman, and FTIR analysis, confirming the formation of a well-crystallized monoclinic phase, a homogeneous morphology, and the characteristic presence of well-defined phosphate groups. Photocatalytic evaluation by Rhodamine B degradation under UV light irradiation shows that the sample prepared by co-precipitation exhibits the best photocatalytic performance, with a degradation rate of 93% after 6h30 min, compared to the methods sol-gel, and solid-solid reaction that show rates of 85% and 83%, respectively. This improvement is attributed to an optimized structural organization that promotes charge transfer and limits electron-hole recombination, thus highlighting the environmental potential of phosphate materials for sustainable photocatalytic applications.

Keywords: Phosphate materials; Synthesis Methods; Monoclinic phase; Rhodamine B and Photocatalytic Activity.

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Numerical optimization of lead-free $FASnI_3$-based perovskite solar cells using SCAPS-1D

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Abstract

In this study, a numerical simulation of a lead-free perovskite solar cell based on the FTO/TiO_2/$FASnI_3$/PTAA/Au architecture was conducted using the SCAPS-1D simulation tool. The initial calibration of the $FASnI_3$ absorber layer was performed using available experimental data, achieving a power conversion efficiency (PCE) of 7.14%, which closely matched the experimental J–V characteristics. To enhance device performance, a systematic optimization of key parameters was carried out, including the absorber layer thickness, defect density, and carrier concentration. Additionally, the influence of various hole transport layer (HTL) materials such as SnS, $MoTe_2$, MoOx, Spiro-OMeTAD, and CuSCN was explored to identify suitable alternatives to the conventional PTAA. The simulation results demonstrated that both structural and interfacial improvements can significantly boost device efficiency. Among the studied configurations, the structure incorporating MoOx as the HTL exhibited a remarkable PCE exceeding 36%, highlighting its potential for high-performance, environmentally friendly photovoltaic applications. This work provides valuable insights into the design and optimization of lead-free perovskite solar cells and underlines the importance of interface engineering in advancing next-generation solar technologies.

$FASnI_3$-SCAPS 1D- Lead-free perovskite- Numerical simulation

Computational Exploration of Fluoro-Isoxazolines as Bioactive Agents: A Green Chemistry and Circular Economy Perspective

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Abstract

In the context of green chemistry and the circular economy, our study focuses on the rational development of new bioactive molecules derived from fluoro-isoxazolines, obtained through 1,3-dipolar cycloaddition reactions known for their energy efficiency and low environmental impact. A fully in silico approach was adopted to evaluate the potential of these compounds as biologically active agents, integrating DFT calculations, ADMET predictions, molecular docking studies, and molecular dynamics simulations.

DFT results revealed favorable reactivity and electronic stability for the investigated fluoro-isoxazolines [1]. Molecular docking showed strong binding affinity toward the selected biological targets, which was further supported by molecular dynamics simulations demonstrating remarkable stability of the ligand–protein complexes. Additionally, ADMET predictions indicated satisfactory pharmacokinetic properties and a promising drug-likeness profile [2].

These computational approaches enable the design of bioactive molecules in a more sustainable, economical, and efficient manner. They support a circular-economy perspective by reducing resource consumption and guiding the development of cleaner, environmentally friendly chemical processes.

Keywords: Fluoro-isoxazolines; 1,3-dipolar cycloaddition; DFT calculations; molecular docking; ADMET predictions; bioactive molecules; green chemistry; sustainable drug design.

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Characterization of low-cost Moroccan pozzolan-alginate adsorbents for methylene blue removal from water

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Abstract

Water contamination due to methylene blue (MB) is a world-wide problem and needs attention by developing good adsorption methods. Consequently, novel inexpensive adsorbents were prepared using Moroccan Pozzolan i.e. Pozzolan Laayoune (PZL) powder, Pozzolan Timahdite (PZT) powder, Pozzolan Laayoune Alginate beads (PZLA-beads), and Pozzolan Timahdite Alginate beads (PZTA-beads). These materials were characterized using X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), X-ray fluorescence (XRF), scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDX), point of zero charge (pHpzc), and Brunauer-Emmett-Teller (BET). These adsorbents were used for the removal of MB from water. The data fitted well to the Langmuir model with maximum adsorption capacities (q_{max}) of 80, 91.73, 62.11, and 67.11 mg/g for PZL powder, PZLA-beads, PZT powder, and PZTA-beads, respectively with pseudo-second-order kinetics. Furthermore, Moroccan pozzolan beads (PZLA-beads) were tested for the treatment of real textile effluents; showing complete removal of MB. The desorption studies demonstrated that the pozzolan-based adsorbents acted as a regenerative, and reusable sorbent. The results indicated that Moroccan pozzolan-based adsorbents may be recommended for the treatment of textile wastewater containing MB dye.

Natural Cellular Materials to Enhance Porous Asphalt Durability

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Abstract

Asphalt pavements are widely used due to their excellent road performance and driving comfort. However, heavy traffic and extreme environmental conditions can cause rapid deterioration, demanding proactive and sustainable maintenance solutions [1]. Previous research has investigated the addition of encapsulated bitumen rejuvenators into asphalt mixtures to enhance the asphalt's self-healing capabilities and potentially provide more efficient maintenance strategies [2][3]. Additionally, recent studies have demonstrated that asphalt mixtures incorporating porous materials, even without containing bitumen rejuvenators, are able to absorb energy from external loads applied [4].

In this context, this study investigates a highly porous natural cellular material as an eco-friendly, widely available and cost-effective additive for asphalt mixtures. The main objective of this research is to assess this additive's potential in improving ravelling resistance, minimizing particle loss and extending pavement lifespan. Mechanical testing such as the Cantabro mass loss test, was conducted on asphalt mixtures with and without the additive to assess these properties.

Results indicated that incorporating up to 1% w/w highly porous natural cellular material into porous asphalt mixtures significantly improves surface ravelling resistance and durability. In asphalt mixtures containing the natural cellular material, mass loss was reduced to less than 25% after completing the Cantabro test. However, the reference asphalt mixture without the additive showed a mass loss of 60%. Therefore, this enhancement of the asphalt performance is attributed to the controlled deformation of the natural cellular material, which effectively absorbs energy and distributes stress throughout the asphalt matrix. These findings highlight the potential of using natural cellular materials to extend pavement lifespan, reduce maintenance costs, and promote more sustainable road construction practices.

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Structural properties of magnesium-doped $BaTiO_3$

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Abstract

In this study, we investigated the structural, and optical properties of Mg-doped $Ba_{1-X}Mg_XTiO_3$ powders synthesized via the sol-gel method for various doping levels (x=0.00, 0.005, 0.01, 0.02, 0.04, and 0.06). XRD analysis confirmed that all $Ba_{1-x}Mg_xTiO_3$ samples crystallize in a pure perovskite-type structure, indicating that Mg^{2+} ions, which have a relatively small ionic radius, are successfully incorporated into the BT lattice at low doping levels ($x \leq 0.06$). The incorporation of magnesium leads to a transition toward a pseudo-cubic phase, reflected by a decrease in tetragonality with increasing Mg concentration. The Rietveld refinement process supports these observations. The crystallite size was estimated using the Debye-Scherrer equation. UV-visible spectroscopy revealed that as the Mg concentration increases from 0 to 0.06, the Urbach energy (Eu) rises from 0.115 eV to 0.153 eV, while the band gap energy (Eg) decreases from 3.228 eV to 3.080 eV. In addition, several optical parameters were extracted and correlated with variations in the Mg concentration (x), including the linear refractive index (n), dielectric constants (ε_1 and ε_2), and optical conductivity (σ_{opt}). These results highlight the potential of $Ba_{1-x}Mg_xTiO_3$ nanoparticles ($x = 0$ to 0.06) for applications in a wide range of optical devices.

Keywords: UV-visible; Band gap; Urbach energy; Magnesium-doped $BaTiO_3$.

Electro-Fenton degradation of Ornidazole using Stainless Steel Electrode as Sources of Ferrous Ions (Fe^{2+})

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Abstract

This study presents a cost-effective and environmentally friendly approach for the removal of Ornidazole from contaminated environments. Carbon felt was used as the cathode, and stainless steel was used as the sacrificial anode, which also serves as an insitu source of Fenton's catalyst (Fe^{2+}) through auto-generation, eliminating the need for external catalyst addition. Different operational parameters were investigated to enhance degradation efficiency. The degradation experiment demonstrated the highest Ornidazole removal efficiency of 90.95 % and a mineralization efficiency of 84.5 % within 120 min under optimal conditions i.e., an applied current of 75 mA, an applied voltage of 2,5 V, an initial solution pH of 5, and an electrode spacing of 1.5 cm. Additionally, quenching experiments confirmed the crucial role of •OH in the degradation process of Ornidazole. Furthermore, the proposed EF process exhibited better effectiveness of Ornidazole degradation even in real water matrices (river water 91.32 % and tap water 94,32 %).

Keywords Ornidazole; Degradation; electro-Fenton; Stainless Steel; Sacrificial anode.

Application of an Arginine-PANI@PP Biocomposite for Orange G dye Removal from Water

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Abstract

A new arginine-doped polyaniline@PP (**Arg-PANI@PP**) biocomposite was prepared through a straightforward in situ chemical polymerization process. The resulting adsorbent was comprehensively characterized through several analytical techniques, including Fourier Transform Infrared Spectroscopy (FTIR), Energy-Dispersive X-ray Spectroscopy (EDS), and Scanning Electron Microscopy (SEM). Batch adsorption experiments were conducted to assess the ability of the synthesized composite to remove Orange G ions from aqueous solutions. The results showed that the adsorption behavior was strongly influenced by physicochemical conditions. The adsorption kinetics followed the pseudo-second-order model, and the equilibrium data were consistent with the Freundlich isotherm. The Arg-PANI@PP biocomposite also exhibited effective regeneration using a basic solution, retaining its performance over repeated cycles. Overall, these findings highlight the potential of the Arg-PANI@PP composite as an efficient and reusable material for wastewater treatment.

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Magnetic Polymer@ZnO Nanocomposite: Facile Preparation and Efficient Visible-Light-Driven Degradation of methylene blue.

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Abstract

The organic dyes lead to the aspect of wather pollution that remains a major international problem. Subsequently, the photocatalytic treatment has been extensively used as a viable method of enhancing water quality. In the present study. Simply a Mechanochemical was used to produce the nanocomposite magnetic polymer @ ZnO. The photocatalyst has been characterized by X-Ray Diffraction (XRD), Scanning Electron Microscopy with the Energy Dispersive X-ray Spectoscopy (SEM/EDX), and Diffuse Reflectance Spectroscopy (DRS). The findings of these studies proved the successful creation of the photocatalyst. Photodegradation was experimented using methylene blue (MB) dye under visible light irradiation that led to a photodegradation of 95% after 180 minutes of light irradiation using 1g.L^{-1} of nanocomposite in an aqueous solution of methylene blue (MB) at 12mg.L^{-1}.

Keywords: Photocatalysis –Visible light – Degradation – Dye – Magnetic polymer @ ZnO

Green synthesis of natural organic compound-modified layered double hydroxide: An effective adsorbent for basic dye in aqueous solutions

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Abstract

Synthetic colorants are one of the most toxic organic pollutants to human health, highlighting the urgent need to develop highly efficient adsorbents for its removal. This study investigates the eco-friendly synthesis of NiZnFe layered double hydroxides (LDH) modified with natural organic and calcined at controlled temperature as an innovative adsorbent for the removal of cationic dye, Toluidine Blue (TB), from aqueous solutions. The synthesis was carried out via a co-precipitation method, and characterization was performed using techniques such as XRD, FTIR, SEM, EDS, and zeta potential. To enhance the adsorption process of TB dye, experiments were conducted in a batch reactor to investigate the effects of key parameters such as contact time, initial dye concentration, pH, adsorbent dosage, and solution temperature.

The adsorption effect was evaluated using Langmuir, Freundlich and Temkin isotherm models, complemented by pseudo-first, pseudo-second order and Elovich kinetic models to analyze the process behavior. Adsorption tests revealed that the process fits Elovich kinetics and the Temkin isotherm, achieving a notable adsorption capacity of 64.63 mg/g and a removal efficiency of 70%. Furthermore, The thermodynamic results indicated that the adsorption of TB onto NiZnFe-LDH modified with natural organic and calcined at 200C is a spontaneous, endothermic, and entropy-driven process, becoming more favorable with increasing temperature. Consequently, this work presents a sustainable method for obtaining an environmentally friendly adsorbent from modified anionic clay, which has a high potential to replace commercial adsorbents in wastewater treatment.

Keywords: Adsorption, Natural organique, Layered double hydroxide, wastewater treatment.

LDH Material for Pharmaceutical Contaminant Removal from Water

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Abstract

Pharmaceutical compounds, particularly anti-inflammatories, are increasingly recognized as environmental contaminants due to their persistence and potential ecological impacts [1]. After use, these substances can enter water and soil through human excretion or inadequate waste management, posing risks to aquatic and terrestrial ecosystems [2]. Effective strategies for their removal are therefore essential to protect environmental and public health. Layered double hydroxides (LDHs) have emerged as promising materials for environmental applications due to their adsorption capabilities [3]. In this study, an intercalated ZnAl-LDH was explored for the adsorption of diclofenac sodium from aqueous solutions, with attention to parameters such as contact time, adsorbent dosage, solution pH, and initial contaminant concentration.

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Enhancement of Geopolymer Composite Properties Using Alkali-Treated Doum Palm Fibers

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Abstract:

With increasing global concern over environmental sustainability, geopolymers have attracted significant interest as eco-friendly alternatives to conventional cementitious materials. However, their practical application is often limited by inherent brittleness and low flexibility. This study investigates the development of lightweight geopolymer composites (LWGCs) reinforced with alkali-treated short-leaf date palm fibers (SLDPFs), using copper mine waste (CMW) as the primary aluminosilicate source. The effects of fiber treatment and content (1–5 wt.%) on the mechanical and physical properties of the composites were systematically evaluated. The results showed that fiber incorporation significantly enhanced the modulus of rupture (MOR), modulus of elasticity (MOE), and compressive strength, with optimal performance observed at 2–3 wt.% fiber content. Excessive fiber addition led to decreased mechanical performance due to agglomeration and increased porosity. FTIR and SEM analyses revealed improved fiber–matrix interfacial bonding and changes in the geopolymer gel structure after fiber treatment. Water absorption and thickness swelling increased with higher fiber content but remained within acceptable limits at moderate dosages. These findings demonstrate that alkali-treated date palm fibers, when used at optimal concentrations, can markedly improve the mechanical performance and durability of sustainable geopolymer composites. This work highlights the potential for valorizing agricultural and mining wastes in the production of high-performance, eco-friendly building materials.

***Keywords**:* Geopolymer, alkali treated fibers, palm doum fibers, ecofriendly composites, mechanical, physical properties.

Adsorption of toluidine blue from water using organic matter-modified lamellar double hydroxide: characterization. Isotherm and kinetics studies

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Abstract:

Synthetic colorants constitute a major class of toxic organic pollutants, posing serious risks to human health and highlighting the urgent need for efficient and sustainable adsorbents for wastewater treatment. In this study, an environmentally friendly synthesis of nickel-zinc-iron layered double hydroxides (NiZnFe-LDHs), modified with organic matter and thermally treated by controlled-temperature calcination, is reported for the adsorption of the cationic dye Toluidine Blue (TB) from aqueous solutions. The adsorbent was synthesized via a co-precipitation method and thoroughly characterized using X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), and zeta potential analysis. Batch adsorption experiments were conducted to evaluate the effects of key operational parameters, including contact time, initial dye concentration, solution pH, adsorbent dosage, and temperature. Adsorption kinetics were analyzed using pseudo-first-order, pseudo-second-order, and Elovich models, while equilibrium data were fitted to Langmuir, Freundlich, and Temkin isotherms. The results indicated that the adsorption process followed the Elovich kinetic model and was best described by the Temkin isotherm, with a maximum adsorption capacity of 64.63 mg g^{-1} and a removal efficiency of 70%. Thermodynamic analysis further revealed that the adsorption process was spontaneous, endothermic, and driven by entropy, with higher temperatures enhancing the favorability of dye removal. Altogether, this research introduces a sustainable approach to fabricating eco-friendly adsorbents using modified anionic clays. The findings underscore the high potential of NiZnFe-LDH modified with organic matter as a viable alternative to conventional adsorbents in wastewater treatment applications.

Keywords: Adsorption, Layered double hydroxide (LDH), Green synthesis, Toluidine blue, Organic matter modification.

Innovative Monitoring and Sustainable Management of Water Resources in the Ziz Basin, Morocco

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Abstract:

The Ziz Basin in southeastern Morocco faces escalating water stress due to rapid population growth, agricultural expansion, and increasing climate variability. In this semi-arid region, effective monitoring of water resources is essential to preserve ecosystems and support sustainable livelihoods of local communities.

This study adopts innovative digital approaches to assess the the spatiotemporal dynamics of water resources in the Ziz Basin. Using Google Earth Engine (GEE), we calculated satellite-derived indices, notably the Normalized Difference Water Index (NDWI) and the Normalized Difference Vegetation Index (NDVI), to quantify changes in surface water extent and vegetation cover over time. Furthermore, Machine learning techniques were applied to classify vulnerability zones and identify areas at high risk of water scarcity, integrating satellite data with key climatic variables such as precipitation, temperature, and evapotranspiration.

The results reveal pronounced seasonal and interannual fluctuations in surface water availability, with significant reductions during prolonged dry periods. Critical hotspots, particularly in agricultural zones and traditional oases, were identified as highly vulnerable to water stress. These findings provide a scientific basis for sustainable water management strategies, including improved irrigation efficiency, groundwater protection, and conservation of seasonal wetlands.

By integrating remote sensing, geospatial analytics, and artificial intelligence, this study demonstrates a scalable, modern framework for environmental monitoring and sustainable water resource governance. The proposed methodology offers actionable insights for policymakers and stakeholders aiming to enhance resilience in arid and semi-arid regions facing similar hydrological challenges.

Keywords: Ziz Basin, water resources management, remote sensing, NDWI, NDVI, Google Earth Engine, machine learning, semi-arid regions.

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Effect of Yttrium Doping on the Structural and Dielectric Properties of Perovskite Ceramics.

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Abstract:

Perovskite with the general formula ABO_3, is an important class of functional materials because of their remarkable structural flexibility and wide range of physical properties.

In this study, nano-polycrystalline $BaTiO_3$ ceramics substituted with different percentages of yttrium (20, 40, 60, and 80 mol%) were synthesised using the sol–gel method. The solubility of rare earth ions in the $BaTiO_3$ lattice depends on the ionic radius difference between substituted and substitute atoms. $BaTiO_3$ crystallises in a perovskite structure, in which Y ions substitute Ba atoms. X-ray diffraction analysis showed the presence of a tetragonal phase. In this work, we explored the effect of Y^{3+} content on $BaTiO_3$ ceramic materials. The incorporation of yttrium into the $BaTiO_3$ unit cell slightly altered the bond vibrations of the crystal lattice. We observed that all synthesised phases crystallise in a tetragonal lattice, as confirmed by Raman-active modes. Y-doped $BaTiO_3$ ceramics show high dielectric constant values and low dielectric losses. On the other hand, Curie–Weiss law analysis confirms that all samples are normal ferroelectrics with a first-order phase transition. The increase in electrical conductivity is linked to the formation of oxygen vacancies arising from molecular dissociation during the synthesis process [1].

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Structural and Microstructural Characterization of a Mixed Sb/Ga Lead Orthophosphate

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Abstract

This paper presents the synthesis, microstructural morphology and Raman-Infrared spectroscopic of the orthophosphate $Pb(SbGa)_{0.5}(PO_4)_2$. This structure was refined by the Rietveld method using X-ray powder diffraction data, in the monoclinic system with the C2/c space group (Z = 4). Microstructural morphology and chemical compositions of this material are studied by (SEM) analysis.

Keywords: Orthophosphate; SEM; X-ray powder diffraction; Rietveld method

Enhancing the surface properties of steel alloy using a thiosemicarbazone-based inhibitor as an eco-friendly functional material with excellent electrochemical stability

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Abstract

The corrosion inhibition performance of 2-(4-methoxybenzylidene)-N-methylhydrazine-1-carbothioamide (MBHM) for carbon steel (CS) in a 1.0 M HCl solution was investigated using electrochemical techniques. EIS and PDP measurements were employed to assess the corrosion behavior and inhibition efficiency of the studied inhibitor. The results showed that the η_{EIS} increased with increasing inhibitor concentration, reaching a maximum value of 91.58 % at 5×10^{-3} M. PDP results indicated a marked reduction in corrosion current density from 1012.84 $\mu A.cm^{-2}$ in the uninhibited solution to 99.52 $\mu A.cm^{-2}$ in the presence of the inhibitor, suggesting effective corrosion protection. The adsorption behavior follows the Langmuir isotherm, indicating strong inhibitor-metal interactions. The inhibition mechanism arises from the adsorption of organic molecules via heteroatoms and π-electron systems, enabling donor-acceptor interactions with iron atoms, as confirmed by DFT and DFTB studies. Furthermore, after 72 h of immersion, MBHM maintained a high inhibition efficiency 84.15% and R_p 230.40 $\Omega.cm^2$, confirming the long-term stability of the protective film. The present investigation demonstrates that MBHM exhibits excellent corrosion inhibition performance for CS in acidic media. Its adsorption behavior, supported by both experimental and theoretical analyses, confirms its effectiveness and highlights its potential as a sustainable inhibitor for industrial applications.

Equilibrium and Kinetic studies on the adsorption of Enrofloxacin from aqueous media onto a novel dextrose-coated layered double hydroxides.

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Abstract

Enrofloxacin (ENR), a commonly used antibiotic, has become a persistent pollutant in aquatic environments, posing ecological risks. This study explores dextrose-modified MgZnAl-layered double hydroxide (Dxt@S-LDH) as an efficient adsorbent for removing ENR from water. The composite was thoroughly characterized using Fourier-transform infrared spectroscopy (FT-IR), X-ray diffraction (XRD), scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDS), differential thermal and thermogravimetric analyses (DTA/TGA), solid-state nuclear magnetic resonance (ss-NMR), Brunauer-Emmett-Teller (BET) surface area analysis, and determination of the point of zero charge (pHpzc) to understand its physicochemical properties.

Batch adsorption experiments were conducted to evaluate the effects of key operational parameters, including initial ENR concentration, adsorbent dosage, contact time, solution pH, temperature, and ionic strength. The adsorption equilibrium data were best described by the Temkin isotherm model. The results indicated that ENR adsorption onto Dxt@S-LDH is a spontaneous and exothermic process, achieving a removal efficiency of 75.92% and a maximum adsorption capacity of 169.70 mg g^{-1}. Kinetic studies revealed that the adsorption followed a pseudo-second-order model, suggesting that chemisorption predominates in the removal mechanism.

Thermodynamic analysis using Van't Hoff plots showed that the adsorption process is endothermic, with positive changes in enthalpy and entropy, indicating that higher temperatures favor ENR uptake. Overall, the study demonstrates that the Dxt@S-LDH composite is an effective and sustainable adsorbent for removing ENR from water, offering a promising solution for mitigating pharmaceutical contamination in aquatic environments. These findings highlight the composite's strong potential for practical applications in treating antibiotic-contaminated wastewater and reducing the environmental risks associated with pharmaceutical pollutants.

Keywords: Adsorption; Enrofloxacin; Layered double hydroxide; Dextrose; Composite.

Efficient adsorption of pharmaceutical drug Enrofloxacin by dextrose functionalized MgZnAl-LDH: Integrated experimental and Monte Carlo computational assessment

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Abstract

The widespread presence of pharmaceutical contaminants like enrofloxacin (ENR) in water is an emerging environmental concern, emphasizing the need for effective remediation. In this study, a dextrose-functionalized layered double hydroxide composite (Dxt@S-LDH) was synthesized and tested for ENR adsorption. Characterization using techniques such as XRD, FTIR, SEM–EDS, solid-state NMR, DTA/TGA, BET analysis, and zeta potential measurements revealed a porous structure with moderate surface area and abundant active groups, enhancing its adsorption capacity.

Batch adsorption experiments were conducted to examine the effects of key parameters such as initial ENR concentration, pH, temperature, ionic strength, contact time, and adsorbent dosage. Results indicated that ENR removal by Dxt@S-LDH is a spontaneous, exothermic process, achieving a removal efficiency of 75.92% and a maximum adsorption capacity of 169.70 mg g^{-1}. Kinetic analysis revealed that the adsorption is best described by the pseudo-second-order model, suggesting that chemisorption is the dominant removal mechanism.

To understand the adsorption process at the molecular level, DFT calculations and Monte Carlo simulations were used to examine the interactions between ENR and the Dxt@S-LDH surface. Theoretical analyses, including molecular orbital analysis, electrostatic mapping, and adsorption energy calculations, confirmed the strong affinity and stability of ENR on the composite. The agreement between theoretical and experimental results further validates the models. In conclusion, this study shows that Dxt@S-LDH is an effective, eco-friendly adsorbent for ENR removal, offering a promising solution to pharmaceutical pollution in aquatic environments.

Keywords: Adsorption; Hydroxychloroquine; Layered double hydroxide; Composite; Density functional theory.

pH-Controlled synthesis of TiO_2 photocatalyst nanoparticles for optimized structural and functional properties

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Abstract

Titanium dioxide (TiO_2) is among the most extensively studied semiconductor materials for photocatalytic applications due to its excellent chemical stability, non-toxicity, low cost, and strong oxidative potential under irradiation. In this study, TiO_2 nanoparticles were synthesized via a sol-gel method under controlled pH conditions to tailor their crystallization pathway and optimize their structural and functional properties. The effect of pH on the resulting TiO_2 phase composition, crystallinity, and photocatalytic efficiency was investigated, with the aim of developing improved materials for sustainable water decontamination applications [1, 2, 3].

TiO_2 nanoparticle samples were synthesized at different pH values using a controlled sol-gel process involving a titanium alkoxide precursor. Acidic and basic environments were adjusted using diluted nitric acid or sodium hydroxide respectively, to regulate the hydrolysis and condensation rates. The synthesized TiO_2 photocatalysts were systematically characterized using X-ray diffraction (XRD) to determine their crystal structure and phase composition, scanning electron microscopy (SEM) to examine their morphology and size, and FTIR spectroscopy to identify their functional groups and chemical bonds. These characterization techniques provided a comprehensive understanding of the effect of synthesis pH on their properties.

The XRD, FTIR, and EDX analyses demonstrate that the pH applied during sol–gel synthesis strongly affects the structural organization, chemical bonding, and elemental composition of the resulting TiO_2 nanoparticles. The observed variations in crystallinity, surface-related functional groups, and chemical composition confirm that pH is a key parameter governing the structural and functional properties of the material. The synthesized TiO_2 nanoparticles are intended for future application in water decontamination processes.

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Mechanochemical Construction of a AgI–BiOI@g-C_3N_4 Heterojunction as a High-Performance Photocatalyst for Advanced Water Decontamination

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Abstract

The continuous discharge of textile dyes into aquatic environments represents a major challenge for water quality and ecosystem sustainability, showing the need for efficient and practical treatment technologies. Photocatalytic degradation is recognized as a promising, environmentally friendly approach for the removal of organic pollutants from wastewater. In this study, an efficient heterojunction photocatalyst based on AgI–BiOI and g-C_3N_4 was synthesized using a simple mechanochemical method. The structural, morphological, and optical properties of the synthesized materials were investigated using X-ray diffraction (XRD), scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy (SEM/EDX), Fourier-transform infrared spectroscopy (FTIR), and diffuse reflectance spectroscopy (DRS), confirming the successful formation of the heterojunction. The photocatalytic performance was evaluated through the degradation of Rhodamine B (RhB) in aqueous solution, with particular attention to key operational parameters relevant to water treatment applications, including catalyst dosage, pH, initial dye concentration, scavenger effects, and reusability. The AgI–BiOI/g-C_3N_4 heterojunction with an optimal ratio of 0.8 exhibited significantly enhanced photocatalytic activity, achieving an apparent degradation rate 14.5 times higher than that of pristine g-C_3N_4. The improved performance is attributed to the effective charge separation at the heterojunction interface. These findings demonstrate the strong potential of the developed photocatalyst for practical water purification and environmental remediation applications.

Biochar-Supported $Cu_2(OH)_2CO_3$@CuAl Layered Double Hydroxide Composite with Enhanced Interfacial Adsorption for the Effective Removal of Anionic and Cationic Dyes

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Abstract

This work reports the rational design of a novel biochar-supported hybrid adsorbent based on the integration of $Cu_2(OH)_2CO_3$ and CuAl layered double hydroxide using Argania spinosa–derived biochar as a sustainable supporting matrix. The synthesis strategy was optimized to promote effective interfacial coupling between the inorganic phases and the biochar substrate, leading to improved structural integrity and enhanced surface functionality. The as-prepared composite was comprehensively characterized by X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), and scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy (SEM–EDX), confirming the successful formation of the hybrid architecture and homogeneous elemental distribution. The adsorption performance of the $Cu_2(OH)_2CO_3$@CuAl LDH composite was systematically evaluated toward the removal of both anionic Eriochrome Black T and cationic Methylene Blue from aqueous media. The effects of key operational parameters, including adsorbent dosage, solution pH, initial dye concentration, and temperature, were thoroughly investigated. Kinetic and isotherm analyses were conducted to elucidate the adsorption mechanisms and quantify the adsorption capacity of the composite. In addition, regeneration and reusability studies demonstrated the excellent structural stability and sustained adsorption efficiency of the material over multiple adsorption–desorption cycles. The results reveal that the synthesized hybrid composite exhibits high adsorption performance toward diverse dyes, showing its strong potential as a cost-effective and sustainable adsorbent for advanced wastewater treatment applications.

Sustainable Synthesis of $CaCO_3$@Zn–Al MMO Core–Shell Nanoflowers for Enhanced Visible-Light Degradation

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Abstract

In this study, a type-I heterojunction photocatalyst based on eggshell waste doped mixed metal oxides (ES@ZnAl MMO) was developed for the efficient degradation of Rhodamine B (RhB) under visible-light irradiation. The ES@ZnAl MMO core–shell nanostructure was synthesized using waste eggshells and Zn Al layered double hydroxide (LDH) as primary precursors through mechanochemical assembly followed by thermal treatment. This process resulted in the formation of $CaCO_3$ in both calcite and vaterite phases, together with mixed metal oxides (ZnO and Al_2O_3) derived from LDH. The establishment of a heterojunction between the semiconductor components significantly enhanced charge separation, increased active sites, and reduced the bandgap energy from 5.72 to 3.44 eV, leading to improved photocatalytic activity. The structural characteristics, elemental composition, morphological features, and optical properties of the ES@ZnAl MMO nanocomposite were characterized using various analytical techniques. Under optimal conditions, the ES@ZnAl MMO photocatalyst achieved over 98% degradation of RhB, outperforming pristine ZnAl LDH, ZnAl MMO, and eggshell waste. Moreover, the ES@ZnAl MMO heterojunction exhibited excellent stability, maintaining 99% photocatalytic efficiency after five consecutive cycles. It also demonstrated high degradation efficiencies toward other organic pollutants, including Orange G (OG), Indigo Carmine (IC), Methylene Blue (MB), and 2,4-dichlorophenol (2,4-DP), with removal efficiencies of 97%, 99%, 99%, and 87%, respectively. Owing to its low cost, sustainability, and high photocatalytic performance, this heterojunction presents a promising and economically viable strategy for environmental remediation and the treatment of diverse organic pollutants.

Construction of Ag_2CO_3/Ag_2O@NiFe LDH Nanoheterostructure for Enhanced Visible-Light Photocatalytic Degradation of Methylene Blue

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Abstract:

The photocatalyst Ag_2CO_3/Ag_2O@NiFe LDH nanocomposite was synthesized successfully by a facile co-precipitation method followed by hydrothermal treatment. The as-prepared photocatalyst demonstrated excellent physicochemical and optical properties using various characterization techniques. It was found that the photodegradation performance of NiFe LDH for MB dye removal can be significantly improved by appropriate Ag incorporation. The optimal composite which had a 0.75 Ag molar ratio demonstrated superior degradation performance for MB dye reaching 99.5%. The degradation efficiency was three times higher compared to pure NiFe LDH. Additionally, the apparent rate constant ($0.028\ \text{min}^{-1}$) was approximately 28 times greater than that of the pure LDH ($0.001\ \text{min}^{-1}$). After 5 successive cycles, the composite exhibited 73% degradation efficiency reflecting its high photostability throughout the regeneration process. The synthesized photocatalyst exhibited exceptional properties, indicating its promising potential for industrial applications in the treatment of dye wastewater.

Co-digestion of Poultry by-products and chicken manure for methane production and digestate conversion into hydrochar for advanced water treatment in a circular green energy framework

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Abstract

Achieving zero waste through the efficient valorization of PBP organic waste presents an ongoing challenge, necessitating the exploration of cleaner methodologies. To address this challenge, a synergistic approach employing both anaerobic digestion (AD), a biological process, and adsorption, a physicochemical process, was adopted. The AD process facilitates the activation of biodegradable organic matter via microbial action, yielding a co-product known as digestate. This digestate, after chemical treatment with nitric acid and thermal activation at T = 500 °C, serves as the precursor for porous carbon characterized by a high specific surface area. The resultant activated carbon was employed in the treatment of wastewater containing dyes, effectively resolving issues related to solid−liquid separation in the adsorption process. Notably, the AD process demonstrated a substantial bio-methane potential (BMP), with an observed production of 15.04 L CH_4 kg·SV−1 under optimal conditions of pH = 8 and an inoculum/substrate ratio of 3. Additionally, findings about the adsorption of methylene blue (MB) from water onto the activated carbon indicated a maximum adsorbed amount of 101.74 mg g−1. The experimental adsorption data exhibited excellent agreement with both pseudo-second order and Langmuir theoretical models. Furthermore, a thermodynamic analysis revealed that the adsorption process is characterized as endothermic and spontaneous. This integrated approach not only addresses the valorization of organic waste but also demonstrates the potential for generating bioenergy through AD while concurrently producing a valuable adsorbent for water treatment applications.

Contribution de l'électrocoagulation à la réduction des colorants synthétiques dans les effluents industriels

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Résumé

Cette étude examine l'électrocoagulation comme méthode efficace pour éliminer la plupart des colorants synthétiques fréquemment présents dans les effluents industriels. Le traitement des eaux usées contenant ces composants constitue un défi environnemental majeur en raison de la persistance et de la toxicité de ces polluants. L'électrocoagulation repose sur la génération in situ de coagulants par électrolyse des électrodes métalliques, entraînant l'agrégation et la précipitation des polluants. L'objectif principal de cette recherche est d'optimiser les paramètres influençant l'efficacité de cette méthode, tels que la densité de courant et la charge électrique spécifique. Une série d'expérimentations a permis d'identifier les conditions optimales pour maximiser l'élimination de ces colorants comme l'Orange G tout en minimisant la consommation énergétique. Les résultats montrent que l'électrocoagulation présente un potentiel considérable pour l'élimination des colorants dans les eaux usées industrielles, avec une efficacité de traitement étroitement liée à ces paramètres. Cette approche offre une solution prometteuse et durable pour traiter les eaux polluées par des colorants synthétiques, contribuant ainsi à la réduction de la pollution et à la préservation de l'environnement.

Mots clés : Electrocoagulation, Industrie textile, Optimisation, Epuration des eaux usées, Electrochimie.

Copper (II) ion adsorption onto a highly efficient adsorbent: Characterization, kinetic modeling, and adsorption isotherms

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Abstract

The development of cost-effective and sustainable adsorbents derived from natural resources has gained increasing attention for heavy metal remediation in aqueous environments [1]. In this work, a highly efficient adsorbent was synthesized from a naturally abundant raw material using a simple and environmentally friendly modification strategy and applied to remove copper ions (Cu^{2+}) from water.

Structural and surface characterizations confirmed the successful enhancement of surface functionality, porosity, and active adsorption sites, which are crucial for copper ion uptake. Batch adsorption experiments were systematically conducted to evaluate the effects of solution pH, contact time, initial Cu^{2+} concentration, and adsorbent dose.

The adsorption process exhibited rapid kinetics, reaching equilibrium within a short time, and followed a pseudo-second-order kinetic model, indicating a chemisorption-dominated mechanism [2]. Equilibrium data were best described by the Langmuir isotherm model, suggesting monolayer adsorption with a high maximum adsorption capacity. Thermodynamic analyses revealed that the adsorption of Cu^{2+} was spontaneous and endothermic. Furthermore, regeneration studies demonstrated high reusability of the adsorbent over multiple cycles with minimal loss in performance. The excellent adsorption efficiency, combined with low cost, abundance of the raw material, and environmental compatibility, highlights the strong potential of this natural-derived adsorbent for practical wastewater treatment applications.

Keywords: Adsorption, Copper ions, Langmuir, Adsorption capacity, wastewater treatment.

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Natural adsorbent for water purification: A Comparative study of organic and inorganic pollutant removal

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Abstract

The increasing presence of diverse contaminants in water resources, including both organic dyes and inorganic ions, has intensified the need for sustainable and eco-friendly purification technologies. In this context, natural adsorbents derived from abundant and low-cost raw materials have emerged as promising candidates for environmental remediation. Their unique physicochemical properties, renewable nature, and minimal environmental impact make them suitable alternatives to conventional treatment methods. Recent studies have highlighted the effectiveness of natural materials in adsorption-based purification processes, demonstrating their ability to efficiently capture a wide range of pollutants from contaminated aqueous systems [1–3].

This work presents a comparative investigation of the adsorption behavior of a natural adsorbent toward the removal of two pollutant classes: an organic dye representative of persistent organic contaminants, and an inorganic ion commonly found in wastewater streams. The influence of key operational parameters, including pH and adsorbent dose, was systematically examined for both pollutant types. Comprehensive characterization of the natural adsorbent was performed using X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), and thermogravimetric analysis (TGA). The findings of this study provide valuable insights into the versatility and efficiency of natural materials in water purification, offering guidance for their potential application in large-scale wastewater treatment processes.

Keywords: Natural clay, Adsorption, Organic pollutants, Inorganic pollutants, Comparative study.

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Synthèse et caractérisation des hydroxydes doubles lamellaires HDLs de type hydrocalumite

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Abstract

Dans le domaine de la recherche scientifique, les applications des matériaux constituent un défi majeur pour les chercheurs à l'échelle mondiale. Toutefois, les étapes de synthèse et de caractérisation approfondie demeurent essentielles et représentent la clé du développement et de l'optimisation de ces applications.

Les argiles anioniques, ou Hydroxydes Doubles Lamellaires (HDL), en particulier ceux de type hydrocalumite, constituent une famille de matériaux d'intérêt croissant dans plusieurs domaine et surtout dans le traitement des eaux. Ces composés peuvent être décrits par la formule chimique générale $[Ca_2M(OH)_6]^{x+}[X.H_2O]^{x-}$, dans laquelle le calcium est toujours présent en tant que cation divalent, tandis que le cation trivalent M^{3+} peut être l'aluminium (Al^{3+}), le fer (Fe^{3+}), le chrome (Cr^{3+}), le gallium (Ga^{3+}) ou le scandium (Sc^{3+}). L'anion Cl est intercalé dans l'espace interlamellaire, accompagné de molécules d'eau.[1]

La phase synthétisée par la méthode de coprécipiation a été caractérisée par diffraction des rayons X (DRX), avec un affinement structural par la méthode de Rietveld, ainsi que par spectroscopie infrarouge (IR), analyse thermogravimétrique (ATG) et spectroscopie d'impédance des solides.

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A cheminformatic and machine learning analysis to explore the chemical space diversity of Nav1.7

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Abstract

Nav1.7 channels, encoded by *SCN9A* and predominantly expressed in peripheral sensory neurons, play a central role in nociceptive signal transmission and represent an important therapeutic target for pain management. This study investigates the chemical diversity of 4,620 potential Nav1.7 inhibitors using integrated cheminformatics and machine learning approaches to identify molecular determinants of inhibitory potency. Key physicochemical descriptors, including hydrogen bond donors and acceptors, topological polar surface area, rotatable bonds, heteroatoms, molecular weight, aromatic rings, and cLogP, were analyzed to assess their influence on activity. Chemical space organization and structural diversity were explored through principal component analysis and scaffold visualization. Thirteen classification-based structure–activity relationship models were developed using Scikit-learn and validated by fivefold cross-validation, with the Extra Trees algorithm showing the best performance. This model achieved strong predictive accuracy across training, validation, and test sets. Active inhibitors exhibited higher molecular weight, lipophilicity, polarity, and aromaticity, while scaffold analysis revealed recurrent cyclic frameworks among dominant chemotypes. Overall, this combined cheminformatic and machine learning framework provides insights into Nav1.7 inhibitor diversity and supports the rational design and prioritization of novel analgesic candidates.

KEYWORDS: Nav1.7; cheminformatics; machine learning; AI.

Polypyrrole Decorated Magnetic Fe_3O_4@NiMgAl-LDH Ternary (M-LDH@PPy) Composite For Efficient Removal of Dichlorprop-P From Water: Adsorption Isotherms, Kinetics, and DFT insights

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Abstract

The extensive application of hazardous pesticides poses significant risks to human health and aquatic ecosystems, necessitating the development of efficient remediation materials. In this work, a novel Polypyrrole-modified magnetic layered double hydroxide composite (M-HDL@PPy) was synthesized through coprecipitation, mechanical stirring, and in situ oxidative polymerization for the adsorption-based removal of the herbicide Dichlorprop-P from aqueous media. The structural, morphological, and physicochemical characteristics of the composite were comprehensively examined using XRD, SEM–EDS, FT-IR, Raman spectroscopy, and BET surface area analysis. Batch adsorption experiments were conducted to evaluate the influence of adsorbent dosage, contact time, solution pH, initial pollutant concentration, and temperature. The adsorption behavior followed pseudo second order and Elovich kinetic models, indicating chemisorption dominated mechanisms. Equilibrium data were well described by Sips, Langmuir, and Temkin isotherms, suggesting heterogeneous surface interactions with a finite number of active sites. Thermodynamic parameters confirmed that the adsorption process is spontaneous and endothermic. The composite also demonstrated good regeneration capability over repeated cycles. Beyond Dichlorprop-P removal, M-HDL@PPy showed high efficiency in treating simulated wastewater containing pharmaceutical and dye contaminants, showing its versatility and strong potential as a multifunctional adsorbent for environmental remediation applications.

Design of a Perovskite-Derived LDH@g-C_3N_4/Polyaniline Hybrid Composite for Enhanced Hexavalent Chromium Remediation

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Abstract

In this work, a novel perovskite-type ABO_3 material derived from Layered Double Hydroxide (LDH) was developed, with graphitic carbon nitride (g-C_3N_4) successfully incorporated through an in-situ growth strategy on the LDH surface to form an ABO_3-LDH@ g-C_3N_4 hybrid. This structure was subsequently functionalized with polyaniline (PANI) via in situ polymerization, yielding the ternary ABO_3-LDH@ g-C_3N_4/PANI composite. Detailed physicochemical characterization confirmed the successful fabrication and structural integrity of the material. The engineered composite exhibited a well-organized, porous bead-like morphology that provided abundant accessible active sites, enabling efficient adsorption of hexavalent chromium from aqueous solutions. Batch adsorption studies were systematically performed to optimize operational parameters, including solution pH, adsorbent dosage, temperature, ionic strength, initial hexavalent chromium concentration, and contact time. The adsorption kinetics showed excellent agreement ($R^2 \approx 0.99$) with the pseudo-second-order model, while equilibrium data were best described by the Freundlich and Temkin isotherm models, indicating heterogeneous surface interactions. Thermodynamic parameters demonstrated that the adsorption process is spontaneous and endothermic. Furthermore, regeneration experiments confirmed the material's good reusability and structural stability, making it an effective adsorbent for heavy metal remediation in water treatment applications.

Corrosion Inhibition of Carbon Steel in Hydrochloric Acid by 3,6-bis(3-pyridyl)pyridazine: Electrochemical, XPS, and Theoretical Study

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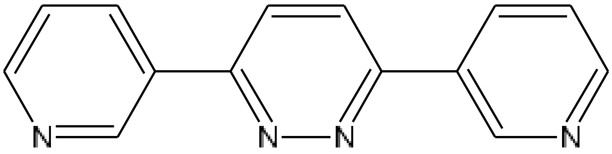
Abstract

Corrosion inhibition of carbon steel in normal hydrochloric acid solution at 30°C by new pirydazine derivative, namely 3,6-bis(3-pyridyl) pyridazine (3-PYP) has been studied by a series of known techniques such as weight loss, polarisation and electrochemical impedance spectroscopy (EIS).



3-PYP

The experimental results have showed that this organic compound revealed a good corrosion inhibition and that the inhibition efficiency is increased with the inhibitor concentration. Potentiodynamic polarisation suggested that it is a mixed type of inhibitor. Two time constants determined by the charge-transfer and the adsorption of the inhibitor, respectively, can be readily outlined. The adsorption of 3-PYP on the carbon steel surface, in 1 M HCl solution, obeyed to the Temkin’s isotherm with a very high negative value of the standard Gibbs free energy of adsorption ΔG°_{ads} (chemisorption). Quantum chemical calculations and X-ray photoelectron spectroscopy (XPS) analysis were carried out to establish the mechanism of corrosion inhibition of carbon steel in 1 M HCl medium in the presence of 3,6-bis(3-pyridyl)pyridazine (3-PYP).

Keywords: *Pyridazine; Carbon steel; Acid solution; EIS; XPS; Acid inhibition*

Carbon Steel Corrosion Inhibition in HCl by 3,6-bis(3-pyridyl)pyridazine: Electrochemical, XPS, and Theoretical Analysis

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Abstract

The corrosion inhibition of carbon steel in 1 M hydrochloric acid at 30 °C by a novel pyridazine derivative, 3,6-bis(3-pyridyl)pyridazine (3-PYP), was investigated using a range of established techniques, including weight loss measurements, polarization studies, and electrochemical impedance spectroscopy (EIS).

The experimental results demonstrated that this organic compound exhibits significant corrosion inhibition, with the inhibition efficiency increasing as the inhibitor concentration rises. Potentiodynamic polarization studies indicated that 3-PYP acts as a mixed-type inhibitor. Two time constants, associated with charge transfer and inhibitor adsorption, were clearly observed. The adsorption of 3-PYP on the carbon steel surface in 1 M HCl followed Temkin’s isotherm, with a highly negative standard Gibbs free energy of adsorption ($\Delta G°$_ads), indicating chemisorption. Additionally, quantum chemical calculations and X-ray photoelectron spectroscopy (XPS) analyses were performed to elucidate the mechanism of corrosion inhibition of carbon steel in 1 M HCl in the presence of 3,6-bis(3-pyridyl)pyridazine (3-PYP).

Keywords: *Pyridazine; Carbon steel; Acid solution; EIS; XPS; Acid inhibition*

Geopolymer Membranes: A good perspective for wastewater treatment

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Abstract

Organic dyes are widespread water pollutants that pose environmental risks. Developing efficient and sustainable methods for their removal is therefore essential. In this study, geopolymer membranes were synthesized from a kaolinite-rich clay widely accessible in Morocco using an alkaline activation solution [1, 2, 3].
The objective of this work is to evaluate the application of these membranes for the removal by adsorption/filtration of the methylene blue, an organic dye, from aqueous solutions [4]. The initial tests carried out on the elaborate membranes show encouraging results; they allow the decolorization of the initial methylene blue solution. To understand the process of filtration or absorption, the membranes before and after the test will be characterized to determine their physicochemical properties, namely: chemical elemental analysis, morphology, porosity, pore size, specific surface area, compressive strength, and water permeability.

Keywords: Geopolymer membranes, kaolinite-rich clay, Methylene blue dye, Adsorption, Filtration.

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Simulation, techno-economic and life cycle impact assessment of ABS metallization using conductive polymers

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Abstract

An innovative metallization process of acrylonitrile–butadiene–styrene (ABS) using a conductive polypyrrole (PPy) interlayer is investigated as a sustainable alternative to conventional industrial metallization. The process, including surface preparation, chemical treatment, pyrrole polymerization, washing, drying, and copper electrodeposition, was modelled using Aspen Plus to perform mass and energy balances and to size equipment at a semi-pilot scale.

A techno-economic analysis was carried out to estimate capital (CAPEX) and operating (OPEX) costs, showing that the process is economically coherent at pilot scale, with raw materials being the main contributor to operating costs. In parallel, a comparative Life Cycle Assessment (LCA) was conducted using openLCA to evaluate the environmental performance of the proposed process against a conventional metallization route.

The LCA results indicate a clear reduction in environmental impacts, particularly in human toxicity and related impact categories, mainly due to reduced use of hazardous chemicals, lower processing temperatures, and optimized material consumption enabled by the conductive polymer interlayer. Overall, this study demonstrates that the PPy-based metallization process is technically feasible, economically viable at pilot scale, and environmentally advantageous, highlighting its strong potential for sustainable industrial implementation.

Keywords : ABS metallization; Polypyrrole; Process simulation; Techno-economic analysis; Life Cycle Assessment; Sustainable manufacturing.

Acknowledgments

We would like to thank the Moroccan Ministry of Higher Education, Scientific Research and Innovation, the OCP Foundation, the UM6P, and the CNRST who funded this work through the APRD research program

Heterojunction-based oxide photocatalysts for visible-light-driven degradation of organic dyes in water

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Abstract

Heterojunction-based oxide photocatalysts were designed and evaluated for use in the visible-light-driven degradation of organic dyes in water. A vanadium oxide component was synthesized using a co-precipitation method and then combined with a bismuth-based oxide via a solid–solid mixing process to create an efficient Z-scheme heterojunction. X-ray diffraction (XRD) analysis confirmed the formation of the composite materials, and scanning electron microscopy (SEM) revealed their morphological features. Diffuse reflectance spectroscopy (DRS) revealed band gap energies of 2.26 eV and 2.9 eV for pure vanadium oxide and bismuth-based oxide, respectively. Photocatalytic experiments showed that the intermediate biphasic system exhibited the greatest activity in terms of organic dye degradation when using Rhodamine B as a model pollutant. The reaction followed pseudo-first-order kinetics, with an apparent rate constant (Kapp) of approximately 0.016 min^{-1}, achieving up to 98% degradation within 60 min under visible-light irradiation. Trapping experiments indicated that photogenerated holes (h^+) and superoxide radicals ($O_2^{\cdot -}$) played a dominant role in the degradation process, supporting a Z-scheme charge transfer mechanism. The photocatalyst also demonstrated good stability and reusability over multiple cycles, highlighting its potential for visible-light-driven water purification applications.

Keywords:
Photocatalysis; RhB photodegradation; visible-light irradiation

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Geopolymer Membranes : A Sustainable Alternative for Seawater Desalination

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Abstract

Seawater desalination represents a critical approach to mitigating global freshwater scarcity; however, conventional polymeric and ceramic membranes commonly employed in desalination technologies are often limited by high production costs, membrane fouling, limited chemical stability, and environmental concerns [1]. In recent years, geopolymer membranes have emerged as a potential alternative owing to their inorganic aluminosilicate framework, which provides high thermal and chemical stability, adequate mechanical strength, and controllable porosity [2]. These membranes are typically synthesized via alkali activation of low-cost and environmentally friendly precursors such as metakaolin, contributing to improved sustainability. Furthermore, geopolymer membranes exhibit enhanced resistance to aggressive saline environments and operational stability under harsh conditions, making them suitable candidates for membrane-based desalination processes, particularly membrane distillation and filtration applications. Consequently, geopolymer membranes demonstrate significant potential as sustainable and efficient materials for seawater desalination.

Keywords: Geopolymer membranes, Seawater desalination, Aluminosilicate materials, Filtration.

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Photo assisted Heterogeneous Electro-Fenton for Imidacloprid Mineralization from Wastewater using Z-scheme $MnFe_2O_4/g\text{-}C_3N_4$ Nanocomposite: RSM-CCD optimization, DFT calculation, Mechanism pathway and Toxicity analysis

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Abstract

$MnFe_2O_4/g\text{-}C_3N_4$ composites were developed as efficient catalysts for the photo-assisted heterogeneous electro-Fenton (HPEF) process aimed at the mineralization of imidacloprid (IMD) from wastewater. The structural, morphological, and surface properties of the prepared catalysts were thoroughly investigated using XRD, FTIR, Raman spectroscopy, N_2 adsorption–desorption, SEM-EDS, TEM, and XPS, confirming the successful incorporation of $MnFe_2O_4$ into the $g\text{-}C_3N_4$ matrix. The photocatalytic–electrochemical performance of $MnFe_2O_4/g\text{-}C_3N_4$ was evaluated under visible light irradiation in an electrochemical cell, demonstrating a remarkable capability for IMD degradation and mineralization with enhanced energy efficiency. The optimization of operational parameters was conducted through response surface methodology based on central composite design (RSM-CCD). Mechanistic insights were further supported by radical scavenging tests, which identified hydroxyl radicals as the dominant reactive oxygen species (ROS). Density functional theory (DFT) calculations provided theoretical confirmation of the reactive sites of the composite. The toxicity assessment of transformation products, as identified by LC-MS, revealed that the HPEF process effectively reduced the toxicity profile of IMD and its intermediates. Finally, the catalyst exhibited high recyclability and structural stability over multiple cycles, as verified by after use characterizations. This study highlights the potential of $MnFe_2O_4/g\text{-}C_3N_4$ as a promising catalyst for sustainable wastewater treatment through an advanced photo-assisted electro-Fenton approach.

Keywords: Imidacloprid, Heterogeneous photo-electro-Fenton, $MnFe_2O_4/g\text{-}C_3N_4$, Pesticide degradation, Wastewater treatment.

Photocatalytic Degradation of Organic Dyes Using Bismuth Rare-earth Titanate Nanocomposites: Comparing Synthesis Methods

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Abstract

Wastewater from textile and dyeing industries contains toxic organic dyes that threaten aquatic life and human health. Among the various remediation approaches, photocatalysis has emerged as a promising technique where materials absorb light energy to generate reactive species capable of breaking down these pollutants.

In this work, we synthesized Bismuth Rare-earth Titanate (BRT) nanocomposites using two different methods: solid-state reaction and coprecipitation. Our goal was to compare how these synthesis routes affect the material's structure, morphology, and ultimately its ability to degrade organic dyes. We characterized the prepared samples using XRD, SEM, and FTIR, then tested their photocatalytic activity by monitoring dye degradation under UV-visible light.

The comparison revealed significant differences in the properties and performance of BRT materials depending on the synthesis method used. By understanding these differences, we aim to optimize the preparation parameters to produce nanoparticles better suited for practical wastewater treatment applications. This research contributes to developing effective and sustainable solutions for removing toxic pollutants from industrial effluents, addressing a critical environmental challenge.

Keywords: Bismuth Rare-earth Titanate (BRT), coprecipitation method, photocatalysis, structure, morphology, photocatalytic activity.

Experimental and Computational Studies on the Inhibition Performances of 5-nitrobenzimidazole-2-thione for the Corrosion of Mild Steel in Hydrochloric Acid

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Abstract

Organic inhibitors are widely used to protect metal surfaces against corrosion. In this work, the corrosion inhibition performance and adsorption behavior of a newly synthesized benzimidazole-derived compound 5-nitrobenzimidazole-2-thione (5-NBT) for C48 carbon steel in 1.0 mol.L^{-1} HCl solution at 298 K have been investigated by using weight loss measurements, potentiodynamic polarization (PDP), electrochemical impedance spectroscopy (EIS) and surface analysis methods combined with density functional theory (DFT) calculation as well as molecular dynamics (MD). The inhibition efficiencie is found to be quite high, up to 88.46% at the best concentration of 10^{-3} mol.L^{-1}. EIS results demonstrated that the polarization resistance was saliharply enhanced and double-layer capacitance was decreased, indicating that inhibitor molecule was adsorbed effectively onto the steel surface. The results of PDP analysis revealed that works as the mixed-type inhibitor, retarded anodic and cathodic reactions .Adsorption studies revealed that the inhibitor obey the Langmuir isotherm indicating monolayer adsorption. DFT calculations revealed electronic descriptors that correlate well with the experimental results and MD simulations showed parallel adsorption on an iron surface by the inhibitors.

Keywords**:** Corrosion inhibitor, Benzimidazole, Carbon steel, DFT, Molecular Dynamics, Electrochemical Techniques.

Electrochemical detection of Aflatoxin B1 in foods: biological and synthetic recognition strategies

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Abstract

Aflatoxin B1 is a highly toxic mycotoxin frequently contaminating foods such as cereals, nuts and oils [1]. Its detection at trace levels is crucial for food safety and public health. Conventional detection methods include HPLC and ELISA, provide high sensitivity and reliability, but are often time consuming, expensive and require skilled personnel. Electrochemical sensors, on the other hand, have gained traction due to their simplicity, cost effectiveness and rapid response time.

Electrochemical detection of AFB1 relies on recognition elements capable of selectively binding the target toxin. Biological recognition systems, including antibodies, enzymes, and aptamers, have demonstrated excellent selectivity and sensitivity and remain widely used in biosensor development [2],[3]. But these systems often suffer from limited stability, complex storage requirements, variability, and high production costs, which may restrict their applicability in long term monitoring and on field analysis.

Non-biological electrochemical sensors employing synthetic recognition materials have gained increasing attention as a result. These systems utilize engineered surfaces and artificial binding sites designed to selectively capture AFB1 while improving shelf life. They involve synthetic materials such as molecularly imprinted polymers and nanomaterials [4].

Signal transduction in both biological and non-biological electrochemical sensors typically relies on voltammetric or impedimetric techniques, where AFB1 recognition induces measurable changes in current or interfacial resistance.

This work provides a comparative overview of biological and non-biological electrochemical strategies for AFB1 detection, their respective strengths, limitations, and potential applications in food safety monitoring. Emphasis is placed on emerging synthetic recognition approaches and nanomaterial-enhanced sensing platforms as promising directions for developing robust, scalable, and field-deployable detection technologies.

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Investigating halide double perovskites for solar cell applications: first-principles and SCAPS-1D simulation study.

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Abstract

This study investigates the potential of halide double perovskites for solar energy applications, focusing on their structural, electronic, and optical properties. Halide perovskites are known for their remarkable optoelectronic characteristics, making them promising candidates for energy conversion and storage technologies. Computational methods, including the Perdew–Burke–Ernzerhof generalized gradient approximation (PBEsol) and the modified Becke–Johnson (mBJ) approximation, were employed to examine the material's properties. Our results show a high absorption coefficient in both the visible and ultraviolet (UV) range, indicating excellent light absorption. The material also demonstrates direct semiconducting behavior, with a band gap of 1.56 eV (mBJ) and 0.641 eV (PBEsol), ideal for efficient solar conversion. SCAPS-1D simulations predict a power conversion efficiency (PCE) of 28%, suggesting the material's suitability as an effective absorber in perovskite solar cells. The study also discusses the material's stability and potential for large-scale fabrication, highlighting the need for experimental validation to assess performance under real-world conditions. Optimizing stability, exploring material compatibility, and long-term testing will be essential for future practical applications.

Keywords: Double perovskite; Solar cell; DFT; Wien2k; Optoelectronic; SCAPS-1D; Power conversion efficiency (PCE).

Étude des propriétés adsorbantes des matériaux bio-composites : application à l'adsorption des colorants organiques

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Résumé : Les colorants organiques présents dans les milieux aqueux constituent un problème environnemental majeur. Dans le cadre de cette étude, nous nous sommes intéressés à l'élimination du colorant bleu de méthylène en milieu aqueux à l'aide de matériaux à base d'alginate et de nanofils de dioxyde de titane dopés au zirconium (Zr). Une série d'expériences a été menée afin d'étudier l'influence de différentes conditions opératoires sur la capacité d'adsorption du bleu de méthylène.

Les résultats obtenus montrent que le colorant cationique bleu de méthylène s'adsorbe efficacement sur les supports étudiés. L'étude de l'effet du pH indique que l'adsorption du bleu de méthylène est favorisée en milieu acide.

La mise en évidence des interactions possibles entre le colorant et les adsorbants a été réalisée à l'aide de différentes techniques de caractérisation, notamment le MEB**,** l'EDX**, l'**IRTF**, la** DRX et la spectroscopie UV-visible.

L'étude cinétique révèle que le processus d'adsorption des systèmes adsorbant/adsorbat est bien décrit par un modèle cinétique de pseudo-second ordre.

Mots-clés : Biopolymères, Nanofils, Bio-composite, Billes, Adsorption, Bleu de méthylène

Figure 1. Billes de matériaux adsorbants élaborées avant l'adsorption du bleu de méthylène

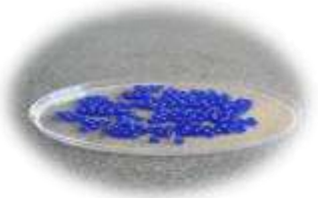

Figure 2. Billes des matériaux adsorbants élaborées après l'adsorption de bleu de méthylène.

Optimization of precipitation conditions for enhanced textural properties and surface reactivity of SDS-assisted mesoporous γ-alumina

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Abstract

The synthesis of mesoporous γ-alumina using soft template is widely utilized in adsorption of pollutants and greenhouse gas due to its advantageous textural properties and chemical stability **[1]**. However, the simultaneous influence of synthesis parameters, particularly surfactant concentration and pH, on its surface free energy remains underexplored **[2]**. This study presents the controlled synthesis of mesoporous γ-alumina via an anionic sodium dodecyl sulfate (SDS)-assisted precipitation method using aluminum nitrate as precursor. The effects of pH, SDS concentration, calcination temperature, and SDS addition sequence on the physicochemical properties and surface reactivity of γ-Al_2O_3 were systematically investigated. Characterization techniques including XRD, FTIR, nitrogen adsorption–desorption (BET), TGA, and contact angle measurements revealed strong dependencies of surface chemistry and mesostructure on synthesis conditions. The optimal sample synthesized at pH 10 with 0.025 M SDS and calcined at 500 °C, with SDS added before-precipitation, exhibited a highly ordered mesoporous framework, a specific surface area of ~183 m^2/g, and an average pore size of ~7 nm. Notably, surface polarity increased markedly from ~12% for pristine γ-alumina to ~54% under optimal conditions, indicating enhanced hydrophilicity attributed to effective micelle templating. Overall, this study provides a simple, economical, and environmentally friendly route for tailoring mesoporous γ-alumina with controlled polarity and improved textural properties. The findings highlight the strong interplay between synthesis conditions and surface reactivity, offering a robust strategy for designing γ-alumina materials with enhanced performance in adsorption and catalytic applications.

Keywords: Mesoporous γ-Alumina, Precipitation, SDS concentration, pH effect, Surface free energy, Textural properties.

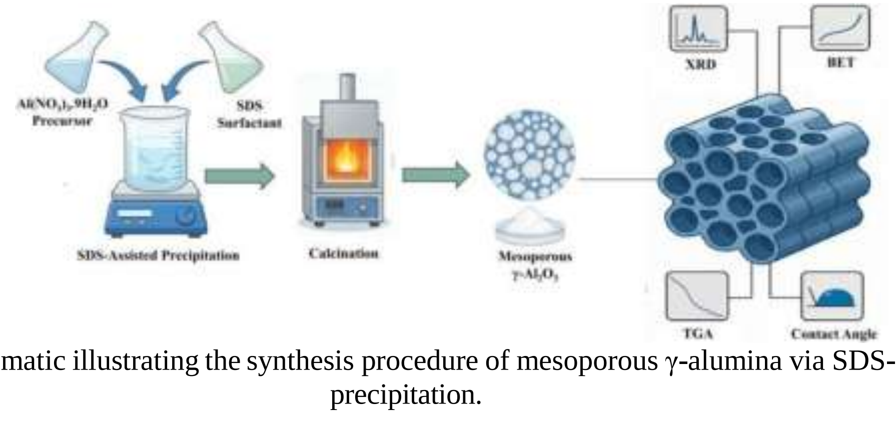

Figure 1. Schematic illustrating the synthesis procedure of mesoporous γ-alumina via SDS-assisted precipitation.

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Electro-assisted heterogeneous activation of peroxydisulfate by N-doped biochar for the combined adsorption and degradation of organic contaminants

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Abstract

N-doped biochar (NBC) has emerged as a promising catalyst for peroxydisulfate (PDS) activation owing to its surface functionalities and porous architecture. However, its practical application remains constrained by difficulties in controlling reaction kinetics and catalyst deactivation caused by natural organic matter (NOM) and competing anions. In this study, a hybrid system coupling electrolysis (E) with NBC was developed to activate PDS in batch mode for the removal of venlafaxine (VFX), used as a model contaminant. The proposed E–NBC/PDS process promotes degradation through three synergistic mechanisms: (i) dual activation of PDS by NBC and electrochemical reactions, (ii) adsorption of pollutants onto NBC, and (iii) generation of multiple reactive species. The system achieved 99.9 % VFX removal, significantly outperforming individual processes such as PDS alone (4.1 %), NBC adsorption (40 %), or electrolysis (38.8 %). Using boron-doped diamond (BDD) and carbon felt (CF) electrodes with NaCl electrolyte further enhanced VFX degradation kinetics compared to alternative electrodes and electrolytes. Mechanistic insights from radical scavenging tests and X-ray photoelectron spectroscopy confirmed the involvement of both non-radical pathways (electron transfer, $^1O_2$) and radical species ($O_2^{\bullet -}$, •OH). Overall, the E–NBC/PDS system activates PDS via electrochemical, surface functional group, and alkaline pathways, demonstrating high efficiency for VFX elimination and offering a promising strategy for groundwater remediation.

Keywords: Sewage sludge digestate, N-doped biochar, Peroxydisulfate, Electro-activation, Mechanism, Water treatment

Synergistic adsorption-photocatalysis using $Bi_{24}O_{31}Cl_{10}$/bentonite composites for visible-light wastewater treatment

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Abstract

A hybrid strategy combining adsorption and visible-light photocatalysis was investigated for the removal of persistent organic pollutants (POPs) from wastewater. The system relies on a Sillén-type bismuth oxychloride photocatalyst, $Bi_{24}O_{31}Cl_{10}$, coupled with a purified natural bentonite support. Prior to composite fabrication, $Bi_{24}O_{31}Cl_{10}$ was optimized through a comparative evaluation of different synthesis routes. The best-performing phase was identified by linking crystallinity, morphology, surface features, and optical response to photocatalytic activity. The selected (optimized) Bi24O31Cl10 exhibited effective removal of representative pollutants (model dyes and selected antibiotics) under visible light. To improve pollutant preconcentration, recovery, and reuse, $Bi_{24}O_{31}Cl_{10}$/bentonite composites were prepared with various mass fractions and evaluated under visible light using Rhodamine B as a model compound. The composite containing 75 wt% $Bi_{24}O_{31}Cl_{10}$ delivered the best performance and maintained good stability upon reuse. Mechanistic insights from scavenger tests indicate that holes (h^+) and hydroxyl radicals (•OH) dominate the degradation pathway, while superoxide radicals ($\bullet O_2^-$) contribute to a lesser extent. Overall, combining an efficient visible-light photocatalyst with an abundant natural support provides a promising route toward stable and reusable materials for wastewater depollution.

Keywords : Persistent organic pollutants, Heterogeneous photocatalysis, Adsorption, Bismuth oxychlorides, Bentonite, Composite materials.

Nitrogen-doped carbon supported on quartz sand for peroxymonosulfate activation: Generation of reactive radicals for Orange G degradation

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Abstract

A nitrogen-doped carbon composite (NC@QS) was synthesized by coating quartz sand with a conducting polymer followed by pyrolysis at 600 °C, and subsequently evaluated as an efficient activator of peroxymonosulfate (PMS) for the degradation of Orange G (OG). The physicochemical properties of the catalyst were examined using XRD, FTIR, SEM, and EDX analyses, confirming the successful formation of a carbon-rich, heteroatom-doped structure. The NC@QS/PMS system exhibited outstanding catalytic activity, achieving 98.69% OG degradation and 84% COD removal within 60 min. Reactive species quenching experiments demonstrated that $SO_4^{\bullet-}$, $^{\bullet}OH$, and $O_2^{\bullet-}$ contribute to the oxidation process, while singlet oxygen ($^1O_2$) was identified as the dominant reactive species responsible for dye mineralization. A mechanistic pathway involving electron-transfer-driven PMS activation and the generation of both radical and non-radical oxidants was proposed. The catalyst also showed good reusability, maintaining 88.11% degradation efficiency after four cycles; after thermal regeneration at 600 °C, its activity was restored to 94.91%. These results highlight the potential of NC@QS as a stable, low-cost, and highly effective PMS activator for the degradation of recalcitrant azo dyes.

Phosphate-Based Sustainable Materials for Environmental Remediation: From Design to Application

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Abstract

Water stands as the most crucial and indispensable element on our planet, playing a vital role in sustaining the essential activities of all living beings. However, the continuous degradation of water quality in our water resources is attributed to the rapid expansion of the population, industrialization, urban development, domestic and agricultural practices, and various geological and environmental shifts. Many contaminants such as toxic heavy metal ions, pharmaceuticals, dyes, phenols, pesticides, detergents, and other persistent organic pollutants have been widely reported in water bodies around the world. Several methods have been developed so far for water treatment, such as electrochemical treatment, filtration, crystallization, flotation, ion exchange, adsorption, and distillation. Nevertheless, many of these techniques come with limitations, including high cost, poor efficiency, incomplete pollutant removal, and high energy usage. Among the cited strategies, adsorption is considered the most favorable method owing to its ease of operation, low cost, and high selectivity.

Most of carbohydrate biopolymers possess an eco-friendly and renewable nature, leading to their remarkable effectiveness in adsorbing pollutants from wastewater, as demonstrated in various studies [1]. Their biodegradable characteristics allow microorganisms in the environment to easily break them down, rendering them environmentally friendly and contributing to the reduction of waste accumulation. In this work different materials and composites were investigated as an adsorbent for removing organic dyes and antibiotic molecules from aqueous solutions. It also delved into the impact of different experimental conditions such as contact time, concentration of pollutant, temperature and pH levels, on the removal of MB by the developed PMCC polymer.

Keywords: Wastewater, Biopolymer, Organic pollutant, Biocomposite, Water Remediation.

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In situ preparation of 3D flower like BiOBr/$Bi_{24}O_{31}Br_{10}$ composite by annealing hydrothermal method for the Ciprofloxacin degradation under simulated sunlight irradiation

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Abstract

In the general framework of photodegradation of pollutants in aqueous environments, a BiOBr (denoted as BOB) precursor was first obtained by hydrothermal synthesis, and then, thermally treated at 400, 450, 500, 550 and 600 °C. The decomposition of the BiOBr phase consisted in the progressive formation of $Bi_{24}O_{31}Br_{10}$ (Bi_{24}) phase leading to a BiOBr/$Bi_{24}O_{31}Br_{10}$ composite system. The phase transformation was analyzed using TDA-TGA, X-ray diffraction (XRD), Raman spectroscopy, scanning electron microscopy (SEM) coupled with energy dispersive X-Ray analysis (SEM-EDX). The optical properties were investigated with UV-visible diffuse reflection spectroscopy (DRS). The band and electronic structures of the single phases BiOBr and $Bi_{24}O_{31}Br_{10}$ were determined from calculations using Density Functional theory (DFT). These BiOBr/$Bi_{24}O_{31}Br_{10}$ composite systems were used to photodegrade the antibiotic ciprofloxacin (CIP) under simulated-sunlight irradiation. The optimal photocatalytic efficiency was obtained from the BOB-450 mix system obtained at 450 °C, characterized by approximately 22 mol % of Bi_{24} phase. The variable photocatalytic performance was ascribed to the flower-like porous morphologies and the probable existence of homo and heterojunctions in this system. The main parameters influencing the photocatalytic activity of BiOBr/$Bi_{24}O_{31}Br_{10}$ composites such as pH, CIP content, photocatalyst amount and irradiation type were analyzed. The photocatalytic mechanism and the factors driving the enhanced performance of BOB-450 system was proposed.

Keywords: Hydrothermal synthesis; BiOBr/$Bi_{24}O_{31}Br_{10}$ composite; DFT calculations; photocatalysis; ciprofloxacin photodegradation

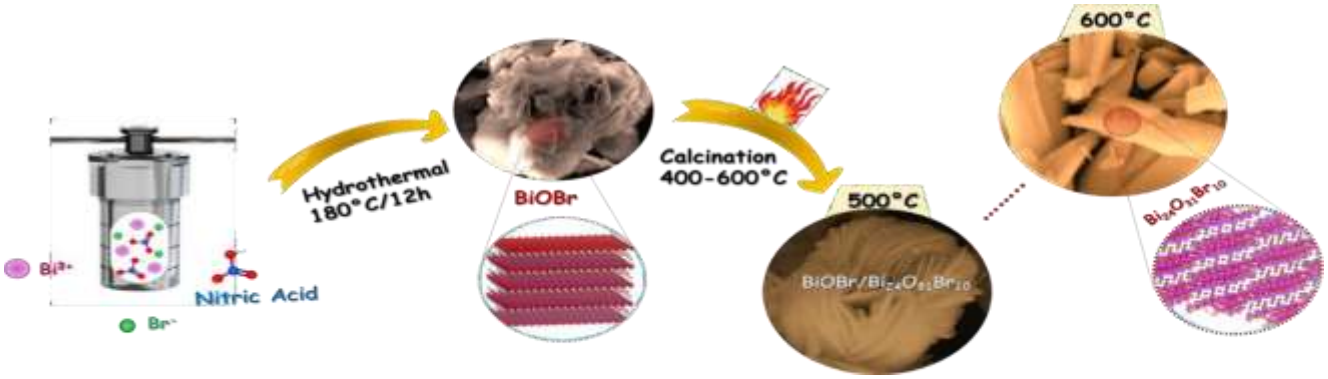

Fig. 1: synthesis process of the BiOBr based samples.

Biological and Synthetic Recognition Strategies for Electrochemical Detection of Aflatoxin B1 in Foods

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Abstract

Aflatoxin B1 (AFB1), one of the most toxic mycotoxins, poses a serious threat to food safety through its widespread contamination of cereals, nuts, and edible oils [1]. Reliable detection at trace levels is therefore essential for consumer protection and public health.

While conventional analytical methods such as HPLC and ELISA offer high sensitivity, their cost, complexity, and time requirements limit their use in routine or field-based monitoring. Electrochemical sensors present a compelling alternative, combining rapid response, low cost, and operational simplicity.

Two major recognition strategies have been explored for AFB1 electrochemical detection. Biological systems, including antibodies, aptamers, and enzymes, offer outstanding selectivity [2],[3], but are hampered by stability concerns, demanding storage conditions, and elevated production costs. Synthetic recognition materials, particularly molecularly imprinted polymers (MIPs) and engineered nanomaterials, address these limitations by providing robust, stable, and cost-effective artificial binding sites tailored for AFB1 capture [4].

Signal transduction in both approaches relies on voltammetric or impedimetric techniques, translating AFB1 binding events into measurable electrochemical signals.

This work presents a comparative assessment of biological and synthetic electrochemical sensing strategies, highlighting their performance, limitations, and prospects for real-world food safety applications, with particular focus on nanomaterial-enhanced platforms as scalable, field-deployable solutions.

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Design of a Magnetic Polypyrrole-Graphene Oxide composite for Enhanced Adsorptive Removal of Rhodamine B from Water.

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Abstract

Synthetic dye water pollution is a significant environmental issue that needs an efficient and recyclable adsorbent. In this work, the formation of a magnetic polypyrrole/graphene oxide nanocomposite (FPGO) was performed using a hydrothermal method and was analyzed by XRD, SEM, FTIR, and UV-Vis spectroscopy, which proved the effective formation of a nanoparticle and its functional incorporation. Rhodamine B (RhB) was used as a model pollutant to measure the adsorption performance. Nanocomposite had a high removal efficiency of 96% at a pH neutral. Kinetic data were pseudo-second-order, showing chemisorption, and equilibrium data were well-fitted with the Langmuir isotherm. Thermodynamic results revealed an exothermic and spontaneous adsorption process. These results show how FPGO can be effectively used in the treatment of wastewater using dye removal.

Keywords: Adsorption - Dye - Graphene oxide - Magnetic Polymer - Wastewater

Digestate derived carbon from tea residues as a promising material for aqueous dye removal

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Abstract

The management of digestate generated during anaerobic digestion remains a major challenge despite the environmental and energetic benefits of this biological process. In this work, tea waste digestate was explored as a precursor for the production of value-added carbon materials intended for water treatment applications. A carbonaceous adsorbent was first obtained by pyrolysis of tea waste digestate at 600 °C, then chemically modified using nitric acid to improve its surface reactivity and adsorption-related properties. The acid treatment was expected to promote the development of oxygenated surface functionalities and enhance the affinity of the material toward organic pollutants. The resulting activated carbon was investigated for the removal of methylene blue from aqueous solution as a model dye pollutant. This study highlights an integrated strategy that connects anaerobic digestion residue management with wastewater remediation, offering a sustainable route for converting an abundant by-product into a functional adsorbent. Such an approach supports resource recovery, waste minimization, and the implementation of circular economy principles in environmental applications.

Keywords: Tea waste digestate, Activated carbon, Waste valorization, Adsorption, MB removal.

Inhibition of corrosion of stainless steel by thym and artemisia extracted oils in 1M hydrochloric acid medium

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Abstract

Corrosion, a gradual degradation of metals and alloys, occurs as a result of chemical or electrochemical reactions with their environment. To prevent it, they can be protected in several ways. A protective coating such as paint, plastic, or zinc can be applied to their surface. Electrochemical methods can also be used by reducing the potential difference using an electric current. Finally, another approach is to introduce corrosion inhibitors into the environment chemicals that slow down the degradation process.

This study examines the effectiveness of two natural essential oils-thyme essential oils (TEO) and Artemisia herba essential oils (AEO) in protecting C38 mild steel from corrosion in an acidic environment. This will be achieved by employing advanced electrochemical methods, including potentiostatic and potentiodynamic polarization and electrochemical impedance spectroscopy. The results of this research will help us determine whether these essential oils can act as environmentally friendly corrosion inhibitors for metallic materials in aqueous environments. We observed that the effectiveness of these oils increased with their concentration, reaching a peak of 76% for thyme oil and 91% for Artemisia oil. These observations indicate that both oils act as mixed inhibitors, although their action is primarily directed toward the anode. The tests also showed that the higher the concentrations of thyme and Artemisia, the greater the charge transfer resistance and the lower the double-layer capacitance values. In summary, this research provides crucial data on the potential use of thyme and Artemisia essential oils as environmentally friendly corrosion inhibitors for C38 mild steel in aqueous environments.These results confirm that the inhibitors adsorb onto the metal's surface. The consistent findings across all three techniques electrochemical impedance spectroscopy, potentiodynamic and potentiostatic polarization support this conclusion. The adsorption mechanism was also found to follow the Langmuir isotherm.

Keywords: Corrosion inhibition, essential oils, adsorption, PDP, EIS

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Limitations and operational drawbacks of fine-bubble aeration systems in biological reactors treating dairy wastewater

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ABSTRACT

Fine-bubble aeration systems are widely used in biological reactors for dairy wastewater treatment because of their high theoretical oxygen transfer efficiency. However, their performance at full scale is often affected by high organic loads, fats, and suspended solids. This study examines the main limitations of fine-bubble aeration in treating high-strength dairy wastewater (COD > 6000 mg/L) using combined experimental and modeling approaches. Results from 25 sampling campaigns show that carbon removal remains relatively high (COD removal: 76.6 ± 2.5%), whereas nitrification is highly unstable (NH_4^+ removal: 15.2 ± 20.1%), indicating significant oxygen transfer limitations.

The findings demonstrate that diffuser fouling and hydrodynamic inefficiencies lead to the formation of oxygen-deficient zones, promoting unstable nitrification pathways. Aeration energy consumption was estimated at 1.3 kWh per kg COD removed, significantly higher than values reported for optimized systems. This work suggests that fine-bubble aeration may become a limiting factor in modern dairy wastewater treatment plants and supports the re-evaluation of aeration design strategies.

Keywords: Fine-bubble aeration; Dairy wastewater treatment; Oxygen transfer efficiency; Aeration energy consumption; Diffuser fouling.

PRESENTATIONS ORALES

Thème 3 : Technologies pour l'environnement et la Transition énergétique

Impact of environmental conditions on the corrosion behavior of metals in photovoltaic systems: contribution to the sustainability of solar energy

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The energy transition towards sustainable development relies on the reliability and sustainability of photovoltaic (PV) systems. However, the corrosion of metal components, accelerated by climatic and environmental conditions, compromises their long-term performance. This study aims to evaluate the mechanisms of electrochemical corrosion affecting aluminum frame (Al6063 alloy) and tin-coated copper interconnect tapes (C932), characterized by XRF spectroscopy.

The tests were carried out using a potentiostat-galvanostat OrigaStat (OGS200) in an electrochemical cell with three electrodes. The samples were immersed in media simulating aggressive environments: NaCl saline 3.5% and acetic acid CH3COOH at 10% and 30%. Measurements of free potential and potentiodynamic polarization made it possible to determine the electrochemical parameters (Ecorr, Icorr, Rp).

The results show a pronounced corrosive activity in the chlorinated medium, with Ecorr(Al6063) = –593 mV/Ag/AgCl and Ecorr(C932) = –578 mV/Ag/AgCl, indicating localized (pitting) corrosion. In contrast, a tendency toward passivation is observed in acidic media (Ecorr(Al6063) = –462 mV/Ag/AgCl, Ecorr(C932) = –450 mV/Ag/AgCl). These results confirm the impact of extreme climatic conditions on material degradation.

Analysis of corrosion potentials shows that Ecorr values shift toward more negative values when moving from the 30% acidic medium to the 10% acidic medium, and then to the saline medium (NaCl 3.5%). This decrease in corrosion potential suggests a likely increase in the corrosion rate, attributed to the presence of chloride ions (Cl^-), which are responsible for pitting corrosion of aluminum and its alloys.

The swept potential range does not reveal any passivation phenomenon for the materials studied in these corrosive media.

In the continuation of this work, we will focus on protecting these materials, conducting a detailed study of degradation mechanisms, and developing strategies to improve their service life, in order to enhance the durability and reliability of photovoltaic structures exposed to aggressive environments.

Keywords: Corrosion; Electrochemistry; Solar panels; Metallic materials; Durability; Climate; Environment; Renewable energy; Environmental health.

Electrochemical Study of Iron Phosphate–Based Cathode Materials in Aqueous Electrolytes

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Abstract

The growing demand for energy due to population growth has led to an energy crisis. To address this situation, research is underway to explore materials capable of safely storing energy. Studies mainly focus on the electrochemical performance of these materials in an aqueous environment, due to their potential advantages such as high ionic conductivity, increased safety, and potentially lower costs. However, it is important to note that batteries using aqueous media may have a lower voltage limit and lower energy density than batteries using organic media.

The chosen material, based on iron and phosphate, possesses several remarkable properties. Its olivine-type crystalline structure provides it with chemical stability. Furthermore, its high density allows it to store more energy per unit volume. It is also low in solubility, ensuring its stability and durability as an electrode. In terms of electrochemical performance, it is commonly used as a positive electrode material in lithium-ion and sodium-ion batteries due to its high operating voltage, cyclic stability, and low toxicity. Iron phosphate-based materials are particularly promising due to their low cost, non-toxicity, and the abundance of their components (iron and phosphate) in nature. However, these materials exhibit limited ionic conductivity, which can be a disadvantage. Doping techniques or structural modification can be employed to improve this conductivity. Additionally, the material has a high diffusion coefficient, facilitating the rapid transport of sodium ions, and a remarkable specific capacity, thereby increasing the amount of stored energy.

Keywords: batteries, energy storage, lithium-ion, performance, sodium-ion.

Enhancing the surface properties of steel alloy using a thiosemicarbazone-based inhibitor as an eco-friendly functional material with excellent electrochemical stability

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ABSTRACT

The corrosion inhibition performance of 2-(4-methoxybenzylidene)-N-methylhydrazine-1-carbothioamide (MBHM) for carbon steel (CS) in a 1.0 M HCl solution was investigated using electrochemical techniques. EIS and PDP measurements were employed to assess the corrosion behavior and inhibition efficiency of the studied inhibitor. The results showed that the η_{EIS} increased with increasing inhibitor concentration, reaching a maximum value of 91.58 % at 5 $\times 10^{-3}$ M. PDP results indicated a marked reduction in corrosion current density from 1012.84 $\mu A.cm^{-2}$ in the uninhibited solution to 99.52 $\mu A.cm^{-2}$ in the presence of the inhibitor, suggesting effective corrosion protection. The adsorption behavior follows the Langmuir isotherm, indicating strong inhibitor-metal interactions. The inhibition mechanism arises from the adsorption of organic molecules via heteroatoms and π-electron systems, enabling donor-acceptor interactions with iron atoms, as confirmed by DFT and DFTB studies. Furthermore, after 72 h of immersion, MBHM maintained a high inhibition efficiency 84.15% and R_p 230.40 $\Omega.cm^2$, confirming the long-term stability of the protective film. The present investigation demonstrates that MBHM exhibits excellent corrosion inhibition performance for CS in acidic media. Its adsorption behavior, supported by both experimental and theoretical analyses, confirms its effectiveness and highlights its potential as a sustainable inhibitor for industrial applications.

Corrosion Inhibition of Carbon Steel in Hydrochloric Acid by 3,6-bis(3-pyridyl)pyridazine: Electrochemical, XPS, and Theoretical Study

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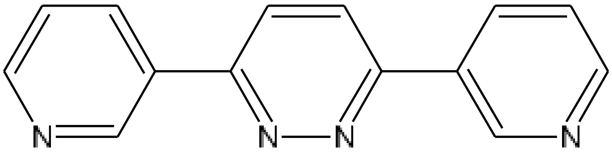
Abstract

Corrosion inhibition of carbon steel in normal hydrochloric acid solution at 30°C by new pirydazine derivative, namely 3,6-bis(3-pyridyl) pyridazine (3-PYP) has been studied by a series of known techniques such as weight loss, polarisation and electrochemical impedance spectroscopy (EIS).



3-PYP

The experimental results have showed that this organic compound revealed a good corrosion inhibition and that the inhibition efficiency is increased with the inhibitor concentration. Potentiodynamic polarisation suggested that it is a mixed type of inhibitor. Two time constants determined by the charge-transfer and the adsorption of the inhibitor, respectively, can be readily outlined. The adsorption of 3-PYP on the carbon steel surface, in 1 M HCl solution, obeyed to the Temkin's isotherm with a very high negative value of the standard Gibbs free energy of adsorption ΔG°_{ads} (chemisorption). Quantum chemical calculations and X-ray photoelectron spectroscopy (XPS) analysis were carried out to establish the mechanism of corrosion inhibition of carbon steel in 1 M HCl medium in the presence of 3,6-bis(3-pyridyl)pyridazine (3-PYP).

Keywords: *Pyridazine; Carbon steel; Acid solution; EIS; XPS; Acid inhibition*

Investigating halide double perovskites for solar cell applications: first-principles and SCAPS-1D simulation study.

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Abstract

This study investigates the potential of halide double perovskites for solar energy applications, focusing on their structural, electronic, and optical properties. Halide perovskites are known for their remarkable optoelectronic characteristics, making them promising candidates for energy conversion and storage technologies. Computational methods, including the Perdew–Burke–Ernzerhof generalized gradient approximation (PBEsol) and the modified Becke–Johnson (mBJ) approximation, were employed to examine the material's properties. Our results show a high absorption coefficient in both the visible and ultraviolet (UV) range, indicating excellent light absorption. The material also demonstrates direct semiconducting behavior, with a band gap of 1.56 eV (mBJ) and 0.641 eV (PBEsol), ideal for efficient solar conversion. SCAPS-1D simulations predict a power conversion efficiency (PCE) of 28%, suggesting the material's suitability as an effective absorber in perovskite solar cells. The study also discusses the material's stability and potential for large-scale fabrication, highlighting the need for experimental validation to assess performance under real-world conditions. Optimizing stability, exploring material compatibility, and long-term testing will be essential for future practical applications.

Keywords: Double perovskite; Solar cell; DFT; Wien2k; Optoelectronic; SCAPS-1D; Power conversion efficiency (PCE).

PRESENTATIONS ORALES

T4. Approches transversales

Lixiviation assistée par hyperoxygénation à l’aide du réacteur Aachen : une approche environnementalement responsable pour le traitement des minerais d’or réfractaires

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Résumé

Le traitement hydrométallurgique des minerais d’or réfractaires demeure confronté à des défis persistants liés à une forte consommation énergétique, à une utilisation intensive des réactifs et à des impacts environnementaux significatifs. Les voies conventionnelles de prétraitement oxydatif, telles que le grillage, l’oxydation sous pression et la bio-oxydation, sont efficaces mais souvent coûteuses en capital et pénalisantes sur le plan environnemental. Dans ce contexte, les technologies d’hyperoxygénation à fort cisaillement apparaissent comme une alternative prometteuse à faible impact pour l’amélioration de la récupération de l’or.

Ce travail présente des résultats obtenus à l’échelle laboratoire et pilote concernant l’application du réacteur à fort cisaillement Aachen comme étape de pré-oxydation en amont d’un circuit de lixiviation sur charbon (CIL) traitant des minerais d’or doublement réfractaires. Le réacteur permet un transfert de masse de l’oxygène considérablement amélioré et génère des conditions de cisaillement intense, favorisant l’oxydation partielle des minéraux sulfurés et l’atténuation des effets de *preg-robbing*, sans recours à des oxydants chimiques. Les concentrations d’oxygène dissous ont été augmentées des niveaux conventionnels de 6–8 mg/L à plus de 30 mg/L, ce qui s’est traduit par une accélération notable des cinétiques de lixiviation.

L’intégration de la pré-oxydation par le réacteur Aachen a conduit à une amélioration de la récupération de l’Or par 11% et une réduction significative de la consommation de cyanure de sodium, atteignant jusqu’à 20 % pour les minerais sulfurés sous des conditions de broyage standard, et dépassant 40 % lorsqu’elle est combinée à un broyage fin. Ces réductions contribuent directement à l’amélioration des performances environnementales en diminuant les risques liés au cyanure et la demande globale en réactifs. Contrairement aux méthodes d’oxydation conventionnelles, le procédé ne génère ni émissions gazeuses ni effluents acides.

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AI-Driven Green Finance and Its Implications for Environmental Sustainability: A Systematic Review

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Abstract

As the challenges of climate change and environmental degradation continue growing, there is a pressing need for more sustainable financial solutions. In this context, Artificial Intelligence (AI) has emerged as a catalyst for green finance, providing better tools for risk assessment, sustainability evaluation, and smart green investment decision-making.

This study aims to provide a synthesis of the academic literature on the intersection between Artificial Intelligence and green finance, with a focus on environmental sustainability, energy transition, and climate-related financial decisions.

A Systematic Literature Review (SLR) was conducted following the PRISMA methodology. The analysis is based on a structured search of the Web of Science database using the keywords "Artificial Intelligence" and "Green Finance" for the period 2015–2026. After applying strict inclusion and exclusion criteria, a final sample of 43 articles was retained.

The results highlight three main findings. First, AI is widely used to improve environmental and climate risk assessment, particularly through predictive modeling of carbon emissions and energy efficiency. Second, AI-based tools enhance ESG measurement and sustainability evaluation, contributing to greater transparency in green finance. Third, AI supports the optimization of green financial decisions, including sustainable investment strategies and energy transition financing. Nevertheless, the review reveals persistent gaps, notably the limited attention to emerging economies and the weak integration of policy considerations.

This review offers a structured overview of the nexus between AI and green finance nexus and charts future research directions to enhance the role of intelligent financial systems in environmental sustainability.

Key words: Artificial Intelligence; Green Finance; Environmental Sustainability; Systematic Literature Review.

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Quand la technologie finance la durabilité : Revue systématique sur l'intersection entre la FinTech , finance verte et performance ESG (Environnementale, sociale , et de performance) des entreprises.

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Résumé

Cette étude examine l'apport des technologies financières (FinTech) à la performance environnementale, sociale et de gouvernance (ESG), avec un intérêt particulier pour les économies émergentes. En s'appuyant sur une revue systématique de la littérature, fondée sur 44 articles en libre accès publiés entre 2021 et 2025 et indexés dans Web of Science, l'étude analyse les mécanismes par lesquels la finance numérique et la finance verte contribuent au financement durable et à l'amélioration de la gouvernance des entreprises. Les résultats mettent en évidence que les innovations FinTech favorisent une allocation plus efficace des ressources, réduisent les asymétries d'information et soutiennent l'accès aux financements verts. Toutefois, l'impact de ces technologies sur la performance ESG apparaît hétérogène et dépend de plusieurs facteurs structurels, notamment la taille des entreprises, leur structure de propriété et leur secteur d'activité. L'étude souligne également certaines limites liées aux infrastructures numériques, aux cadres réglementaires et aux inégalités d'accès à la technologie dans les pays émergents. Enfin, des recommandations managériales et des pistes de recherche futures sont proposées afin d'approfondir l'analyse du rôle de la FinTech dans la transition vers une finance durable.

Mots clés : FinTech, Finance verte , Performance ESG, ODD

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Assessing the Impact of Drought on Territorial Dynamics in the Tensift Basin: Contribution of Remote Sensing and Artificial Intelligence

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Résumé

Le bassin de Tensift connaît depuis plus de deux décennies une aggravation des épisodes de sécheresse, liée à la variabilité climatique accrue, àla rareté de précipitations et des ressources hydriques, et aux transformations rapides des usages du sol sous l'effet de l'intensification agricole et de l'urbanisation. Notre étude vise à analyser l'évolution spatio-temporelle de la sécheresse entre 2017 et 2024 à travers l'exploitation d'indices satellitaires (NDVI, VCI, TCI, VHI) et de modèles d'intelligence artificielle. Une tendance négative du NDVI montre par Les séries temporelles satellitaires qu'est entre (−0.002 à −0.004 par an) dans le bassin, révélant une dégradation négative de la couverture végétale. Les années 2017, 2020, 2021 et 2022 se distinguent par des valeurs faibles de VCI et VHI (souvent < 0,30), impliquant un stress hydrique sévère. et l'analyse spatiale des séries montre que le Sud-Ouest du bassin (Chichaoua, Sidi Mokhtar) est le plus touché, tandis que les zones de piémont du Haut Atlas bénéficient d'une meilleure résilience grâce aux apports nivaux. Ce pondent dans Marrakech, la progression urbaine contribue à une réduction des terres agricoles et à une intensification du stress hydrique. Concernant Les modèles IA testés (Random Forest, SVM, LSTM) présentent des performances élevées avec R^2 entre 0.70 et 0.85 et MAE entre 0.04 et 0.06, confirmant leur capacité à prédire les niveaux futurs de stress hydrique. Notre étude apporte ainsi une vision intégrée de l'évolution du stress environnemental et de son impact sur la dynamique territoriale du Tensift, offrant des outils utiles pour l'aide à la décision et la planification résiliente.

Mots Clés: drought, remote sensing, NDVI, territorial dynamics, AI.

PRESENTATIONS PAR AFFICHE

Évaluation bibliographique préliminaire des impacts des microplastiques sur les poissons pélagiques de la côte marocaine.

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Résumé

Les activités anthropiques ont augmenté le niveau de pollution par les microplastiques le long du littoral marocain, créant ainsi une menace sérieuse pour les écosystèmes marins. Les poissons pélagiques, qui font partie des espèces les plus consommées au Maroc, sont très exposés à l'accumulation de particules microplastiques en raison de leurs habitudes alimentaires et de leur mode de vie en pleine mer. Cette situation pourrait avoir un impact négatif sur la sécurité alimentaire des populations marocaines.

Dans cette étude, nous nous sommes concentrés sur quatre espèces de poissons pélagiques qui ont été choisies afin d'évaluer leur niveau de contamination par les microplastiques.

Pour analyser les microplastiques, plusieurs techniques seront utilisées. La séparation par densité et la digestion chimique permettront d'extraire les particules des tissus des poissons. La stéréo-microscopie nous permettra d'observer et de compter les microplastiques, tandis que la spectroscopie FTIR sera utilisée pour identifier les types de polymères.

Les résultats attendus fourniront des informations utiles sur la quantité, la répartition et les types de microplastiques présents dans ces espèces de poissons. Cela nous aidera à mieux comprendre les risques de la pollution marine pour l'environnement et la santé humaine. L'étude souligne également la nécessité de mesures de protection plus strictes et d'une meilleure gestion des déchets le long de la côte marocaine.

Mots-clés :

Pollution par les microplastiques, littoral marocain, poissons pélagiques, sécurité alimentaire, écosystèmes marins, foie, muscle, séparation par densité, digestion chimique, stéréo-microscopie, spectroscopie FTIR, identification des polymères.

CaCO3 recovery by reacting rejected brine water (RBW) with both Ca(OH)2 and CO2 : its recycling (CaCO3) in desalination post-treatment and in water salinity reduction

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Abstract

This study adopts a two-fold approach. The first focuses on the valorization of rejected brine water (RBW) from desalination plants by producing useful chemicals, such as calcium carbonate ($CaCO_3$), while simultaneously reducing brine salinity, thus helping protect aquatic ecosystems. The second approach involves reusing and recycling the recovered chemicals, particularly calcium carbonate, for the remineralization of the reverse osmosis permeate within the desalination facility as part of post-treatment.

Preliminary results show that adding calcium hydroxide ($Ca(OH)_2$) and carbon dioxide (CO_2) to RBW leads to the precipitation of $CaCO_3$ and a decrease in water salinity. The mass of precipitated $CaCO_3$ increases with higher doses of both reactants. Furthermore, high CO_2 flow rates significantly reduce the salinity of the discharged brine. The produced $CaCO_3$ was loaded into a pilot-scale calcite bed for use in the second stage of the study. Results indicate that remineralization using the recovered $CaCO_3$ can effectively restore the calco-carbonic equilibrium of the permeate, bringing it to potable water standards. However, this process is highly dependent on several parameters, including CO_2 flow rate, permeate flow velocity, and bed thickness, which all significantly impact the overall efficiency.

Keywors : Reject brine water (RBW), Desalination, CaCO3 precipitation, Remineralization

Synthesis of zeolite from red clay mud

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Abstract

Zeolites, aluminosilicates with 3D framework, that are mostly applied as catalysts, ion exchangers, and adsorbents, are one of the crucial materials with several industrial applications ranging from water purification to gas separation and heterogeneous catalysis [1-2]. Industrial/mining wastes and natural clays provide sustainable and low-cost sources of aluminosilicates precursors for the production of synthetic zeolites [3].

Red clay mud, an unexploitable sterile layer removed during mining operations prior to reach iron-bearing ore, is rich in silica and aluminum oxides was used as the main raw material for zeolite synthesis. An alkaline activation with a specific Si/Na ratio followed by hydrothermal treatment was done. The obtained powder was characterized by different techniques. X-ray diffraction confirmed the formation of crystalline zeolite phase type P1. Morphology was observed using scanning electron microscopy that revealed the defined zeolite crystals. Textural analysis demonstrated a significant increase in specific surface area. Our study presents a significant method to transform red clay mud into framework zeolite. Further studies are planned to investigate the functionality of the synthesized zeolite.

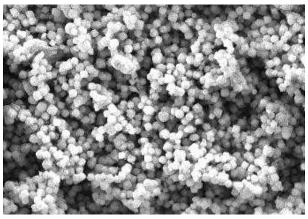

Figure 1. SEM image of synthesized zeolite.

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Bio-Based Packaging Materials: Formulation and Properties for Environmentally Friendly Applications

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Abstract

In response to the environmental challenges associated with plastic pollution and waste management, the development of bio-based packaging materials represents a strategic alternative for reducing the environmental footprint of food packaging. Derived from renewable resources such as polysaccharides (starch, cellulose, chitosan*), proteins (gelatin, plant proteins), or lipids, these biomaterials enable the design of biodegradable and/or compostable films that meet current requirements for sustainability and the preservation of aquatic ecosystems. They also offer a promising pathway for meeting the ambitious objectives of the European PPWR regulation, which by 2030 aims to drastically reduce conventional plastics and accelerate the transition toward circular, recyclable, or bio-based packaging solutions.

The formulation of such films relies on the optimization of several parameters: selection of the biopolymer, incorporation of plasticizers to adjust flexibility, and addition of natural additives capable of providing specific functionalities (antimicrobial activity, antioxidant properties, or improved barrier performance). Processing techniques such as solution casting and extrusion are implemented within low-energy approaches compatible with sustainable production.

The final properties of the films, including mechanical strength, barrier performance, morphology, and water sensitivity, depend strongly on the formulation and internal structuring of the material. While moisture sensitivity remains a major challenge for their use in food packaging, recent advances in the physico-chemical modification of bio-based matrices are opening new possibilities for increasingly high-performance solutions aligned with current regulatory and environmental expectations.

In this study, new bio-based films are currently being developed. Expected outcomes include improvements in mechanical properties, morphological organization, structural and functional stability, and the ability to extend the shelf life of fresh fruits and vegetables. These films aim to provide enhanced resistance and added functionality, enabling realistic applications within food supply chains while reducing the overall environmental impact.

This work therefore contributes to a deeper understanding of formulation mechanisms in bio-based materials and supports the development of innovative, sustainable packaging solutions compatible with European targets for reducing conventional plastics.

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Hydrological modeling of the oued amzaz watershed in morocco using gis and hec-hms

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Abstract

This study investigates hydrological flood risks in the Oued Amzaz watershed, located upstream of the Sebou basin in Morocco, a region frequently affected by intense hydrometeorological events. Due to its physiographic characteristics and rainfall variability, the watershed is highly susceptible to flooding.

The proposed methodology integrates Geographic Information Systems (GIS) and hydrological modeling using the HEC-HMS model. Hydrological and topographic data were collected, processed, and analyzed to extract the main morphometric and hydrological parameters of the basin. A representative hydrological model was developed and calibrated to simulate runoff processes.

The results allow a better understanding of the hydrological behavior of the watershed and highlight its sensitivity to extreme precipitation events. This work provides a useful decision-support tool for flood risk assessment and contributes to improving watershed management and mitigation strategies in vulnerable regions.

Keywords: Flood risk, Hydrological modeling, GIS, HEC-HMS, Watershed

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Sustainable Clay Bricks from Recycled Wood Ash and Pottery Waste: A Green Alternative for Construction

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ABSTRACT

Clay, one of the oldest construction materials known to humanity, has been used for millennia to build dwellings around the world. In recent decades, however, the expansion of urbanization and the influence of Western construction practices have led to the widespread adoption of cement-based materials, resulting in higher building costs and increased energy consumption for thermal comfort.

In light of growing environmental concerns, there is renewed interest in sustainable construction methods. In Morocco—particularly in mountainous areas like the village of Tighmi—local artisans continue to rely on traditional materials.

Additionally, more affluent individuals are increasingly embracing natural materials such as clay, earth, and wood. Recycling waste within the construction sector also offers a viable solution to environmental challenges, especially regarding waste management. For instance, wood ash is being explored for its potential reuse.

This study investigates the incorporation of wood ash and crushed pottery waste into the production of eco-friendly bricks. Laboratory tests were conducted by varying the proportions of these additives in clay mixtures to identify optimal compositions that enhance thermal and mechanical performance. The prepared samples were shaped into bricks and cylindrical specimens for testing.

The results indicate that adding 20% wood ash significantly improves thermal performance. In contrast, crushed pottery waste increases water absorption, with maximum mechanical strength achieved at a 5% substitution level. Therefore, replacing 20% of clay with wood ash or 5% with crushed pottery waste allows for the production of environmentally friendly blocks with thermal resistance comparable to that of conventional construction materials.

Key words : ***Eco-friendly construction, Clay, Waste recycling, Thermal resistance.***

Microplastic pollution in Morocco’s High Atlas: First evidence and selective impact on soil microbiome across an elevational gradient

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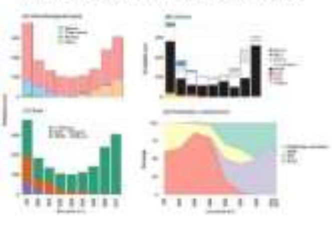
Abstract

Microplastics (MPs) are emerging contaminants in terrestrial ecosystems, yet their distribution and ecological impacts in remote mountain soils remain poorly understood. This study investigated MP contamination along an elevational gradient on Mount Toubkal (500–4167 m), the highest peak in North Africa. Soil samples were collected from nine elevations and analyzed for MP abundance, morphology, size, color, and polymer composition. MPs were quantified via density separation and stereomicroscopy, with polymer confirmation by FTIR and surface analysis using SEM-EDX. DNA was extracted from each sample and sequenced (Illumina MiSeq) targeting bacterial 16S rRNA and fungal ITS regions. MPs were found across all sites, with 1693 particles identified and an average concentration of 23.2 MP/kg of soil. Fibers dominated, especially at higher altitudes, while smaller particles (<500 µm) and lighter polymers (e.g., polystyrene, cellulose acetate) increased with elevation. Surface degradation features confirmed environmental weathering. Correlation analyses linked MPs traits to microbial composition: bacterial communities showed no significant response, but fungal richness and diversity declined with increasing abundance of fibrous MPs, PVC, and small particles. At the phylum level, fungal groups responded selectively to MPs’ traits, suggesting that MPs act as environmental filters. These findings reveal the widespread presence of MPs in alpine soils and their trait-specific impacts on fungal communities, emphasizing the need to account for MP heterogeneity in ecological risk assessments.

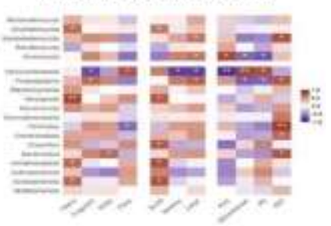
Microplastics detected from 500 to 4167 m show altitude-dependent traits and microbial associations

Microplastics (MPs) abundance



MPs vary with altitude; fibers and small particles dominate at higher elevations

MPs-microbe interactions



Distinct microbial groups respond differently to MP characteristics; fungi are more sensitive than bacteria

Keywords: Microplastics, Mountain soils, Microbiome, Elevational gradient, Polymer degradation.

MWCNT-PMB Modified Electrode for Enhanced Detection of Methiocarb Insecticide

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Abstract

A glassy carbon electrode modified with multi-walled carbon nanotubes poly (methylene blue) (MWCNT-PMB/GCE) was developed as a promising electrode for the electrochemical sensing of Methiocarb (MTC). The electrode was prepared by synthesizing a PMB layer using cyclic voltammetry at an optimized cycle number of 30, followed by the deposition of MWCNT on the surface. The resulting MWCNT-PMB film has been characterized using scanning electron microscopy, electrochemical impedance spectroscopy, and cyclic voltammetry. The results show enhanced electrochemical properties, including an increased active surface area (1.35 mm^2) and improved conductivity ($R_{ct} = 15\ \Omega$). These features contributed to improved sensitivity, selectivity, and a lower oxidation potential for detecting MTC. The electrochemical detection of MTC was carried out in Britton Robinson buffer at an optimized pH of 5, using the differential pulse voltammetry method. The calibration plot exhibited linearity between 10 and 100 µM(R^2=0.99) in the standard solution. The detection limit for MTC was determined to be 2.72 µM. Furthermore, the fabricated sensor was successfully applied to quantify MTC in human serum within the concentration range of 10–70 µM(R^2 = 0.97), with a detection limit of 9.98 µM. The sensor demonstrated reliable performance with acceptable recovery results.

Characterization of low-cost Moroccan pozzolan-alginate adsorbents for methylene blue removal from water

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Abstract

Water contamination due to methylene blue (MB) is a world-wide problem and needs attention by developing good adsorption methods. Consequently, novel inexpensive adsorbents were prepared using Moroccan Pozzolan i.e. Pozzolan Laayoune (PZL) powder, Pozzolan Timahdite (PZT) powder, Pozzolan Laayoune Alginate beads (PZLA-beads), and Pozzolan Timahdite Alginate beads (PZTA-beads). These materials were characterized using X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), X-ray fluorescence (XRF), scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDX), point of zero charge (pHpzc), and Brunauer-Emmett-Teller (BET). These adsorbents were used for the removal of MB from water. The data fitted well to the Langmuir model with maximum adsorption capacities (q max) of 80, 91.73, 62.11, and 67.11 mg/g for PZL powder, PZLA-beads, PZT powder, and PZTA-beads, respectively with pseudo-second-order kinetics. Furthermore, Moroccan pozzolan beads (PZLA-beads) were tested for the treatment of real textile effluents; showing complete removal of MB. The desorption studies demonstrated that the pozzolan-based adsorbents acted as a regenerative, and reusable sorbent. The results indicated that Moroccan pozzolan-based adsorbents may be recommended for the treatment of textile wastewater containing MB dye.

Electro-Fenton degradation of Ornidazole using Stainless Steel Electrode as Sources of Ferrous Ions (Fe^{2+})

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Abstract

This study presents a cost-effective and environmentally friendly approach for the removal of Ornidazole from contaminated environments. Carbon felt was used as the cathode, and stainless steel was used as the sacrificial anode, which also serves as an insitu source of Fenton's catalyst (Fe^{2+}) through auto-generation, eliminating the need for external catalyst addition. Different operational parameters were investigated to enhance degradation efficiency. The degradation experiment demonstrated the highest Ornidazole removal efficiency of 90.95 % and a mineralization efficiency of 84.5 % within 120 min under optimal conditions i.e., an applied current of 75 mA, an applied voltage of 2,5 V, an initial solution pH of 5, and an electrode spacing of 1.5 cm. Additionally, quenching experiments confirmed the crucial role of •OH in the degradation process of Ornidazole. Furthermore, the proposed EF process exhibited better effectiveness of Ornidazole degradation even in real water matrices (river water 91.32 % and tap water 94,32 %).

Keywords Ornidazole; Degradation; electro-Fenton; Stainless Steel; Sacrificial anode.

Application of an Arginine-PANI@PP Biocomposite for Orange G dye Removal from Water

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Abstract

A new arginine-doped polyaniline@PP (**Arg-PANI@PP**) biocomposite was prepared through a straightforward in situ chemical polymerization process. The resulting adsorbent was comprehensively characterized through several analytical techniques, including Fourier Transform Infrared Spectroscopy (FTIR), Energy-Dispersive X-ray Spectroscopy (EDS), and Scanning Electron Microscopy (SEM). Batch adsorption experiments were conducted to assess the ability of the synthesized composite to remove Orange G ions from aqueous solutions. The results showed that the adsorption behavior was strongly influenced by physicochemical conditions. The adsorption kinetics followed the pseudo-second-order model, and the equilibrium data were consistent with the Freundlich isotherm. The Arg-PANI@PP biocomposite also exhibited effective regeneration using a basic solution, retaining its performance over repeated cycles. Overall, these findings highlight the potential of the Arg-PANI@PP composite as an efficient and reusable material for wastewater treatment.

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Valorisation of rose distillation waste as a biofertilizer: impacts on soil health and floral yield of *Rosa damascena*

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Abstract

Rose distillation waste (RDW), a major byproduct of essential oil extraction, accumulates in large quantities near distillation facilities, posing significant environmental challenges. However, this underutilized biomass represents a promising and sustainable resource for agricultural applications. This study evaluates the potential of rose distillation waste (RDW) as a biofertilizer for *Rosa damascena*, with particular emphasis on its effects on soil health and floral yield. A field experiment was conducted at Kelaât M'Gouna (southeastern Morocco) during the 2023 growing year, encompassing two consecutive flowering seasons. The trial was laid out in a randomized complete block design with three treatments: an untreated control, RDW applied alone, and RDW combined with microbial inoculation. Each treatment was replicated within blocks to account for field variability. Soil physicochemical and biological properties, along with floral yield parameters, were monitored to assess the agronomic effectiveness of RDW-based amendments under field conditions. The application of RDW alone significantly improved key soil physicochemical and biological properties, including water-holding capacity (+14.09%), enhanced nutrient cycling, as evidenced by a significant improvement in the soil carbon-to-nitrogen (C/N) ratio (+7.31%), and increased microbial activity. Notably, when RDW was combined with microbial inoculants, a strong synergistic effect was observed, leading to marked increases in dehydrogenase (2.75 µg TPF·g^{-1} dry weight·24 h^{-1}) and β-glucosidase (71.39 µg PNG·g^{-1} dry weight·h^{-1}) activities, which are critical indicators of microbially mediated organic matter decomposition. These improvements in soil health translated into a significant increase in floral yield, reaching 6.67 t·ha^{-1}. Overall, our findings demonstrate that RDW should not be considered waste, but rather a valuable bioresource with proven agronomic benefits. Furthermore, inoculating RDW with beneficial microbes further increased its beneficial effects, offering an innovative and sustainable strategy to improve soil health and crop productivity.

Keywords: *Rosa damascena*, rose distillation waste, soil microbial activity, soil amendment, sustainable agriculture.

Magnetic Polymer@ZnO Nanocomposite: Facile Preparation and Efficient Visible-Light-Driven Degradation of methylene blue.

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Abstract

The organic dyes lead to the aspect of wather pollution that remains a major international problem. Subsequently, the photocatalytic treatment has been extensively used as a viable method of enhancing water quality. In the present study. Simply a Mechanochemical was used to produce the nanocomposite magnetic polymer @ ZnO. The photocatalyst has been characterized by X-Ray Diffraction (XRD), Scanning Electron Microscopy with the Energy Dispersive X-ray Spectoscopy (SEM/EDX), and Diffuse Reflectance Spectroscopy (DRS). The findings of these studies proved the successful creation of the photocatalyst. Photodegradation was experimented using methylene blue (MB) dye under visible light irradiation that led to a photodegradation of 95% after 180 minutes of light irradiation using 1g.L^{-1} of nanocomposite in an aqueous solution of methylene blue (MB) at 12mg.L^{-1}.

Keywords: Photocatalysis –Visible light – Degradation – Dye – Magnetic polymer @ ZnO

The synthesis of a magnetic polymer @ZnO nanocomposite is a facile process, and it exhibits visible-light photocatalytic degradation of organic dyes.

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Abstract

Wather pollution caused by organic dyes remais a critcal global challenge. In response, photocatalytic treatement has been widely implemented as an effective approach to improve water quality. In the present study. The nanocomposite magnetic polymer @ ZnO was synthesized a simple Mechanochemical. The photocatalyst was characterized using X-Ray Diffraction (XRD), Scanning Electron Microscopy combined with Energy Dispersive X-ray Spectoscopy (SEM/EDX), and Diffuse Reflectance Spectroscopy (DRS). The results of these studies demonstrated the succeful formation of the photocatalyst. The photodegradation was tested by methylene blue (MB) dye under visible light irradiation resulting in photodegradation efficiency of 95% after 180 min of irradiation using 1g.L^{-1} of nanocomposite in an aqueous solution of MB at 12 mg.L^{-1}.

Keywords: Photocatalysis – Degradation – Dye – Visible light – Magnetic polymer @ ZnO

Adsorption of toluidine blue from water using organic matter-modified lamellar double hydroxide: characterization. Isotherm and kinetics studies

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Abstract:

Synthetic colorants constitute a major class of toxic organic pollutants, posing serious risks to human health and highlighting the urgent need for efficient and sustainable adsorbents for wastewater treatment. In this study, an environmentally friendly synthesis of nickel-zinc-iron layered double hydroxides (NiZnFe-LDHs), modified with organic matter and thermally treated by controlled-temperature calcination, is reported for the adsorption of the cationic dye Toluidine Blue (TB) from aqueous solutions. The adsorbent was synthesized via a co-precipitation method and thoroughly characterized using X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), and zeta potential analysis. Batch adsorption experiments were conducted to evaluate the effects of key operational parameters, including contact time, initial dye concentration, solution pH, adsorbent dosage, and temperature. Adsorption kinetics were analyzed using pseudo-first-order, pseudo-second-order, and Elovich models, while equilibrium data were fitted to Langmuir, Freundlich, and Temkin isotherms. The results indicated that the adsorption process followed the Elovich kinetic model and was best described by the Temkin isotherm, with a maximum adsorption capacity of 64.63 mg g^{-1} and a removal efficiency of 70%. Thermodynamic analysis further revealed that the adsorption process was spontaneous, endothermic, and driven by entropy, with higher temperatures enhancing the favorability of dye removal. Altogether, this research introduces a sustainable approach to fabricating eco-friendly adsorbents using modified anionic clays. The findings underscore the high potential of NiZnFe-LDH modified with organic matter as a viable alternative to conventional adsorbents in wastewater treatment applications.

Keywords: Adsorption, Layered double hydroxide (LDH), Green synthesis, Toluidine blue, Organic matter modification.

Effect of Yttrium Doping on the Structural and Dielectric Properties of Perovskite Ceramics.

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Abstract

Perovskite with the general formula ABO_3, is an important class of functional materials because of their remarkable structural flexibility and wide range of physical properties.

In this study, nano-polycrystalline $BaTiO_3$ ceramics substituted with different percentages of yttrium (20, 40, 60, and 80 mol%) were synthesised using the sol–gel method. The solubility of rare earth ions in the $BaTiO_3$ lattice depends on the ionic radius difference between substituted and substitute atoms. $BaTiO_3$ crystallises in a perovskite structure, in which Y ions substitute Ba atoms. X-ray diffraction analysis showed the presence of a tetragonal phase. In this work, we explored the effect of Y^{3+} content on $BaTiO_3$ ceramic materials. The incorporation of yttrium into the $BaTiO_3$ unit cell slightly altered the bond vibrations of the crystal lattice. We observed that all synthesised phases crystallise in a tetragonal lattice, as confirmed by Raman-active modes. Y-doped $BaTiO_3$ ceramics show high dielectric constant values and low dielectric losses. On the other hand, Curie–Weiss law analysis confirms that all samples are normal ferroelectrics with a first-order phase transition. The increase in electrical conductivity is linked to the formation of oxygen vacancies arising from molecular dissociation during the synthesis process [1].

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Efficient adsorption of pharmaceutical drug Enrofloxacin by dextrose functionalized MgZnAl-LDH: Integrated experimental and Monte Carlo computational assessment

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Abstract

The widespread presence of pharmaceutical contaminants like enrofloxacin (ENR) in water is an emerging environmental concern, emphasizing the need for effective remediation. In this study, a dextrose-functionalized layered double hydroxide composite (Dxt@S-LDH) was synthesized and tested for ENR adsorption. Characterization using techniques such as XRD, FTIR, SEM–EDS, solid-state NMR, DTA/TGA, BET analysis, and zeta potential measurements revealed a porous structure with moderate surface area and abundant active groups, enhancing its adsorption capacity.

Batch adsorption experiments were conducted to examine the effects of key parameters such as initial ENR concentration, pH, temperature, ionic strength, contact time, and adsorbent dosage. Results indicated that ENR removal by Dxt@S-LDH is a spontaneous, exothermic process, achieving a removal efficiency of 75.92% and a maximum adsorption capacity of 169.70 mg g^{-1}. Kinetic analysis revealed that the adsorption is best described by the pseudo-second-order model, suggesting that chemisorption is the dominant removal mechanism.

To understand the adsorption process at the molecular level, DFT calculations and Monte Carlo simulations were used to examine the interactions between ENR and the Dxt@S-LDH surface. Theoretical analyses, including molecular orbital analysis, electrostatic mapping, and adsorption energy calculations, confirmed the strong affinity and stability of ENR on the composite. The agreement between theoretical and experimental results further validates the models. In conclusion, this study shows that Dxt@S-LDH is an effective, eco-friendly adsorbent for ENR removal, offering a promising solution to pharmaceutical pollution in aquatic environments.

Keywords: Adsorption; Hydroxychloroquine; Layered double hydroxide; Composite; Density functional theory.

Biochar-Supported $Cu_2(OH)_2CO_3$@CuAl Layered Double Hydroxide Composite with Enhanced Interfacial Adsorption for the Effective Removal of Anionic and Cationic Dyes

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Abstract

This work reports the rational design of a novel biochar-supported hybrid adsorbent based on the integration of $Cu_2(OH)_2CO_3$ and CuAl layered double hydroxide using Argania spinosa–derived biochar as a sustainable supporting matrix. The synthesis strategy was optimized to promote effective interfacial coupling between the inorganic phases and the biochar substrate, leading to improved structural integrity and enhanced surface functionality. The as-prepared composite was comprehensively characterized by X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), and scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy (SEM–EDX), confirming the successful formation of the hybrid architecture and homogeneous elemental distribution. The adsorption performance of the $Cu_2(OH)_2CO_3$@CuAl LDH composite was systematically evaluated toward the removal of both anionic Eriochrome Black T and cationic Methylene Blue from aqueous media. The effects of key operational parameters, including adsorbent dosage, solution pH, initial dye concentration, and temperature, were thoroughly investigated. Kinetic and isotherm analyses were conducted to elucidate the adsorption mechanisms and quantify the adsorption capacity of the composite. In addition, regeneration and reusability studies demonstrated the excellent structural stability and sustained adsorption efficiency of the material over multiple adsorption–desorption cycles. The results reveal that the synthesized hybrid composite exhibits high adsorption performance toward diverse dyes, showing its strong potential as a cost-effective and sustainable adsorbent for advanced wastewater treatment applications.

Construction of Ag_2CO_3/Ag_2O@NiFe LDH Nanoheterostructure for Enhanced Visible-Light Photocatalytic Degradation of Methylene Blue

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Abstract

The photocatalyst Ag_2CO_3/Ag_2O@NiFe LDH nanocomposite was synthesized successfully by a facile co-precipitation method followed by hydrothermal treatment. The as-prepared photocatalyst demonstrated excellent physicochemical and optical properties using various characterization techniques. It was found that the photodegradation performance of NiFe LDH for MB dye removal can be significantly improved by appropriate Ag incorporation. The optimal composite which had a 0.75 Ag molar ratio demonstrated superior degradation performance for MB dye reaching 99.5%. The degradation efficiency was three times higher compared to pure NiFe LDH. Additionally, the apparent rate constant (0.028 min^{-1}) was approximately 28 times greater than that of the pure LDH (0.001 min^{-1}). After 5 successive cycles, the composite exhibited 73% degradation efficiency reflecting its high photostability throughout the regeneration process. The synthesized photocatalyst exhibited exceptional properties, indicating its promising potential for industrial applications in the treatment of dye wastewater.

Co-digestion of Poultry by-products and chicken manure for methane production and digestate conversion into hydrochar for advanced water treatment in a circular green energy framework

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Abstract

Achieving zero waste through the efficient valorization of PBP organic waste presents an ongoing challenge, necessitating the exploration of cleaner methodologies. To address this challenge, a synergistic approach employing both anaerobic digestion (AD), a biological process, and adsorption, a physicochemical process, was adopted. The AD process facilitates the activation of biodegradable organic matter via microbial action, yielding a co-product known as digestate. This digestate, after chemical treatment with nitric acid and thermal activation at T = 500 °C, serves as the precursor for porous carbon characterized by a high specific surface area. The resultant activated carbon was employed in the treatment of wastewater containing dyes, effectively resolving issues related to solid−liquid separation in the adsorption process. Notably, the AD process demonstrated a substantial bio-methane potential (BMP), with an observed production of 15.04 L CH4 kg·SV−1 under optimal conditions of pH = 8 and an inoculum/substrate ratio of 3. Additionally, findings about the adsorption of methylene blue (MB) from water onto the activated carbon indicated a maximum adsorbed amount of 101.74 mg g−1. The experimental adsorption data exhibited excellent agreement with both pseudo-second order and Langmuir theoretical models. Furthermore, a thermodynamic analysis revealed that the adsorption process is characterized as endothermic and spontaneous. This integrated approach not only addresses the valorization of organic waste but also demonstrates the potential for generating bioenergy through AD while concurrently producing a valuable adsorbent for water treatment applications.

Contribution de l'électrocoagulation à la réduction des colorants synthétiques dans les effluents industriels

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Résumé

Cette étude examine l'électrocoagulation comme méthode efficace pour éliminer la plupart des colorants synthétiques fréquemment présents dans les effluents industriels. Le traitement des eaux usées contenant ces composants constitue un défi environnemental majeur en raison de la persistance et de la toxicité de ces polluants. L'électrocoagulation repose sur la génération in situ de coagulants par électrolyse des électrodes métalliques, entraînant l'agrégation et la précipitation des polluants. L'objectif principal de cette recherche est d'optimiser les paramètres influençant l'efficacité de cette méthode, tels que la densité de courant et la charge électrique spécifique. Une série d'expérimentations a permis d'identifier les conditions optimales pour maximiser l'élimination de ces colorants comme l'Orange G tout en minimisant la consommation énergétique. Les résultats montrent que l'électrocoagulation présente un potentiel considérable pour l'élimination des colorants dans les eaux usées industrielles, avec une efficacité de traitement étroitement liée à ces paramètres. Cette approche offre une solution prometteuse et durable pour traiter les eaux polluées par des colorants synthétiques, contribuant ainsi à la réduction de la pollution et à la préservation de l'environnement.

Mots clés : Electrocoagulation, Industrie textile, Optimisation, Epuration des eaux usées, Electrochimie.

Natural adsorbent for water purification: A Comparative study of organic and inorganic pollutant removal

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Abstract

The increasing presence of diverse contaminants in water resources, including both organic dyes and inorganic ions, has intensified the need for sustainable and eco-friendly purification technologies. In this context, natural adsorbents derived from abundant and low-cost raw materials have emerged as promising candidates for environmental remediation. Their unique physicochemical properties, renewable nature, and minimal environmental impact make them suitable alternatives to conventional treatment methods. Recent studies have highlighted the effectiveness of natural materials in adsorption-based purification processes, demonstrating their ability to efficiently capture a wide range of pollutants from contaminated aqueous systems [1–3].

This work presents a comparative investigation of the adsorption behavior of a natural adsorbent toward the removal of two pollutant classes: an organic dye representative of persistent organic contaminants, and an inorganic ion commonly found in wastewater streams. The influence of key operational parameters, including pH and adsorbent dose, was systematically examined for both pollutant types. Comprehensive characterization of the natural adsorbent was performed using X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), and thermogravimetric analysis (TGA). The findings of this study provide valuable insights into the versatility and efficiency of natural materials in water purification, offering guidance for their potential application in large-scale wastewater treatment processes.

Keywords: Natural clay, Adsorption, Organic pollutants, Inorganic pollutants, Comparative study.

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A cheminformatic and machine learning analysis to explore the chemical space diversity of Nav1.7

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Abstract:

Nav1.7 channels, encoded by *SCN9A* and predominantly expressed in peripheral sensory neurons, play a central role in nociceptive signal transmission and represent an important therapeutic target for pain management. This study investigates the chemical diversity of 4,620 potential Nav1.7 inhibitors using integrated cheminformatics and machine learning approaches to identify molecular determinants of inhibitory potency. Key physicochemical descriptors, including hydrogen bond donors and acceptors, topological polar surface area, rotatable bonds, heteroatoms, molecular weight, aromatic rings, and cLogP, were analyzed to assess their influence on activity. Chemical space organization and structural diversity were explored through principal component analysis and scaffold visualization. Thirteen classification-based structure–activity relationship models were developed using Scikit-learn and validated by fivefold cross-validation, with the Extra Trees algorithm showing the best performance. This model achieved strong predictive accuracy across training, validation, and test sets. Active inhibitors exhibited higher molecular weight, lipophilicity, polarity, and aromaticity, while scaffold analysis revealed recurrent cyclic frameworks among dominant chemotypes. Overall, this combined cheminformatic and machine learning framework provides insights into Nav1.7 inhibitor diversity and supports the rational design and prioritization of novel analgesic candidates.

KEYWORDS: Nav1.7; cheminformatics; machine learning; AI.

Design of a Perovskite-Derived LDH@g-C_3N_4/Polyaniline Hybrid Composite for Enhanced Hexavalent Chromium Remediation

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Abstract

In this work, a novel perovskite-type ABO_3 material derived from Layered Double Hydroxide (LDH) was developed, with graphitic carbon nitride (g-C_3N_4) successfully incorporated through an in-situ growth strategy on the LDH surface to form an ABO_3-LDH@ g-C_3N_4 hybrid. This structure was subsequently functionalized with polyaniline (PANI) via in situ polymerization, yielding the ternary ABO_3-LDH@ g-C_3N_4/PANI composite. Detailed physicochemical characterization confirmed the successful fabrication and structural integrity of the material. The engineered composite exhibited a well-organized, porous bead-like morphology that provided abundant accessible active sites, enabling efficient adsorption of hexavalent chromium from aqueous solutions. Batch adsorption studies were systematically performed to optimize operational parameters, including solution pH, adsorbent dosage, temperature, ionic strength, initial hexavalent chromium concentration, and contact time. The adsorption kinetics showed excellent agreement ($R^2 \approx 0.99$) with the pseudo-second-order model, while equilibrium data were best described by the Freundlich and Temkin isotherm models, indicating heterogeneous surface interactions. Thermodynamic parameters demonstrated that the adsorption process is spontaneous and endothermic. Furthermore, regeneration experiments confirmed the material’s good reusability and structural stability, making it an effective adsorbent for heavy metal remediation in water treatment applications.

Carbon Steel Corrosion Inhibition in HCl by 3,6-bis(3-pyridyl)pyridazine: Electrochemical, XPS, and Theoretical Analysis

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Abstract

The corrosion inhibition of carbon steel in 1 M hydrochloric acid at 30 °C by a novel pyridazine derivative, 3,6-bis(3-pyridyl)pyridazine (3-PYP), was investigated using a range of established techniques, including weight loss measurements, polarization studies, and electrochemical impedance spectroscopy (EIS).

The experimental results demonstrated that this organic compound exhibits significant corrosion inhibition, with the inhibition efficiency increasing as the inhibitor concentration rises. Potentiodynamic polarization studies indicated that 3-PYP acts as a mixed-type inhibitor. Two time constants, associated with charge transfer and inhibitor adsorption, were clearly observed. The adsorption of 3-PYP on the carbon steel surface in 1 M HCl followed Temkin’s isotherm, with a highly negative standard Gibbs free energy of adsorption (ΔG°_ads), indicating chemisorption. Additionally, quantum chemical calculations and X-ray photoelectron spectroscopy (XPS) analyses were performed to elucidate the mechanism of corrosion inhibition of carbon steel in 1 M HCl in the presence of 3,6-bis(3-pyridyl)pyridazine (3-PYP).

Keywords: *Pyridazine; Carbon steel; Acid solution; EIS; XPS; Acid inhibition*

Simulation, techno-economic and life cycle impact assessment of ABS metallization using conductive polymers

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Abstract

An innovative metallization process of acrylonitrile–butadiene–styrene (ABS) using a conductive polypyrrole (PPy) interlayer is investigated as a sustainable alternative to conventional industrial metallization. The process, including surface preparation, chemical treatment, pyrrole polymerization, washing, drying, and copper electrodeposition, was modelled using Aspen Plus to perform mass and energy balances and to size equipment at a semi-pilot scale.

A techno-economic analysis was carried out to estimate capital (CAPEX) and operating (OPEX) costs, showing that the process is economically coherent at pilot scale, with raw materials being the main contributor to operating costs. In parallel, a comparative Life Cycle Assessment (LCA) was conducted using openLCA to evaluate the environmental performance of the proposed process against a conventional metallization route.

The LCA results indicate a clear reduction in environmental impacts, particularly in human toxicity and related impact categories, mainly due to reduced use of hazardous chemicals, lower processing temperatures, and optimized material consumption enabled by the conductive polymer interlayer. Overall, this study demonstrates that the PPy-based metallization process is technically feasible, economically viable at pilot scale, and environmentally advantageous, highlighting its strong potential for sustainable industrial implementation.

Keywords : ABS metallization; Polypyrrole; Process simulation; Techno-economic analysis; Life Cycle Assessment; Sustainable manufacturing.

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Heterojunction-based oxide photocatalysts for visible-light-driven degradation of organic dyes in water

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Abstract

Heterojunction-based oxide photocatalysts were designed and evaluated for use in the visible-light-driven degradation of organic dyes in water. A vanadium oxide component was synthesized using a co-precipitation method and then combined with a bismuth-based oxide via a solid–solid mixing process to create an efficient Z-scheme heterojunction. X-ray diffraction (XRD) analysis confirmed the formation of the composite materials, and scanning electron microscopy (SEM) revealed their morphological features. Diffuse reflectance spectroscopy (DRS) revealed band gap energies of 2.26 eV and 2.9 eV for pure vanadium oxide and bismuth-based oxide, respectively. Photocatalytic experiments showed that the intermediate biphasic system exhibited the greatest activity in terms of organic dye degradation when using Rhodamine B as a model pollutant. The reaction followed pseudo-first-order kinetics, with an apparent rate constant (Kapp) of approximately 0.016 min^{-1}, achieving up to 98% degradation within 60 min under visible-light irradiation. Trapping experiments indicated that photogenerated holes (h^+) and superoxide radicals ($O_2^{\cdot -}$) played a dominant role in the degradation process, supporting a Z-scheme charge transfer mechanism. The photocatalyst also demonstrated good stability and reusability over multiple cycles, highlighting its potential for visible-light-driven water purification applications.

Keywords:
Photocatalysis; RhB photodegradation; visible-light irradiation

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Geopolymer Membranes : A Sustainable Alternative for Seawater Desalination

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Abstract

Seawater desalination represents a critical approach to mitigating global freshwater scarcity; however, conventional polymeric and ceramic membranes commonly employed in desalination technologies are often limited by high production costs, membrane fouling, limited chemical stability, and environmental concerns [1]. In recent years, geopolymer membranes have emerged as a potential alternative owing to their inorganic aluminosilicate framework, which provides high thermal and chemical stability, adequate mechanical strength, and controllable porosity [2]. These membranes are typically synthesized via alkali activation of low-cost and environmentally friendly precursors such as metakaolin, contributing to improved sustainability. Furthermore, geopolymer membranes exhibit enhanced resistance to aggressive saline environments and operational stability under harsh conditions, making them suitable candidates for membrane-based desalination processes, particularly membrane distillation and filtration applications. Consequently, geopolymer membranes demonstrate significant potential as sustainable and efficient materials for seawater desalination.

Keywords: Geopolymer membranes, Seawater desalination, Aluminosilicate materials, Filtration.

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Photo assisted Heterogeneous Electro-Fenton for Imidacloprid Mineralization from Wastewater using Z-scheme $MnFe_2O_4/g\text{-}C_3N_4$ Nanocomposite: RSM-CCD optimization, DFT calculation, Mechanism pathway and Toxicity analysis

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Abstract

$MnFe_2O_4/g\text{-}C_3N_4$ composites were developed as efficient catalysts for the photo-assisted heterogeneous electro-Fenton (HPEF) process aimed at the mineralization of imidacloprid (IMD) from wastewater. The structural, morphological, and surface properties of the prepared catalysts were thoroughly investigated using XRD, FTIR, Raman spectroscopy, N_2 adsorption–desorption, SEM-EDS, TEM, and XPS, confirming the successful incorporation of $MnFe_2O_4$ into the $g\text{-}C_3N_4$ matrix. The photocatalytic–electrochemical performance of $MnFe_2O_4/g\text{-}C_3N_4$ was evaluated under visible light irradiation in an electrochemical cell, demonstrating a remarkable capability for IMD degradation and mineralization with enhanced energy efficiency. The optimization of operational parameters was conducted through response surface methodology based on central composite design (RSM-CCD). Mechanistic insights were further supported by radical scavenging tests, which identified hydroxyl radicals as the dominant reactive oxygen species (ROS). Density functional theory (DFT) calculations provided theoretical confirmation of the reactive sites of the composite. The toxicity assessment of transformation products, as identified by LC-MS, revealed that the HPEF process effectively reduced the toxicity profile of IMD and its intermediates. Finally, the catalyst exhibited high recyclability and structural stability over multiple cycles, as verified by after use characterizations. This study highlights the potential of $MnFe_2O_4/g\text{-}C_3N_4$ as a promising catalyst for sustainable wastewater treatment through an advanced photo-assisted electro-Fenton approach.

Keywords: Imidacloprid, Heterogeneous photo-electro-Fenton, $MnFe_2O_4/g\text{-}C_3N_4$, Pesticide degradation, Wastewater treatment.

Z-Scheme-Driven Photoelectrocatalytic Degradation of Tetracycline over $(1-x)Cu_3(PO_4)_2/xBi_2O_3$ Composites under Visible Light

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Abstract

$(1-x)Cu_3(PO_4)_2/xBi_2O_3$ composites were synthesized via a solid-state route and systematically characterized to evaluate their structural, optical, and photoelectrochemical properties. XRD, FT-IR, and SEM analyses confirmed the successful formation of a well-integrated heterostructure with intimate interfacial contact between $Cu_3(PO_4)_2$ and Bi_2O_3 phases. UV–Vis diffuse reflectance spectroscopy revealed enhanced visible-light absorption, with band gap energies of 3.20 eV for $Cu_3(PO_4)_2$ and 2.84 eV for Bi_2O_3. Among the investigated compositions, the x = 0.8 composite exhibited the best performance toward tetracycline degradation under visible-light irradiation. Electrochemical analyses, including OCP, EIS, and Mott–Schottky measurements, demonstrated improved charge separation and interfacial charge transfer, supporting the formation of a direct Z-scheme heterojunction between n-type $Cu_3(PO_4)_2$ and p-type Bi_2O_3. Under optimized conditions, the x = 0.8 composite achieved 82% photocatalytic degradation within 90 min and complete removal within 15 min in the photoelectrocatalytic mode. Radical scavenging experiments identified holes (h^+) and superoxide radicals ($\bullet O_2^-$) as the dominant reactive species, explaining the superior photoelectrocatalytic activity of the heterostructure.

Keywords: Solid-state; Bi_2O_3; $Cu_3(PO_4)_2$; Photocatalysis; Photoelectrocatalysis; Z-Scheme; Tetracycline.

ZIF-67@Digestate Derived Co,N-Doped Biochar Membranes for Sulfamethoxazole Removal through Peroxydisulfate Activation

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Abstract

The ubiquitous presence of sulfamethoxazole (SMX) within aquatic ecosystems coupled with the increasing production of sewage sludge digestate (SSD) has emerged as a critical environmental challenge. This necessitates the development of efficient decontamination strategies and sustainable waste management approaches. Herein, magnetic Co_x-NBC composites were synthesized by integrating ZIF-67 and nitrogen-rich biochar (NBC) through ball milling and thermal treatment. These elaborated materials were comprehensively characterized and demonstrated exceptional performance as metal-doped carbocatalysts, exhibiting synergistic capabilities in both the adsorption and catalytic degradation of sulfamethoxazole (SMX) through efficient activation of peroxydisulfate (PDS). The results indicate that the biochar matrix plays a pivotal role in facilitating the uniform dispersion of ZIF-67 particles, effectively suppressing their aggregation, enhancing structural stability, and providing additional adsorption sites for sulfamethoxazole (SMX). A comprehensive investigation of key operational parameters was conducted within the Co_x-NBC/PDS system, including the initial pH of the SMX solution, catalyst dosage, PDS concentration, and the presence of inorganic ions and humic substances. Furthermore, the dominant reactive oxygen species (ROS) involved in SMX degradation were systematically identified through quenching experiments, offering critical insight into the underlying catalytic mechanisms.

Keywords: Biochar, ZIF-67, Enhanced functionalities, Peroxydisulfate activation, Sulfamethoxazole degradation

Biological and Synthetic Recognition Strategies for Electrochemical Detection of Aflatoxin B1 in Foods

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Abstract

Aflatoxin B1 (AFB1), one of the most toxic mycotoxins, poses a serious threat to food safety through its widespread contamination of cereals, nuts, and edible oils [1]. Reliable detection at trace levels is therefore essential for consumer protection and public health.

While conventional analytical methods such as HPLC and ELISA offer high sensitivity, their cost, complexity, and time requirements limit their use in routine or field-based monitoring. Electrochemical sensors present a compelling alternative, combining rapid response, low cost, and operational simplicity.

Two major recognition strategies have been explored for AFB1 electrochemical detection. Biological systems, including antibodies, aptamers, and enzymes, offer outstanding selectivity [2],[3], but are hampered by stability concerns, demanding storage conditions, and elevated production costs. Synthetic recognition materials, particularly molecularly imprinted polymers (MIPs) and engineered nanomaterials, address these limitations by providing robust, stable, and cost-effective artificial binding sites tailored for AFB1 capture [4].

Signal transduction in both approaches relies on voltammetric or impedimetric techniques, translating AFB1 binding events into measurable electrochemical signals.

This work presents a comparative assessment of biological and synthetic electrochemical sensing strategies, highlighting their performance, limitations, and prospects for real-world food safety applications, with particular focus on nanomaterial-enhanced platforms as scalable, field-deployable solutions.

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Photocatalysis and Photoelectrocatalysis: From Fundamental Principles to Applications

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Abstract

Photocatalysis is a process that requires the absorption of light by a semiconductor, (TiO_2, ZnO…) ; when the photon energy is higher than the band gap of the material, it generates electron–hole pairs[1]. These charge carriers undergo surface redox reactions, which can be used for pollutant degradation, hydrogen evolution reaction (HER), CO_2 reduction and other such applications. Among them, it is well known that highly reactive species such as hydroxyl radicals and superoxide ions are an essential driver for the oxidation and mineralization of these contaminants [2].
However, its efficiency is constrained by the rapid recombination of charge carriers and poor visible light absorption. Moreover, many materials still have low quantum efficiency and poor stability [3].
Photoelectrocatalysis is a more efficient process that involves the application of an external electrical bias to accelerate charge separation, minimize recombination and lead to enhanced catalytic performance compared with traditional photocatalytic systems. Such a combined process offers better efficiency and stability, which could be a potential route for sophisticated environmental and energy applications [4].
This work explores advanced materials used in photocatalysis and photoelectrocatalysis, focusing on inorganic semiconductors (TiO_2, ZnO, $Mx(PO_4)_3$) for pollutant degradation, hydrogen production, and CO_2 reduction. It highlights the challenges related to efficiency under visible light as well as the development of structured materials.

Keywords: Photocatalysis, Photoelectrocatalysis, semiconductor

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Digestate derived carbon from tea residues as a promising material for aqueous dye removal

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Abstract

The management of digestate generated during anaerobic digestion remains a major challenge despite the environmental and energetic benefits of this biological process. In this work, tea waste digestate was explored as a precursor for the production of value-added carbon materials intended for water treatment applications. A carbonaceous adsorbent was first obtained by pyrolysis of tea waste digestate at 600 °C, then chemically modified using nitric acid to improve its surface reactivity and adsorption-related properties. The acid treatment was expected to promote the development of oxygenated surface functionalities and enhance the affinity of the material toward organic pollutants. The resulting activated carbon was investigated for the removal of methylene blue from aqueous solution as a model dye pollutant. This study highlights an integrated strategy that connects anaerobic digestion residue management with wastewater remediation, offering a sustainable route for converting an abundant by-product into a functional adsorbent. Such an approach supports resource recovery, waste minimization, and the implementation of circular economy principles in environmental applications.

Keywords: Tea waste digestate, Activated carbon, Waste valorization, Adsorption, MB removal.

Waste to wealth approach: Valorization of red clay mud into ceramic membranes for microfiltration

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Abstract

Recently, ceramic membranes have gained increasing attention as a promising technology for water treatment. Their properties, including thermal stability, chemical resistance, and mechanical strength, make them a suitable alternative to polymeric membranes [1,2]. These properties enable their operation under harsh conditions, including high temperatures and corrosive environments, making them suitable for water treatment applications. Despite these advantages, their high production cost represents a limitation for widespread use, thus directing research toward the development of low-cost ceramic membranes capable of achieving comparable properties at reduced cost [3–5].

Red clay mud is an abundant clay rich waste generated during iron ore extraction, typically containing more than 5% Fe_2O_3. It is often landfilled without utilization and generally considered as low-value waste [6]. In this study, we investigated its potential for conversion into ceramic membranes. Several formulations were prepared by incorporating low-cost additives, and the membranes were sintered at moderate temperatures. The prepared ceramic membranes were characterized by X-ray diffraction, scanning electron microscopy, and measurements of physical, mechanical, and chemical properties. The results demonstrate the suitability of using red clay mud as a primary raw material for the fabrication of ceramic membranes.

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