# ICNN-2025


## Third International Conference on Nanosciences & Nanotechnology (ICNN-2025)

**November 24-26**

**Nouakchott - Mauritania**



كلية العلوم والتقنيات

Faculté des Sciences et Techniques

# Third International Conference on Nanosciences & Nanotechnology (ICNN-2025)

ICNN-2025

## Avant-propos

La faculté des Sciences et Techniques organise la Conférence Internationale sur les Nanosciences et les Nanotechnologies (ICNN 2025), qui se tient à Nouakchott, en Mauritanie. À l'image des précédentes éditions, ICNN 2025 se veut un rendez-vous scientifique majeur, riche en nouveautés et en avancées récentes dans le domaine des nanosciences.

Cette édition réunira huit conférences plénières, dix communications orales et une session posters présentées par d'éminents professeurs et chercheurs provenant de la Tunisie, le Sénégal, le Maroc, l'Algérie, la France, l'Espagne, l'Arabie Saoudite et la Mauritanie.

L'un des temps forts de cette année sera l'organisation d'une session spéciale intitulée : « Nanosciences et Industrie Minière : Vers une Valorisation Durable des Ressources Mauritaniennes » préparée en collaboration avec les principales sociétés minières, notamment SNIM, MCM et Tasiast.

Nous espérons que ICNN 2025 constituera un espace privilégié pour débattre des dernières avancées de la recherche en nanosciences et nanotechnologies, tout en souhaitant à nos invités un séjour aussi agréable qu'enrichissant.

Nous adressons nos remerciements les plus sincères à l'ensemble des conférenciers et participants qui ont accepté de prendre part à cette edition ainsi qu'à l'ensemble des institutions et entreprises qui ont sponsorisé cette manifestation scientifique.

.

**Conferences Chairs**
Yacoub Diagana
Mohamed Abdellah Lemine Kerim

**Scientific Committee**

**Aliou Hamady Barry (Chairman),**

*FST, Nouakchott University, Mauritania*,

**Mohamed Henini,**

*Nottingham University, UK*

**Mohamed Bououdina**,

Prince Sultan University, Saudi Arabia

**Yacoub Diagana**,

*FST, Nouakchott University, Mauritania*,

**Lassad El Mir**,

*Gabess University, Tunisia*

**Housseinou Ba**,

*Expert AFNOR Nanotechnologie, France*

**M A Lemine Kerim,**

*Imam University, Saudi Arabia*

**Abdel Kader Mahmoud,**

*FST, Nouakchott University, Mauritania*,

**Mohamed A. M'Hamed**

*FST, Nouakchott University, Mauritania*,

**Mohamed Abderrahmane Senhoury,**

*FST, Nouakchott University, Mauritania*,

**Dr Rabia Yahya**

*FST, Nouakchott University, Mauritania*,

## Organizing Committee

**Ali Boukhary, UN President, Honorary President**

**Mohamed A. M'Hamed**

**Abdellahi Eboubekrine**

**Mohamed Abderrahmane Senhoury**

**Teyeb Mahmoud**

**Mohamed Mokhtar Dah**

**Mohamed Mohamed Lemine Yacoubi**

**Khalidou Ba**

**Eya M'Hamed**

**Rabia Yahya**

**Aichetou kane**

**Brahim El Khalil Mohamed**

# Invited Speakers

## Nanocellulose: from hype to industrial reality

**Youssef Habibi**
Sustainable Materials Research Center (SusMat-RC)
University Mohammed VI Polytechnic (UM6P), Ben Guerir, Morocco
*Email:* youssef.habibi@um6p.ma

***Abstract***

In conjunction with the growing interest in developing circular economies through the substitution of fossil carbon by renewable resources, interest in biomass feedstock does not appear to wane but will continue to attract considerable attention in our society during the so-called the 4th industrial revolution. In fact, with total production estimated to be $10^{13}$ tons with a yearly growth of ~ 3 x $10^{11}$ tons, biomass is not only abundant, renewable, and sustainable but represents the limitless potential to supplant or at minimum complement fossil resources. Therefore, the conversion of these resources into sustainable value-added chemicals, fillers, polymers, and materials is surfacing as a potential answer to face the expected scarcity of fossil resources and consequently addresses timely issues of sustainability and ecological consciousness. Indeed, herein we argue for a renewed interest in biomass as a limitless resource of chemicals, polymers, and materials within the construct of the biorefinery for the processing, fractionation, and full recovery of all components to convert them to non-traditional high-added value and sophisticated uses.

Since their first isolation in 1940s by Randy, nanocrystalline cellulose has started attracting the attention of the material community. Later during 1980s, Turbark group's succeeded in extracting a new kind of nanocellulose, called at that time microfibrillated cellulose, stimulating further interest in these renewable building blocks. Nowadays with the emergence of the green portfolio, numerous efforts are being focused on the use of materials from renewable resources, and we are attesting a huge and unprecedented interest in nanocellulose and their industrialization is evolving as a potential alternative to many non-organic fillers. This interest is due to their renewability and biodegradability, in addition to their appealing intrinsic properties such as low density, high surface area and outstanding mechanical properties. Moreover, nanocelluloses possess a spectacular ability to self-organize into liquid crystalline arrangements. All these impressive properties allow their use in a wide range of applications. This plenary lecture will provide an overview of recent advances in nanocellulose processing followed by a few examples related to their nanotechnology uses.

***Brief biography:***

*Dr. Habibi is a Full Professor and Chair of Sustainable Materials at Mohamed IV Polytechnic University and a Fellow of the Royal Society of Chemistry. He holds a dual Ph.D. degree in organic chemistry from Joseph Fourier University (Grenoble, France) and the University of*

*Cadi Ayyad (Marrakech, Morocco). Dr. Habibi works across many branches of the development of sustainable functional (bio)materials and his research interests include the design of new bio-derived polymers, and the development of high-performance nanocomposites from lignocellulosic materials including natural nano-sized fillers, biomass conversion technologies, and the application of novel analytical tools to biomass. He published over 120 research articles or invited reviews in high-standard peer-review journals, (co)edited and/or (co)authored several books and book chapters. He enjoys an H-index of 61 with more than 26000 citations.*

***For more information:***

***https://scholar.google.com/citations?user=OQL6PDYAAAAJ&hl=en***

## Biomedical applications of infrared emitted nanosensors: present and future

**Prof Daniel Jaque**

*Nanomateraisl for BIOimaging Group*

*Departamento de Física de Materiales, Facultad de Ciencias, Universidad Autónoma de Madrid, Madrid 28049, Spain*

*Email: daniel.jaque@uam.es*

**Abstract:** A luminescent nanothermometer is a nanoparticle whose luminescence results strongly temperature dependent. These nanomaterials allow remote thermal sensing. If the nanothermometers operate in the infrared (the so-called biological windows) are capable of remote thermal sensing in cells, tissues, organs and animals. Remote reading of the temperature of living organisms has been used for understanding their vital functions, to control treatments and to diagnosis diseases. But the use of nanothermometers for thermal sensing in biological systems is not free from artefacts and uncertainties that could make the thermal reading useless. To avoid them, new nanomaterials and technologies must be developed and combined. In this talk examples of these new approaches leading to reliable and precise thermal sensing in biological media will be described to demonstrate the actual potential of nanothermometry in biomedicine.

***Brief biography:***

*Prof. Daniel Jaque is a physicist specialized in nanomaterials and bioimaging. He leads the nanoBIG group at UAM, pioneering luminescence sensing. He has coordinated major European projects (COST, Marie Curie, FET-OPEN) and delivered invited talks at international conferences. He has held academic leadership roles as Vice-Rector for Scientific Policy at UAM and supervised numerous PhD theses. Prof. Jaque has also been an invited professor in the UK, Brazil, China, and Australia, fostering global collaborations in physics and nanotechnology.*

***For more information:*** *https://scholar.google.com/citations?user=EJxaJYsAAAAJ&hl=es*

## Nanomaterials - Application to Magnetic Refrigeration

**Professor Mohammed AZZAZ**
Head of USTHB's physical-chemical analysis technical platform
Materials Science and Engineering Laboratory – USTHB
E-mail : mohamed.azzaz@usthb.edu.dz

**Abstract**
Soft magnetic materials are at the forefront of contemporary scientific and technological progress, with applications spanning cutting-edge fields such as energy harvesting, storage systems, and magnetic refrigeration. Their effective utilization hinges on precise material characterization and a deep understanding of magnetic behavior. Given the strong dependence of magnetic properties on nanostructural features, nanocrystalline magnetic materials can be engineered with exceptional performance.
Microstructure plays a critical role in determining magnetic behavior-finer grain sizes and uniform distribution typically enhance magnetic properties. Selecting suitable magnetic materials for specific applications also requires careful consideration of the **maximum operating temperature**, as materials exhibiting optimal magnetic fields at room temperature may lose functionality if exposed to temperatures exceeding their Curie point, resulting in demagnetization. Among promising magnetic materials, **off-stoichiometric Heusler alloys** have attracted significant theoretical and experimental interest due to their unique magnetocaloric properties, especially when their composition deviates from phase stability centers. Notably, Ni-Co-Mn-Al alloys undergo pronounced structural and magnetic changes under external magnetic fields. This study explores the influence of Co and Al substitutions on the magnetocaloric performance of **$Ni_{50-x}Co_xMn_{31}Al_{19}$ and $Ni_{50-x}Co_xMn_{32}Al_{18}$ Heusler systems**, shedding light on composition-dependent enhancements in functional behavior.

***Brief biography:*** Mohammed Azzaz is a professor of materials engineering at USTHB, specializing in polymer science, magnetic materials, and advanced characterization techniques. He obtained his PhD in 1991 from the École des Mines de Nancy (France), with a specialization in Materials Engineering. As head of the Physico-chemical Analysis Facility, he leads research on nanostructured materials, focusing on magnetic behavior and rheological properties. His expertise spans transmission electron microscopy (TEM), focused ion beam (FIB) imaging, and 3D reconstruction, contributing to a deeper understanding of structure–property relationships. He is actively involved in international conferences, collaborative training programs, and the dissemination of scientific knowledge through refined technical reports and publications.

***Formore information: https://scholar.google.com/ citations?view_op=search_authors& mauthors=azzaz +mohamed+USTHB&hl =fr&oi=ao***

# Plant biomass-derived hybrid carbon nanomaterials composites for advanced energy storage applications

**Balla D Ngom**
Laboratoire de Photonique Quantique, d'Energie et de Nano-Fabrication, Département de Physique, Faculté des Sciences et Techniques, Université Cheikh Anta Diop de Dakar (UCAD) B.P. 5005 Dakar-Fann Dakar, Sénégal
Email: balla,ngom@ucad.edu.sn or bdngom@gmail.com

**Abstract**
Energy as a commodity is facing a global crisis due to its high demand and consumption in all areas, overuse of fossil fuels is also causing environmental problems such as global warming and depletion of the ozone layer. To solve this problem, researchers have been interested on developing efficient, sustainable, and clean energy storage systems to boost the use of renewable energy. We report on green and ecofriendly biomass derived devices for energy storage applications. From our results on activated carbon nanostructures from peanut shell waste using different porosity-enhancing agents, an asymmetric supercapacitor device was assembled in a neutral electrolyte (2.5 M KNO3) at a cell voltage of 1.8 V, which yielded 224.3 F g−1 specific capacitance at a specific current of 1 A $g^{-1}$ with a corresponding specific energy of 25.2 W h $kg^{-1}$ and 0.9 kW kg−1 of specific power. To enhance the performance of the device, ex-situ nitrogen-doped porous carbon was synthesized and investigated in the same electrolyte. The fabricated device exhibited a 251.2 F g-1 of specific capacitance at a gravimetric current of 1 A g-1) at a wide cell voltage of 2.0 V. A specific energy of 35 Wh kg-1 with a corresponding specific power of 1 kW kg-1 at 1 A g-1 was obtained. For future development of environmentally friendly and sustainable electrode materials, we developed sustainable binary vanadium pentoxide carbon graphene foam composites (V2O5@C-R2HS/GF) using a green method. The device showed high specific energy and specific power values of 55 W h kg−1 and 707 W kg−1, respectively, at a specific current of 1 A g−1. The device presented a good stability test showing 99% capacity retention up to 10000 cycles confirmed by the floating time up to 150 h with specific energy an increase of 23.6% after the first 10 h.

**Keywords:** Biomass, Energy Storage, Supercapacitors, Energy and Power densities

***Brief biography***

Balla Diop Ngom is a Professor of Nanomaterials Physics originally trained in solid state physics at the University Cheikh Anta Diop of Dakar (UCAD) in Dakar, Senegal. His keen interest led him to complete doctoral studies in Physics at the same university. His scientific curiosity led him to pursue a second PhD in nanomaterials physics at the University of the Western Cape (UWC), Cape Town, South Africa. Building on this high-level training, excellent academic record and uncommon motivation and dedication, he returned to Senegal to embark on an academic career of high promise, already delivering spectacular results and outcomes. As a result of these distinguished academic achievements, Prof Balla has gained some twelve years of in-depth knowledge and experience in the multi-disciplinary field of nanoscience, focusing on energy and smart nanomaterials. He has co-authored more than 80 ISI scientific publications, given more than 50 invited lectures at national and international conferences, universities and research institutions including ten lectures at multinational companies. In addition to his outstanding research and training of young scientists, Prof. Ngom is also actively involved in the promotion of science, technology and education motors of development in Africa and the global South, for example via website and social media platforms. Prof Balla is the President of the African Materials research Society (AMRS) and the Chairman of the NanoSciences African Network (NanoAfnet).

**Manufacturing of nanoparticle-based systems for advanced technological applications**

**Lassaad EL MIR**

*Laboratory of Physics of Materials and Nanomaterials Applied at the Environment (LaPhyMNE)*

*Gabes University, Faculty of Sciences of Gabes, 6072 Erriadh Manara City, Gabes, Tunisia.*

*Email:* Lassaad.ElMir@fsg.rnu.tn

**Abstract**

Nanotechnology research has impacted numerous applications in life-saving areas, including energy, water management and purification, artificial intelligence, spacecraft, and quantum computing. However, the specific properties and processes inherent in nanotechnology deserve greater attention. Policies focused on nanoscale applications will ignore the unique properties and challenges posed by nanotechnologies themselves. Recently, systems utilising nanomaterials have attracted significant attention due to their remarkable optical, electrical, and magnetic properties. When dimensions are restricted to the nanoscale, the physical properties of these materials undergo significant transformations. These materials exhibit behaviours intermediate between those of bulk crystals and those of isolated molecules. In nanoparticles, there is a significant spatial imbalance of valence electrons, requiring a small crystal to become large enough to reach the overall electronic structure limit. Mesoscale assemblies may exhibit properties not characteristic of molecules or solids. The main objective of this conference is to present the results of our laboratory in the synthesis and characterisation of nanoparticles, nanocomposites, and thin films. These materials find applications in a wide range of technologies, including energy storage, optoelectronic devices, electronic components, gas sensing, and solar cells.

**Brief biography:**

Prof El Mir completed his Ph.D in 1995 from the Faculty of Sciences in Tunis in collaboration with the University of Paris VI in the field of electronic transport in semiconductors and his "HDR" (Ability of Direction of Research) in 2007 from the College of Sciences in Sfax (Tunisia) in the field of nanotechnology. He is the Director of the Laboratory of Physics of Materials and Nanomaterials Applications at Environment: LaPhyMNE". He has published more than 300 research articles and more than 320 contributions to national and international conferences. He is a reviewer in some journals such as Thin Solid Films, Materials Science and Engineering B, Journal of Physics and Chemistry of Solids, and Journal of Luminescence. He was a supervisor of 30 Ph.D. students. He spent seven years (October 2011- Jun 2018) as a Visitor Professor in the College of Sciences at Al-Imam Mohamed Ibn Saud Islamic University (Saudi Arabia). His main research interest: synthesis and characterisation of nanoparticles, thin films, and nanocomposites for a variety of applications such as visible luminescence thermometry, solar cells, transparent electrodes, advanced catalyst supports, Hyperthermia, water treatment, energy storage, gas sensors, and electronic components.

**From Carbon Chemistry to Graphene-Based Innovation: A Journey from Lab to Industry**

**Housseinou BA**

*BLACKLEAF SAS*

*210 rue Geiler de Kaysersberg, 67400 Illkirch, France*

*Email: hba@blackleaf.fr*

**Abstract**

This talk will explore the journey from academic research on carbon-based materials to the creation of two deeptech ventures focused on applied innovations using graphene. The first part will cover the PhD and postdoctoral work conducted at the Institute for Chemistry and Processes for Energy, Environment and Health (ICPEES, CNRS/University of Strasbourg), centered on the synthesis and advanced characterization of structured carbon materials and their use as platforms for catalytic reactions, energy storage, and air/water purification.

The second part will introduce Blackleaf, a startup co-founded in 2018, which developed an eco-friendly and scalable production method for high-quality graphene, targeting conductive and resistive ink applications — such as printed electronics and thermal management through heating or dissipation coatings.

The final part will present ColMat (created in 2025), a new company aiming to industrialize a new generation of functional carbon-based materials. ColMat focuses on high-performance additives for sectors like energy storage, composites, and green construction, with a strong commitment to ESG and deeptech co-development.

***Brief biography:***

*Dr. Housseinou BA is a material scientist and entrepreneur. He earned his PhD from the Institute for Chemistry and Processes for Energy, Environment and Health (ICPEES), a joint research unit of CNRS and the University of Strasbourg, where he worked on functional carbon-based nanomaterials. He co-founded Blackleaf SAS, which developed eco-friendly graphene for smart coatings, and in 2025 founded ColMat, a company dedicated to sustainable carbon materials for industrial applications. He is also an expert member of the AFNOR standardization commission on nanotechnologies.*

***For more information:*** ***https://scholar.google.com/citations?user=OdetppkAAAAJ&hl=fr***

***Synthesis and applications of metal chalcogenide nanoparticles: Achievements and perspectives***

*Med Abderrahmane Sanhoury*
*Nouakchott University*
*senhourry@yahoo.com*

**Abstract:**
The synthesis of metal chalcogenide nanoparticles (NPs) and their applications including in hybrid organic–inorganic solar cells are described. Such devices are known as potential candidates for low-cost and efficient solar energy conversion and belong to the so-called third-generation solar cells. The various methods of NP synthesis, including those involving greener approaches and their development for application in more efficient solar cell devices, are also presented. Despite the fact that incorporation of oxides and metal nanoparticles has also been successfully achieved in this class of photovoltaic devices, we choose to focus here on metal chalcogenide NPs in light of their important optical and electronic properties. Recent developments on more efficient photovoltaic devices and use of greener alternative methods as well as later strategies for surface chemistry mofification will be also discussed. For instance, we will describe the promising use of plant extracts as source of biomolecules that encapsulate and stabilize metal chalcogenide NPs through the functional groups of these biomolecules. Such NPs could be applied in various scientific fields for enhanced particular properties.

***Brief biography:***

*Med Abderrahmane Sanhoury is currently a Senior lecturer at the Chemistry Department, Faculty of Sciences and Techniques, UN, Nouakchott, Mauritania and Research Assistant at the Faculty of Sciences of Tunis, Tunis, Tunisia. His research focuses on the synthesis and coordination chemistry of organophosphorus compounds including their use as capping agents of metal chalcogenide nanoparticles for photovoltaic applications. He has about 70 publications and is a recipient of the RSC Member Inspirational Award (UK, 2016) and Chinguity prize for Technical Sciences (Mauritania, 2016).*

## *Tailoring Magnetic Nanoparticles For Hyperthermia-Based Cancer Therapy*

*Mohamed Abdellah Lemine*
*Magnetic Material Lab (MLL), Imam Mohammed Ibn Saud IslamicUniversity, Riyadh, Saudi Arabia*

**Abstract:**
Magnetic hyperthermia relies on the ability of MNPs to generate localized heat when exposed to an alternating magnetic field, selectively destroying cancer cells. To optimize heating efficiency of MNPs, key magnetic properties---namely saturation magnetization, Curie temperature, and magnetic anisotropy---can be tuned through cationic substitution of iron ions with alkaline earth metals, transition metals, or nonmagnetic dopants. Such chemical modifications enable precise control over the magnetic response and thermal output of iron oxide nanoparticles. This talk will present recent advancements in magnetic hyperthermia research, with a particular emphasis on our group's contributions to the design and functionalization of theranostic nanomaterials. The presented findings highlight promising in vitro results, indicating the potential of engineered MNPs for targeted cancer therapy.

**Brief biography:**
Mohamed Lemine is currently working as a professor of physics at Al Imam University in Riyadh, Saudi Arabia. Prior to his faculty position at Al Imam University, he was a faculty member at King Khalid University (Saudi Arabia), Picardie University (France) and Lorraine University (France). He received his Ph.D. in Materials Physics (1999) and M.S. degree in Materials Sciences and engineering (1995) from Lorraine University (France). Current research interests touch all aspect of magnetic nanomaterials; these include, but not limited to, magnetic nanoparticles, diluted magnetic semiconductors and magnetic thin film. Mohamed Lemine is research group leader and founder of Magnetic Materials Laboratory (MLL) at Al Imam University (KSA). He is the recipient of numerous awards including the Chinguitt Award for Sciences and Technologies in 2012 (Mauritania), awards for the international publications record at Al imam University., distinguished Scholar Award (AFESD, Kuwait) in 2010. He has a considerable experience in securing external fund (More than 1 million euro), managing research projects, supervising students and teaching. To date he is authored or co-authored more than 100 reviewed journal articles and contributed to four book chapters.

# Oral presentations

# Synthesis and Characterization of $ZnO_{95\%}/Cd_{5\%}$ Nanocomposites via Co-Precipitation Method

Sellemhe Brahim salem[1], Mohammed Ould M'hamed[1*], Khalidou Ba[2], O.M. Lemine[3] and Mohamed Said Mohamed Sidya[1]

[1]*Unité de Chimie Verte, de Valorisation des Bioresources et de l'Environnement (UC2VBE), Département de Chimie, Faculté des Sciences et Techniques, Université de Nouakchott, Mauritania.*

[2]*Unité de recherché: Chimie des Matériaux, Département de Chimie, Faculté des Sciences et Techniques, Université de Nouakchott, Mauritania.*

[3]*Magnetic Materials Lab (MML), Department of Physics, College of Sciences, Imam Mohammad Ibn Saud Islamic University (IMISU), Riyadh 11623, Saudi Arabia.*

**Corresponding Autor's Email: medabdelwedoud@gmail.com ; m.mhamed@univ-nkc.mr*

***Abstract:*** Cadmium-doped ZnO nanocomposites ($ZnO_{95\%}/Cd_{5\%}$) were synthesized using a simple, eco-friendly, and efficient co-precipitation method. X-ray diffraction (XRD) confirmed the formation of a wurtzite ZnO structure, with lattice expansion suggesting effective Cd incorporation. Scanning electron microscopy (SEM) and energy-dispersive X-ray (EDX) spectroscopy demonstrated uniform morphology and homogeneous elemental distribution. These results demonstrate that Cd doping significantly improves the structural characteristics of ZnO, enhancing its potential for applications in optoelectronics, photocatalysis, and gas sensing.

***Keywords*:** Nanocomposite, Zno/Cd, NPs,SEM , EDX ,TG/DSC, FTIR.

## INTRODUCTION

In recent years, metal oxide nanocomposites have attracted significant interest due to their distinctive structural, electrical, photocatalytic, mechanical, adsorptive, thermal, and optical properties [1,2]. Zinc oxide (ZnO) is an intrinsic n-type semiconductor characterized by a wide direct bandgap of 3.37 eV and a high exciton binding energy of 60 meV, making it well-known for its excellent physical, optical, and electrical properties [3]. Cadmium oxide (CdO), also an n-type semiconductor, possesses a direct optical bandgap ranging from 2.2 to 2.5 eV and is noted for its outstanding optical, electrical, catalytic, and chemical characteristics [4]. A variety of synthesis methods have been developed to produce metal oxide nanocomposites with precise control over their structural and functional characteristics. Among them, the co-precipitation technique stands out as the most widely used due to its simplicity, efficiency, low processing temperature, fast reaction time, and cost-effectiveness [5]. The objective of this study is to synthesize ZnO/Cd nanocomposites using the co-precipitation method.

## MATERIALS AND METHODS

ZnO doped with 5% Cd ($ZnO_{95}\%/Cd_5\%$) was synthesized via the co-precipitation method. Cadmium and zinc acetate dihydrates were separately dissolved in deionized water, then combined and stirred for 40 minutes. A NaOH solution was added dropwise to adjust the pH to ~9, followed by 1 hour of stirring to form a precipitate. The product was collected, washed with deionized water and ethanol, and calcinated at 400 °C for 4 hours.

## RESULTS AND DISCUSSION

X-ray diffraction (XRD) serves as the primary technique for characterizing material properties, including crystal structure, crystallite size, and strain. Fig. 1 displays the X-ray diffraction (XRD) pattern of undoped and Cd-doped ZnO nanoparticles. The presence of sharper diffraction peaks in the pattern signifies the commendable crystallinity of the synthesized samples. Moreover, the broad positions of the nanocrystalline samples suggest a strong conformity with the standard ICDD file (ICDD Card no. 36–1451).

The SEM images of the $ZnO_{95\%}/Cd_{5\%}$ nanoparticles display a relatively uniform and densely packed surface morphology, consisting of spherical to slightly irregular grains. These grains are tightly clustered, forming agglomerates due to their nanoscale dimensions and elevated surface energy. This morphological pattern reflects the effectiveness of the co-precipitation synthesis method, which is known for producing nanocrystals with high surface area and abundant active sites [6].

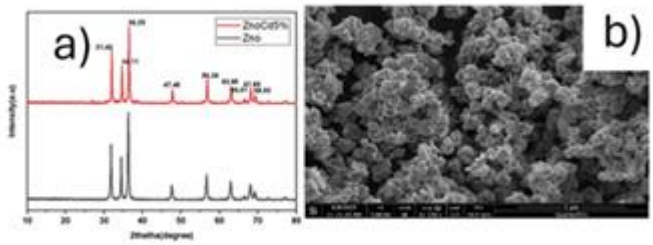



**Fig. 1. a)**XRD and (b) SEM image of ZnO95%/Cd5%

## CONCLUSIONS

In this study, ($ZnO_{95\%}/Cd_{5\%}$) particles were successfully synthesized via the co-precipitation method. Structural, morphological confirmed the effective incorporation of Cd into the ZnO matrix. X-ray diffraction (XRD) analysis revealed a hexagonal wurtzite phase with slight peak shifts indicative of lattice strain caused by Cd doping. SEM analysis showed uniformly dispersed spherical particles.

## REFERENCES


[1] Rajeshwar K, et al. *Chem. Mater,* 2001, **13**, 2765.
[2] Camargo PHC, Satyanarayana KG, Wypych F. *Mater, Res*. 2009, **12**, 1.
[3] Tabib A, et al. *Appl. Surf. Sci.* 2017, **396**, 1528.
[4] Kumar PS, etal. *RSC Adv.* 4 2014, **4**, 32977.

[5] Chaturvedi S, Kuhn M, Jirsak T, Rodriguez JA, González L, Maiti A, Pérez M. *J. Am. Chem. Soc.* 2002, **122**, 12362.
[6] Pratheepa MI, Lawrence M. *Vacuum.* 2019, **162**, 208.

# High electrical conductivity at room temperature of MnCo2O4 Cobaltite spinel prepared by sol gel method

**Issa EL HEDA**
**Sfax University, Tunisie**

**Abstract**
In a nutshell, the sol-gel route was invested to synthesize the pure-phase MnCo2O4 spinel oxide. X-ray diffraction revealed a pure compound that crystallized in the cubic structure with the Fd3m space groupe. The infrared spectrum (IR) displayed two absorption peaks that can be assigned to the Mn-O and Co-O vibrations in the octahedral and tetrahedral sites, respectively. The electrical and dielectric investigation was marked by impedance spectroscopy (IS) at a large frequency (40-106Hz) and temperature ranging from 200 to 440K.To this extent, the DC conductivity presented a semi-conductor behavior. It is worth mentioning that the conductivity of our studied cobaltite spinel proved to be σ= 6.10-3 Sm-1 at room temperature. These finding made of our material a good candidate for potential application as an anode material (fuel cell). The AC conductivity obeys Jonsher's law at low temperatures T<340K and the Drude model at high temperatures T>340K. In addition, the dielectric studies indicated that the permittivity (ε '≈ 103) refers to the contribution of the Maxwell-Wagner polarization. The conductivity analysis confirms the thermally activated dependence on temperature, which goes in good agreement with the impedance and modulus analysis. At this stage of analysis, we would assert that the investigation of MnCo2O4 has been considered technologically important because the compound presents a high conductivity and permittivity at room temperature. From this perspective, these excellent properties make the MnCo2O4 material a promising candidate for electronic applications. Indeed, tacking this area is extremely promising as it lays the ground for fruitful and constrictive investment in vital domains that would further brush up the quality of our everyday life.

**Keywords:** Cobaltite spinel ; dielectric properties; structural properties ; High electrical conductivity

# A green synthesis of a ZnO nanoparticles-based material using *Peganum harmala* leaf extract for photocatalytic degradation of wastewater pollutant dyes

Maime Bouh[(a)], H. Najar[(a)], M A. Sanhoury[(b,c)], Z. Ksibi[(a)]

[a] *Laboratory of Materials Chemistry and Catalysis, Faculty of Sciences of Tunis, Department of Chemistry, University of Tunis El Manar, 2092, Tunis, Tunisia*

[b] *Laboratory of Structural Organic Chemistry: Synthesis and Physico-chemical Studies, Department of Chemistry. Faculty of Sciences of Tunis, University of Tunis El Manar, 2092, Tunis, Tunisia*

[c] *Materials Chemistry Research Unit, Department of Chemistry. Faculty of Sciences and Techniques, UN, Nouakchott, Mauritania*

**Abstract:** The textile industry releases a significant amount of dyes into wastewater, which poses environmental hazards and threatens living organisms. The degradation of these dyes using photocatalysts has garnered attention from various research groups. In this study, we report on the photocatalytic activity of a green synthesized material based on zinc oxide nanoparticles using *Peganum harmala* leaf extract. his system is characterized by its point of zero charge ($pH_pzc$) and by $^1H$ nuclear magnetic resonance ($^1H$ NMR) spectroscopyand IR spectroscopy. The influence of different parameters for the degradation of industrial dye was studied. Results indicate that the zinc oxide nanoparticles synthesized via an environmentally friendly method using a plant leaf extract can be utilized for various environmental and industrial applications.

**Keywords**:ZnOnanoparticles, photodegradation, green synthesis, dye,*Peganumharmala.*

**1. INTRODUCTION:**Nanoscience and nanotechnology are gaining increasing interest. They are the most emerging fields in recent decades and are growing along with physics, chemistry, biology, molecular engineering. Nanomaterials are in versatile use in pharmaceutical, cosmetic, textile, and even electrical and electronics industries. Many types of metal and metal oxide nanoparticles (NPs) such as aluminium, nickel, silver, copper, copper oxide, iron, iron oxide, cerium dioxide, titanium dioxide and zinc oxide (ZnO) are commonly known [1,2]. Among all metal oxides, zinc oxide has several applications of ZnO in engineering, biological and medicinal fields. ZnO NPs have various engineering uses, such as in solar cells, gas sensors, chemical sensors, biosensors and photodetectors [2].

Importantly, studies have supported the synthesis of ZnO NPs in several nanosized from various plant parts like the leaf, flower, seed, fruit, root, rhizome,

stem, bark, shell and peel extracts. For example, researchers have used: leaf extracts of various plants [3], Recently, the green synthesis of ZnO NPs using Cocos nuciera leaf extract with profound antimicrobial, antioxidant and photocatalytic activity was reported [3].

In this work, we describe a green synthesis of a ZnO nanoparticles-based material using *Peganum harmala* leaf extract for photocatalytic degradation of industrial colorant as a polluting dye in wastewater. This plant belongs to the family Zygophyllaceae, and is used in the traditional medicinal systems of Pakistan, China, Morocco, Algeria, and Spain to treat several chronic health disorders [4].

## 2. MATERIALS AND METHODS

The steps used for the synthesis of ZnO nanoparticless are summarized in Figure 1.

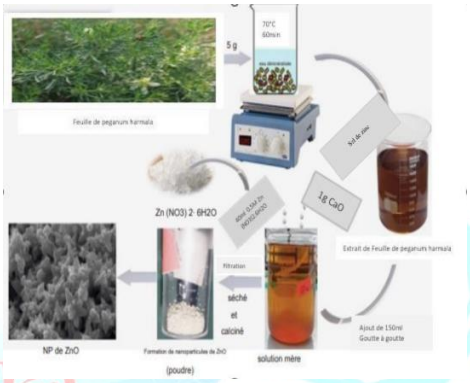



***Figure 1*** **:** *Sequential steps for the synthesis of ZnO NPs using Peganum harmala leaf extract.*

## 3. RESULTS AND DISCUSSION

*3.1. Phytochemical characterization of the Peganum harmala extract by ¹H NMR*

The ¹H NMR spectrum of the *Peganum harmala* leaf extract shows signals in the region of 0.8–1.5 ppm indicating aliphatic protons, typical of methyl or methylene groups. The peaks between 2.5 and 3.5 ppm correspond to protons bound to amine groups or to substituted aromatic rings, which are characteristic of the alkaloids present in this plant [22].

*3.2. Measurement of the Point of Zero Charge (PZC)*

According to figure 2, the material exhibits a point of zero charge (PZC) at approximately pH 10.At pH values below PZC, the surface is positively charged. At pH values above PZC, the surface is negatively charged.

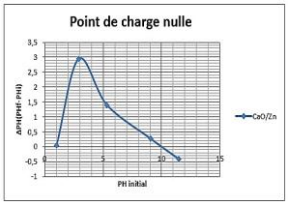


***Figure 2:*** *PZC of ZnO/CaO nanoparticles.*

*3.3. FTIR spectroscopy analysis*

The FTIR spectrum of the prepared ZnO/CaO NPs using *Peganum harmala* extract is illustrated in Figure 3.The peaks that appeared at 3200–3600 $cm^{-1}$ in the FTIR spectrum can be corroborated by the O–H stretching alcohols, stretching vibrations of the primary and secondary amines, and C–H stretching of alkanes. The peaks observed at1568,1411and1100 $cm^{-1}$ were due to the C=C stretching in the aromatic ring in polyphenols and aliphatic amines,while the peak at 2300 $cm^{-1}$ originated from di-substituted alkynes, and the peak at 550 $cm^{-1}$ was from the hexagonal phase of ZnO.

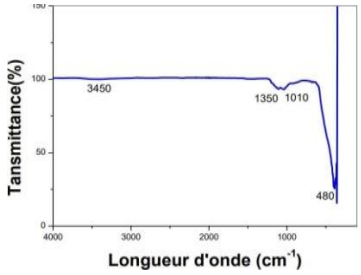



***Figure 3:*** *FTIR spectrum of ZnO/CaO nanoparticles.*

## CONCLUSIONS

We have successfully prepared ZnO/CaO NPs, using *Peganum harmala* leaf extract by a simple, inexpensive and green approach. The prepared NPs were identified and characterized by its point of zero charge ($pH_pzc$), by $^1H$ nuclear magnetic resonance ($^1H$ NMR) spectroscopy and IR analyses. The $^1H$ NMR analysis of the *Peganum harmala* leaf extract confirm the extract's richness in bioactive compounds, particularly alkaloids, and provide a foundation for further chemical and biological studies.FTIR analysis indicated the presence of reducing biomolecules associated with organic functional groups responsible for the encapsulation and stabilization of the NPs.

## REFERENCES

[1] Rastogi A, Zivcak M, Sytar O, Kalaji HM, He X, Mbarki S, Brestic M. 2017 Impact of metal and metal oxide nanoparticles on plant: a critical review. Front. Chem. 5, 1–16. (doi:10.3389/ fchem.2017.00078)

[2] Marassi V, Cristo LD, Smith SGJ, Ortelli S, Blosi M, Costa AL, Reschiglian P, Volkov Y, Prina-Mello A. 2018 Silver nanoparticles as a medical device in healthcare settings: a five step approach for candidate screening of coating agents. R. Soc. Open Sci. 5, 171113. (doi:10. 1098/rsos.171113)

[3] Chang S, Chen K. 2012 Zinc oxide nanoparticle photodetector. J. Nanomater. 2012, 1–5. (doi:10.1155/2012/602398)

[4] Elansary, H.O.; Szopa, A.; Kubica, P.; Ekiert, H.; Al-Mana, F.A.; El-Shafei, A.A. Polyphenols of Frangula alnus and Peganum harmala leaves and associated biological activities. Plants 2020, 9, 1086.

# Bioengineering of α-$Zn_2$-$TiO_4$ nanomaterials using hibiscus sabdariffa: electrochemical, and photocatalytic applications

A. Fall[1*], and M. Maaza[1]

[1]UNESCO-UNISA Africa Chair in Nanosciences-Nanotechnology, College of Graduate Studies, Muckleneuk Ridge, PO Box 392, Pretoria, South Africa

*Corresponding Author: Adama FALL
Email: 64122557@mylife.unisa.ac.za

Bioengineering of bimetallic oxides is a significant requirement for both social and environmental applications. In this work, bimetal oxide nanomaterials, Zinc orthotitanate $\alpha$-$Zn_2$-$TiO_4$ was produced using a green process which utilizes natural extract of *Hibiscus*. A variety of techniques were applied to analyse their physicochemical properties and verify the production of the $\alpha$-$Zn_2$-$TiO_4$ nanoparticles. The XRD analysis illustrated the crystalline structure of the $\alpha$-Zn-$TiO_4$ nanocomposites. The SEM analysis showed the morphology of the compounds $\alpha$-$Zn_2$-$TiO_4$ to be highly porous. The EDS analysis validated the presence of elements such as O, Ti, and Zn while FTIR analysis indicated the existence of multiple functional groups, including O-H, C-H, C=O, Ti-O, and Zn-O bonds in the compound. The PL peaks identified at 240 and 450 nm are attributed to the charge transfer characteristics present in the surface state of the resulting product. The DLS measurement verified the nanoscale distribution of the compounds, corresponding with the findings from the SEM analysis. Moreover, the electrochemical characteristics of $\alpha$-$Zn_2$-$TiO_4$ nanocomposite, along with its effectiveness in degrading Methylene Blue (MB) dye, demonstrated a photodegradation rate of 92.3%, thereby emphasizing the advantages of Hibiscus-mediated green synthesis.

**Keywords:** *Hibiscus,* $\alpha$-$Zn_2$-$TiO_4$, Photoactivity, Electrochemical Properties.

# Ball milling effect on physical properties of magnetite extracted from SNIM iron ore

Zeine Abderrahmane[1], A. H. Barry[1*] and O.M. Lemine[2]

[1]*UR Chimie des Matériaux (ChiMat), Département de Chimie, Faculté des Sciences et Techniques,*
*Université de Nouakchott, Mauritania.*

[2]*Magnetic Material Lab (MLL), Imam University, Riyadh, Saudi Arabia*

**Corresponding Autor's Email: barryaliouhamady@ymail.com*

***Abstract:*** We invstigated the structural and magnetic properties of ball milled magnetite collected from SNIM iron ore by using X ray diffraction (XRD) and Vibrating sample magnetometer (VSM) techniques. XRD results showed that the main peaks of are characteristic of magnetite, with decreases in size. Both sample are ferrimagnetic but the milling induces an increase of saturation from 51.5 emu/g to 57 emu/g indicating the effciency of ball milling technique as method for the improvment of magnetism.

***Keywords*:** Magnetite, Ball milling, XRD, VSM

## INTRODUCTION

In recent years, iron oxides nanoparticles have attracted significant interest due to their several application in many field such such as catalysis, electronicm water treatment, biomedical [1,2] . Among iron oxide NP, magnetite is ferrimagnetic with high saturation and their structural and magnetic properties are size independant [2]. Many research groups synthezided these NPs by using chemical methods such as sol-gel, co-precipitation [3]. In this work, we are investigating the effect of milling on magnetite materials extracted from iron Ore in Mauritania.

## MATERIALS AND METHODS

Magnetite samples were collected from iron ore in Mauritania, which is generally exported outside the country. Sample was ball milled in Fritsch machine (P7) with stainless steel. The rotation speed was 350 rpm with milling time of 20 hrs. XRD analysis was performed using Bruker D8 Discover diffractometer (θ-2θ) equipped with Cu-K$\alpha$ radiation ($\lambda$=1.5406 Å). Vibrating sample magnetometer (VSM, model 7404) equipped with 1.8 T magnet was used for magnetic characterization at room temperature.

## RESULTS AND DISCUSSION

Fig. 1 displays the X-ray diffraction (XRD) pattern of as received and ball milled magnetite. The main peaks are characterisitics of magnetite with the presence of small

peaks du to Silica. After milling, the peaks become broder indicating reduction of size but the phase remains the same. Magnetic measurments at room temperature reveal ferrimagnetic behavior of the as received magnetite with remenance, coercivity and saturation of 4.5 emu/g, 67 Oe and 51.5 emu/g respectively. After milling time of 20h, no change in the magnegtic behavior but the all the parameters increase indicating the transition to hard magnetic materials. The saturation increases slightly 57 emu/g while remenance and coercivity increaes to 13 emu/g and 309 Oe respectively. We can conlude that ball milling induces an increase in the magnetization parameters, which might be intersting for many applications.

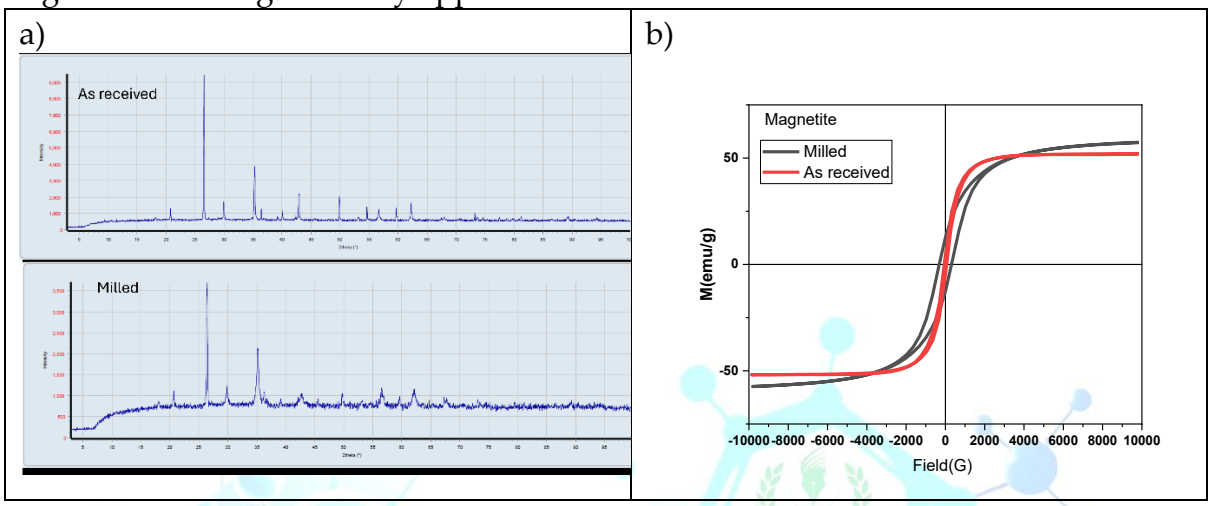



**Fig. 1.** Magnetite as received and ball milled : **a)** XRD and (b) magnetization at room temperature of

## CONCLUSION

In this study, we characterized ball milled magnetite collected from iron ore by using XRD and VSM techniques. Our results reveal that the structure remains the same while the size decreases with milling time. Magnetization measurements show an improvment of magnetization, where saturation increases from 51.1 emu/g to 75 emu/g indicating the effciency of ball milling technique as method for the preparation of magnetic nanoparticles.

## REFERENCES

[1] Lemine, O,M et al. Nanomaterials 2023, 13, 453 .
[2] K. El-Boubbou et al. New Journal of Chemistry, 46 (2022), 5489-5504.
[3] M. L. Rivas-S´anchez et al. Earth Planets Space, 61, 151–160, 2009

# Nanocellulose-Polyaniline Aerogel: A Novel Approach for Solar-Based Water Purification.

Abderrehmane Ejaje [1], Aymen BEN MABROUK [1], Sami BOUFI [1*]

[1] University of Sfax, Faculty of Sciences, LSME, BP 1171, 3018, Sfax, Tunisia.

Abderrehmane ejaje abderrehmane.ejaje.etud@fss.usf.tn

Aymen ben mabrouk aymenbenmabrouk@yahoo.fr

sami_boufi sami_boufi@yahoo.com

***Keywords***: CNF aerogel, polyaniline, photothermal conversion, water purification

## ▪ Objectives

The objective of this study is to develop a hybrid nanocellulose-polyaniline (NFC/PANI) aerogel as a self-floating device for solar steam generation, within the framework of solar energy-based water purification. The hybrid aerogel was synthesized by lyophilizing nanocellulose followed by in situ polymerization of aniline onto the NFC. The study also aimed to analyze the morphology, crystal structure, thermal stability, and interactions between cellulose nanofibrils (CNF) and PANI. This research seeks to optimize the properties of the aerogel, particularly its photothermal conversion efficiency and water vapor evaporation rate, for potential use in water purification applications.

## ▪ MATERIALS AND METHODS

The preparation method used in this study involves the following steps:

- Lyophilization of Nanocellulose: Nanocellulose is first lyophilized (freeze-dried) to form a porous structure.
- In Situ Polymerization of Aniline: Aniline is polymerized onto the nanocellulose (NFC) in situ. This process occurs in the presence of hydrochloric acid (HCl) and ammonium persulfate (APS) as a catalyst.

## ▪ RESULTS AND DISCUSSION

The results obtained from this study are as follows: The NFC-PANI hybrid aerogel displayed outstanding structural and functional properties. It possessed an ultralow density of 0.03 g/cm$^3$ and a porosity exceeding 95%, enabling it to float on water. In addition, the aerogel exhibited remarkable water transport capability and high light absorption efficiency. In terms of photothermal performance, the optimized CNF-PANI [1:20] hybrid aerogel demonstrated excellent photothermal conversion, reaching surface temperatures of approximately 105 °C under xenon lamp irradiation. When applied as a steam evaporation device, the NFC-PANI aerogel achieved a high evaporation rate of up to 6.1 kg m$^{-2}$ h$^{-1}$ under comparable

experimental conditions.

- **CONCLUSIONS**

In summary, CNF/PANI hybrid aerogels were successfully prepared as integrated three-dimensional suspension steam generation materials using a lyophilizaion of CNF and in situ polymerization. The CNF/PANI aerogel demonstrates a promising water evaporation performance, owing to its photothermal conversion capacity of maintaining a temperature high up to about 105 °C under an irradiation of 1 sun in 210s, Under the irradiation of 1 sun, the water evaporation rate and solar steam generation efficiency of the CNF/PANI [1:20] aerogel reached 2,42kg m−2 h−1 and 90%, respectively. The hybrid aerogel achieves high purification for saliner. With these promising properties, this green and sustainable hybrid aerogel may offer great potentials for seawater desalination and wastewater treatment.

**REFERENCES**

[1] Xu C, Zhang J, Shahriari-Khalaji M,Gao M, Yu X, Ye C, Cheng Y and Zhu M (2022) Front. Chem (2022) 5669–5678.

[2] Zhou, L.; Li, X.; Ni, G. W.; Zhu, S.; Zhu, J. The revival of thermal utilization from the sun: interfacial solar vapor generation Natl. Sci. Rev. 2019, 6 (3), 562–578.

[3] N. El Miri, K. Abdelouahdi, A. Barakat, M. Zahouily, A. Fihri, A. Solhy, M. El Achaby, Carbohydrate Polymers. 129 (2015) 156–167.

# Numerical simulation of the effect of nanofluids on the thermal performance of a thermosiphon solar water heater in a Sahelian climate (case study: Mauritania)

Cheikh Brahim Mohameden[1], Khayar Abderrhmane[1], Sidi Mohamed Ahmedou Yahya[1]
Varha Malloume[1], Ahmed Mohamed Yahya[1], Abdel kader Mahmoud[1]

[1] Applied research unit for Renewable Energy, Water and the Environment, Faculty of Science and Technology, University of Nouakchott
cheikhbrahimmohameden@gmail.com

***Abstract:***
This study presents a numerical simulation of the effect of nanofluids on the thermal performance of a thermosyphon solar water heater under Sahelian climate conditions, with a particular focus on Mauritania. The developed model accounts for the modified thermophysical properties of nanofluids obtained by dispersing metallic and oxide nanoparticles ($Al_2O_3$, $TiO_2$, CuO, graphene) into water. The results indicate a significant enhancement in the thermal conductivity of the working fluid, leading to an overall improvement in system efficiency ranging from 5% to 15%, depending on the type and concentration of nanoparticles. The use of nanofluids also reduces the water heating time and optimizes performance during periods of high solar irradiation typical of the Sahelian climate. These findings highlight the potential of nanofluids as an innovative solution to enhance the performance of solar water heaters in Mauritania, while emphasizing the need for further experimental investigations regarding their long-term stability and economic feasibility.

***Keywords*:**
Nanofluids ; Thermosyphon solar water heater ; Numerical simulation ; Thermal performance ; Sahelian climate ; Mauritania ; Energy efficiency.

# First-Principles Study of Mg-Doped Ni Alloys: Phase Stability, Electronic Hybridization and Magnetic Suppression

S.Ahmedbowba[1,*], F.Khadri[1], B.Khalil[2], and O.M.Lemine[3]

[1]LSAMA, Department of Physics, University of Tunis El Manar, Tunis 2092, Tunisia

[2]Department of Physics, University of Nouakchott, Nouakchott, Mauritania

[3]Department of Physics, College of Sciences, Imam Mohammad Ibn Saud Islamic University (IMSIU), Riyadh 11623, Saudi Arabia

*Corresponding Author: ahmedbowba.sidi@etudiant-fst.utm.tn

## Abstract

This study provides a first-principles investigation of the structural, electronic, and magnetic prop- erties of Mg-doped Ni alloys with direct relevance to lightweight magnetic and spintronic applications. Spin-polarized density functional theory calculations, employing PBE and LDA functionals, were per- formed for Mg concentrations between 0 and 40%. The results establish that the hexagonal close-packed phase is energetically favored over the face-centered cubic (fcc) structure. Mg incorporation induces strong Ni-3d/Mg-3s,-3p hybridization, suppresses the density of states at the Fermi level by nearly 40%, and reduces the average Ni magnetic moment from 0.585 $\mu_B$ to 0.324 $\mu_B$. These findings highlight Mg doping as an efficient route for tailoring the functionality of lightweight magnetic materials toward next-generation energy-efficient devices.

**Keywords:** Mg–Ni alloys, Spin-polarized DFT, Electronic structure, Magnetic moment, Phase stability

## INTRODUCTION

Nickel (Ni), an intrinsically ferromagnetic transition metal, is central to materials science owing to its high electrical conductivity, moderate corrosion resistance, and partially filled 3*d* band, which under- pin its roles in catalysis, magnetic storage, and energy conversion. Alloying with lightweight, elec- tropositive magnesium (Mg) offers a promising route to modulate both electronic and magnetic prop- erties while reducing density. This study employs density functional theory (DFT) with Perdew-Burke- Ernzerhof (PBE) and Local Density Approximation (LDA) functionals to systematically investigate Mg- doped hcp-Ni. alloys across 0–40% of Mg substitution, examining: (i) structural and energetic stability,

(ii) electronic structure evolution, and (iii) magnetic moment suppression [1],[2],[3].

## COMPUTATIONAL METHODS

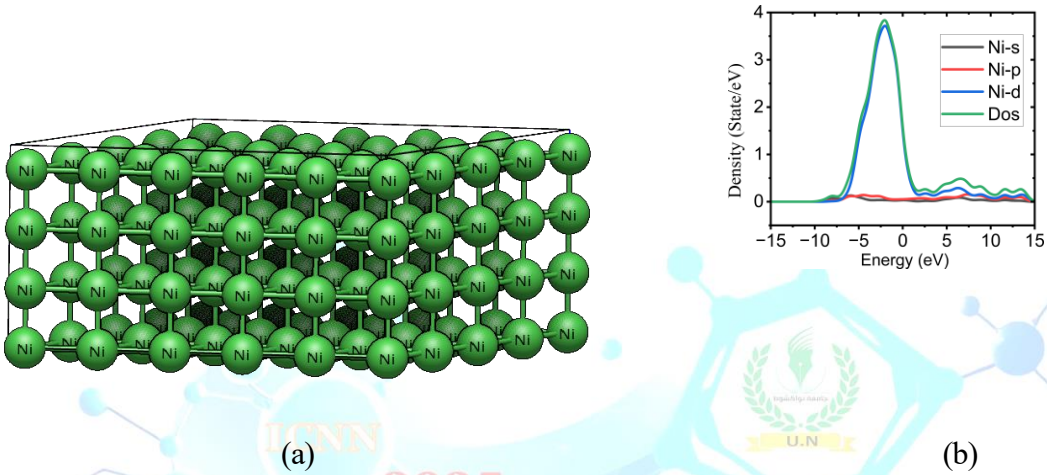
Spin-polarized DFT calculations were performed using the CP2K package code with the Gaussian and Plane-Waves approach. Both fcc and hcp Ni supercells were generated by replicating the conventional unit cell in a 5 × 3 × 4 arrangement, yielding 120-atom models. For the hcp phase, the Mg substi- tution levels of 10%, 20%, 30%, and 40% were modeled. For the structural relaxations we used the Broyden-Fletcher-Goldfarb-Shanno algorithm (BFGH) with convergence criteria of forces 0.05 $eV/\AA$ and displacements 0.05 $\AA$ . The

DZVP-MOLOPT-SR-GTH basis sets and GTH pseudopotentials were employed with a plane-wave cutoff of 500 Ry [4] .

## RESULTS AND DISCUSSION

### Structural Stability

Comparative total-energy analyses revealed the hexagonal close-packed configuration panel a of Fig- ure 1 as energetically more favorable than the face-centered cubic phase. The total energy decreased systematically with increasing Mg concentration for both LDA and PBE functionals, indicating alloy destabilization due to Mg's lower cohesive energy and disruption of Ni–Ni metallic bonding.




(a) (b)

Figure 1: Optimized hcp-Ni supercells: (a) 120 atoms, (b) Density of states (DOS) of pure Ni.

### 1.1 Electronic Structure

Density of states (DOS) analysis revealed pronounced Ni-3*d*/Mg-3*s*/3*p* hybridization and a downward shift of the Ni-*d* band center by approximately 1.2 eV with increasing Mg content. This electronic recon- struction results in a reduction of more than 40% in the density of states at the Fermi level, indicating weakened metallic character and potential magnetic suppression, as illustrated in panel (b) of Figure 1. such behavior is particularly favorable for the design of novel smart materials, where tunable electronic and magnetic properties are essential for advanced functional applications.

Table 1: Binding energy positions of the primary Ni-3*d* peak for different Mg concentrations.

| Mg concentration | LDA (eV) | PBE (eV) |
|---|---|---|
| 0% | -1.3 | -1.5 |
| 10% | -1.8 | -2.0 |

| | | |
|---|---|---|
| 20 % | -2.0 | -2.2 |
| 30% | -2.2 | -2.5 |

### Magnetic Properties

By increasing Mg concentration the total magnetic moment decreased markedly,This reflect a magnetic quenching induced by dilution of the Ni magnetic sublattice with the non-magnetic Mg atoms. The average Ni moment decreases from 0.585 $\mu_B$ to 0.324 $\mu_B$, consistent with the observed reduce in the density of states at the Fermi level.

## CONCLUSIONS

This first-principles study demonstrates that Mg doping effectively modifies Ni's structural, electronic, and magnetic properties. The hcp phase is more stable than the fcc one across all Mg concentrations. The electronic structure shows strong hybridization and a reduced density of states at Fermi level. Magnetic moment Such suppression of the magnetic moment positions Mg–Ni alloys as promising candidates for integration into lightweight magnetic devices, particularly in spintronic architectures, magnetic sensors, and energy-efficient memory technologies, where controlled magnetism and reduced electronic losses are critical.

## References


[1] E. Pellicer, S. Pane´, S. Suriñach et al., *Electrochim. Acta* **56**, 273-281 (2010).

[2] W. Zhang, Y. Li, X. Chen, *Phys. Rev. B* **105**, 184422 (2022).

[3] T. D. Ku¨hne, M. Iannuzzi, M. Del Ben et al., *J. Chem. Phys.* **152**, 194103 (2020).

[4] J. P. Perdew, K. Burke, M. Ernzerhof, *Phys. Rev. Lett.* **77**, 3865-3868 (1996).

# Préparation de nanoparticules de ZnSe et CdSe capées par des ligands phosphorylés du type $R_2NP(O)(OR')_2$ et $(R_2N)_3PO$

Khaled Ebeid,[1,2] S. Camara,[1] I. Zerough,[1,2] M.A.K. Sanhoury, [1,2*]

[1)] *Unité de recherche de chimie des matériaux, Faculté des Sciences et Techniques, Nouakchott, Mauritanie*

[2)] *Laboratoire de Chimie Organique Structurale: Synthèse et Etudes Physicochimiques, groupe de chimie de coordination, Département de chimie, Faculté des Sciences de Tunis, campus universitaire El Manar I, 2092, Tunis, Tunisie*

**Corresponding Autor's Email: senhourry@yahoo.com*

**Résumé**

Les composés organophosphorés sont aujourd'hui des intermédiaires reconnus en synthèse organique et inorganique, leur large potentiel synthétique a été fortement exploité et plusieurs revues y ont été consacrées. En effet, les chalcogénures de phosphine de type $R_3PE$ (E = O, S, Se) sont largement étudiés dans la littérature. En plus, les composés sélénoophosphorés sont particulièrement utilisés comme précurseurs pour la préparation de monocristaux. En continuation de nos travaux sur la chimie des composés organophosphorés, nous décrivons dans ce travail la préparation de nanoparticules de ZnSe et CdSe capées par des ligands phosphorylés du type $R_2NP(O)(OR')_2$ et $(R_2N)_3PO$. Toutes ces nanoparticules ont été caractérisées par diffraction des Rayons-X sur poudre, infrarouge, et UV-visible. La formation des composés a été aussi confirmée en IR par l'apparition des bandes caractéristiques attribuées aux agents coupants autour des NPs en ME.

**Mots clés***:* Agents coupants, zinc et cadmium, nanoparticule ME, IR, RX.

## 1. Introduction :

Les ligands organophosphorés de type $R_3PE$ (E = O, S, Se) sont répandus dans la chimie de coordination des métaux de transition et du groupe principal de métaux [1-3]. Ayant trouvé des applications importantes dans les domaines de la chimie bio inorganique et des nanosciences [4], ils ont attiré attention de plusieurs groupes de recherches [5]. Certains métaux avec les ligands de chalcogenure de phosphines sont utilises pour la préparation de monocristaux de chalcogénures métalliques de type ME (M = Zn, Cd ou Hg ; E = S, Se ou Te) [6]. Nous décrivons dans ce travail la synthèse d'une nouvelle série de nanoparticles (NPs) du type CdSe et ZnSe avec les agents capants phosphorylés du type $(R_2N)_3PO$ ou $R_2NP(O)(OR')_2$ (R' = Hexyl ou Octyl ; $R_2N$ = Pyrrolidinyl ou Pipéridinyl). Ces composés ont été caractérise par diffraction des Rayons-X sur poudre (DRX), infrarouge (IR), et UV-visible (UV-vis). La formation des

composés a été aussi confirmée en IR par l'apparition des bandes caractéristiques attribuées aux agents coupants autour des NPs en ME.

## 2. Matéreils et Méthodes :

Dans un ballon de 250 ml, on dissout 0,28 g d'acétate de métal (1,35mmol), dans une solution de l'agent capant $(Et_2N)_3P(O)$ (1,35mmol). Ce mélange est chauffé à 110°C, puis on ajoute 2.5 ml du séléniure de la phosphine correspondante le mélange réactionnel est chauffé pendant 5h à une température de 150°C. Le méthanol est ajoute à la suspension jaune obtenue pour stimuler une précipitation supplémentaire. Par la suite la suspension est centrifugée 3 fois à 4000 rpm pendant une demi-heure, puis lavée 2 fois par un mélange de 50% méthanol et 50% hexane et séché à l'étuve à 100°C.

## 3. Résultats et Discussion :

La synthèse des nouveaux nanoparticles (NPs) de CdSe et ZnSe capées par les ligands phosphorylés du type type $(R_2N)_3PO$ ou $R_2NP(O)(OR')_2$ (R' = Hexyl ou Octyl ; $R_2N$ = Pyrrolidinyl ou Pipéridinyl). a été effectuée suivant les méthodes décrites dans littérature [7-8] selon le schéma réactionnel suivant :

$$M(CH_3COO)_2 + (Et_2N)_3PSe \xrightarrow[150\ °C\ /\ 5h]{R_3P(O)/(Et_2N)_3P} MSe/(R_3)P(O)$$

M = Cd ou Zn

R1 = $(Et_2N)_3PO$; R2 = $(HexO)_2P(O)Pip$ et R3 = $(OctO)_2P(O)Pyrr$

Ces NPs ont été caractérisées par diffraction des Rayons-X sur poudre (Fig. 1), infrarouge, et UV-visible. La formation de ces NPs a été aussi confirmée en IR par l'apparition des bandes caractéristiques attribuée aux agents coupants phosphorylés (Fig. 2). Ces résultats ont permis de déterminer les tailles de 9 - 14 nm et des énergies de gap (3.00 - 3.60 eV) de différentes NPs.

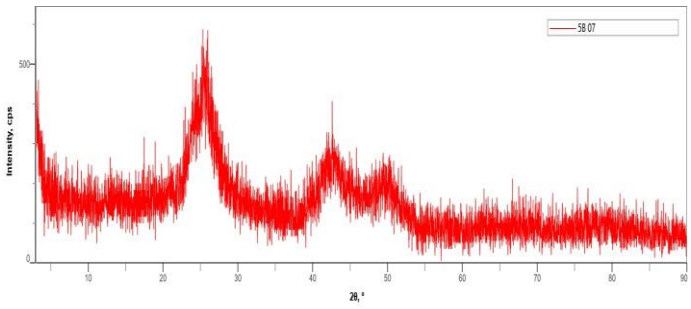
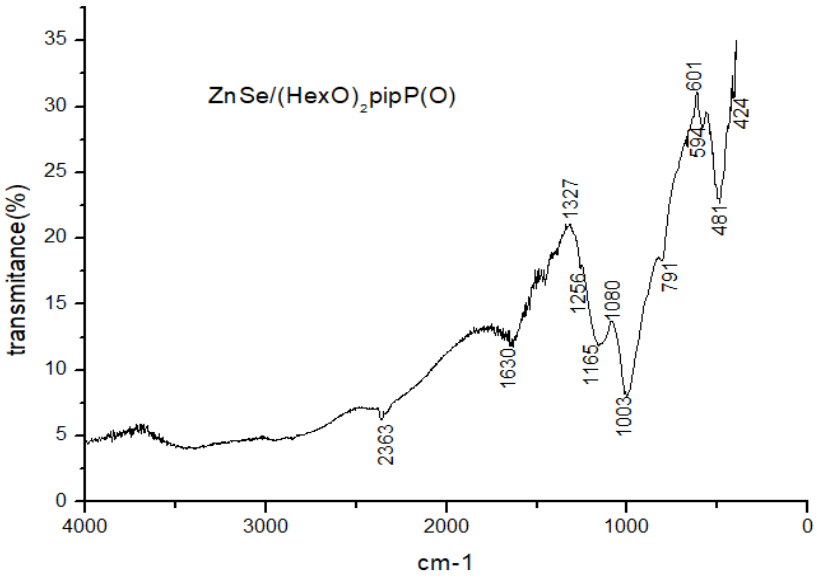



**Fig. 1** : Spectre DRX des nanoparticules de CdSe/$(OctO)_2$PyrrPO.

La figure 1 confirme la phase cubique (zinc-blende) de la structure cristalline des nanocristaux de CdSe capées par le ligand $(OctO)_2$PyrrPO. Leur taille moyenne de 9,4

nm a été calculée à l'aide de l'équation de Scherrer. Les nanocristaux synthétisés ont la même structure cristalline et possèdent chacun une taille moyenne d'environ 12 nm.




**4. C**

Nous av rtir de l'acétate de cadmium et de zinc en présence des différents oxydes des phosphines comme agents capants. Ces nanoparticules ont été caractérisées par DRX, IR et par UV-vis. Les données IR de ces nanoparticules montrent des déplacements des bandes de vibrations υ P=O vers les basses fréquences par rapports à celles de oxydes des phosphines (ligands) libres, ce qui confirme que ces ligands se lient au métal, agissent ainsi comme agents capant. Les spectres UV-Vis permettent d'estimer des valeurs d'énergies de gap de l'ordre de 3,3 eV pour les ZnSe et 3.5 eV pour celles de CdSe. Les analyses par DRX montrent que les nanoparticules de ZnSe et CdSe sont de structure cubique (Zinc Blend) et que leurs tailles varient entre 9 et 16 nm.

**Références :**

[1] M. D. Khan, M. Aamir, N. Revaprasadu., In book: Reference Module in Chemistry, Molecular Sciences and Chemical Engineering., **2020**.

[2] M. M'Haiham, F. Ebnou, K. Ebeid, M. T. Ben Dhia,b et M. A. Sanhoury., *J. Maurit. Chem. Soc*. 2020, **02**, 16-21.

[3] J. Waters, D.J. Crouch, J. Raftery, P. O'Brien. *Chem. Mater.*, 2004, **16**, 3289.

[4] R.A. Kresinski, A.M.J. Lees, A.W.G. Platt, *Polyhedron* ., 2012, **33**,341.

[

# Analyse des performances du stockage solaire dans un capteur à tubes sous vide utilisant un nanofluide $AlO_3$-eau graphite

Sidi Mohamed Mohamed Salem [a], Kamal Bouaraour
[1] *Département de Physique, Faculté des Sciences et Techniques, Université de Nouakchott, Mauritanie*
*Faculté des Sciences et Techniques, Université de Ghardaïa, Algérie*
*Courriels des auteurs correspondants : sasidi309@gmail.com*
*, bouaraourk@yahoo.fr*

***Résumé :*** Le capteur à tube solaire est une méthode efficace et rentable pour convertir l'énergie solaire en chaleur. Cette étude examine théoriquement comment l'utilisation d'un nanofluide $AlO_3$-eau dans un environnement poreux saturé de graphite peut améliorer les performances et le stockage d'énergie. Les équations de conservation ont été déterminées analytiquement et numériquement, et les effets de la température et du nombre de Nusselt sur la porosité, le diamètre des pores, le pourcentage volumique de nanoparticules, la pression et la rayonne conductrice ont été examinés. Les résultats montrent que, comparativement à l'eau seule, le nanofluide améliore significativement les performances et le stockage d'énergie.
***Mots-clés :*** nanofluide, énergie solaire, tube.

## INTRODUCTION

Contrairement aux sources d'énergie conventionnelles, polluantes et éphémères, les énergies renouvelables proviennent de sources durables et propres [1]. Les capteurs de lumière solaire installés dans des tubes immergés constituent un moyen efficace et rentable d'exploiter la source d'énergie la plus abondante et la plus respectueuse de l'environnement [1]. Les performances thermiques de ces capteurs sont améliorées par l'utilisation de nanofluides comme caloporteur de fluide [2]. Introduits par Choi en 1995, les nanofluides sont des colloïdes constitués de nanoparticules solides (1 à 100 nm) dispersées dans des fluides de base comme l'eau, l'huile ou l'éthylène glycol [3,4].

## MATERIAUX ET METHODES

Un modèle 2D a été créé pour un nanofluide $AlO_3$/eau circulant dans un tube immergé saturé en graphite. Les propriétés thermophysiques ont été calculées à partir de la fraction volumique des nanoparticules. Les équations de masse, d'impulsion et d'énergie ont été résolues analytiquement à flux thermique constant. La validation FDM a été réalisée sous MATLAB. La comparaison du nanofluide à l'eau en été et en hiver a permis d'évaluer le stockage d'énergie.

## RESULTATS ET DISCUSSION

Sous le climat de Nouakchott, les performances thermiques de l'eau et des nanofluides $AlO_3$/eau (1,5 % et 6,0 % vol.) ont été évaluées. Les résultats montrent que l'utilisation de nanofluides augmente légèrement la température du fluide par rapport à l'eau, l'effet le plus marqué étant observé à la mi-janvier (Fig. 1). La température maximale

annuelle s'élève progressivement jusqu'à environ 42 °C en décembre, l'impact des nanofluides devenant moins perceptible à des températures ambiantes élevées (Fig. 2). Les gains de performance restent modestes : le tableau 1 montre une amélioration maximale d'environ 0,11 % (nanofluide 1,5 %) et 0,10 % (nanofluide 6,0 %) en février. Tout bien considéré, les nanofluides offrent une amélioration constante mais limitée par rapport à l'eau, confirmant leur potentiel à améliorer la transmission de chaleur dans les climats chauds.

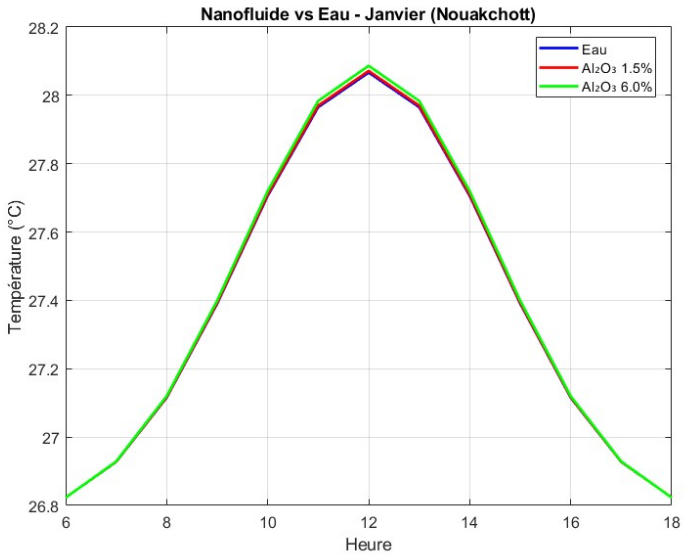



**Fig. 1.** Variation horaire de la température en janvier pour l'eau et les nanofluides $Al_2O_3$/eau à Nouakchott.

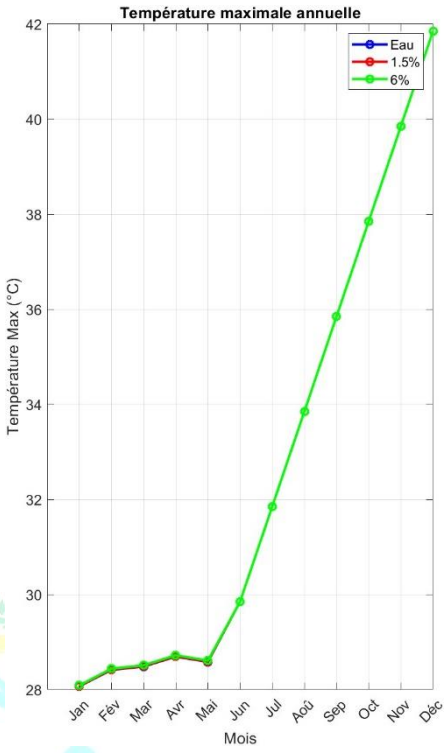



**Fig. 2.** Évolution annuelle de la température maximale pour l'eau et les nanofluides $Al_2O_3$/eau.

**Tableau 1.** Amélioration des performances (%) des nanofluides par rapport à l'eau.

| Mois | Nanofluide (1,5 %) | Nanofluide (6,0 %) |
|---|---|---|
| Janvier | 0,017 – 0,025 | 0,023 – 0,027 |
| Février | 0,070 – 0,107 | 0,096 – 0,110 |

## CONCLUSIONS

Cette étude a montré que, par rapport à l'eau pure, l'utilisation d'un nanofluide $AlO_3$/eau dans un environnement poreux saturé améliore significativement les performances de stockage thermique. Les résultats montrent que même si la porosité, la pression et la rayonne du tube ont un effet inverse, la fraction volumique des nanoparticules et le flux thermique augmentent la température et l'énergie stockée.

Les meilleurs résultats sont obtenus à faibles vitesses et à faibles nombres de Prandtl. Enfin, il est conseillé d'étudier d'autres matériaux et de valider expérimentalement le modèle proposé.

**RÉFÉRENCES**

[1] Sabiha MA, Saidur R, Mekhilef S, et al. *Renew. Sustain. Energy Rev.*, 2015, 51, 1038–1054.
[2] Chopra K, Tyagi VV, Pandey AK, et al. *Appl. Energy*, 2018, **228**, 351–389.
[3] Choi SUS. Enhancing thermal conductivity of fluids with nanoparticles. *Am. Soc. Mech. Eng., Fluids Eng. Div.*, 1995, **231**, 99–105.
[4] Baqaie Saryazdi A, Talebi F, Armaghani T, et al. *Eur. Phys. J. Plus*, 2016, 131.

# Décoration des nanotubes de $TiO_2$ par des nanoparticules de Cu pour des applications environnementales.

*Oumklthoum Mahfoudh Hbib[1,2], Rabia Benabderrahmane Zagouani[2], Anouar Hajjaji[2], Fanta Haidara[1], Mahfoudh Mohamed Abderrahmane Hbib[1], Cheikh Sidi Ethmane Kane[1].*

*[1] Université de Nouakchott, Faculté des Sciences et Techniques, Unité de Recherche, Energies, Matériaux et Télécommunications. BP, 880, Nktt-Mauritanie.*

*[2] Centre de Recherches et des Technologies de l'Énergie, Laboratoire Photovoltaïque, Technopole de Borj-Cédria. BP, Hammam Lif, 2050, Tunis, Tunisie.*

***Résumé :***

La pollution de l'eau par les colorants organiques, comme la Rhodamine B, représente un problème environnemental important. La photocatalyse hétérogène est une méthode prometteuse pour traiter ces polluants, car elle utilise l'énergie solaire pour activer des matériaux photocatalytiques. Le dioxyde de titane ($TiO_2$) est l'un des photocatalyseurs les plus utilisés grâce à sa stabilité, sa non-toxicité et ses bonnes performances sous lumière UV. Les nanotubes de $TiO_2$ (NT- $TiO_2$) présentent une surface active plus élevée, ce qui améliore la dégradation des polluants.

Dans ce travail, nous avons cherché à augmenter l'activité des NT- $TiO_2$ sous lumière visible en les décorant avec des nanoparticules de cuivre (Cu-NPs). Cette décoration favorise la séparation des charges et élargit l'absorption vers le domaine visible. Les échantillons ont été préparés par anodisation, suivie de dépôts successifs par la méthode SILAR. Ils ont été caractérisés par MEB, MET, DRX, réflectivité diffuse et photoluminescence (PL).

Les tests photocatalytiques montrent que sous UV la décoration n'a pas d'effet et le $TiO_2$ pur présente la meilleure activité photocatalytique avec un taux de dégradation de 93,8 % . Sous lumière visible, l'échantillon décoré avec 2 cycles de Cu pendant 30 secondes donne la meilleure performance (56,9 %), supérieure à celle du $TiO_2$ pur (52,9 %). Ces résultats montrent l'intérêt de la décoration au cuivre pour améliorer l'activité des NT- $TiO_2$ sous lumière visible.

***Mots-clés*** : $TiO_2$, nanotubes, cuivre, SILAR, photocatalyse, Rhodamine B.

# Posters

**P1. Hydrothermal—co-precipitation Synthesis of Magnetic $Fe_3O_4/Co_3O_4$ Nanocomposites for efficient Adsorption of phenol in water Treatment.**

Dah Matalaa[b], Alma Mejria, Abdelmoneim Marsa, Chamekh Mbareckb, Abdelmoneim Mars, Chamekh Mbareck

[a.]Laboratory of Natural water treatement (Ladven) water research and technology center(certe) technopole Borj-cedria,BP273,Soliman8020,Tunisia

[b].Membrane,Matériaux,environment et milieu aquatique(2MEMA) University of Nouakchott Al-Aasriya, BP. 5026 FST, Nouakchott, 22245, Mauritania

**P2. Nanostructured electrodes for the study of hydrogen and oxygen evolution reactions: development, characterisation and application**

Mohamed Lemrabott Mohamed [1,2], Abdelmoneim Mars[*]

[1] *Chemestry department, college of sciences, Tunis Elmanar University*

*Email: muhameddlemrabet@gmail.com*

**P3. Nanostructured Tb3+-Doped NaSrGd(MoO4)3 for Ultrasensitive Optical Thermometry Based on Single-Band Ratiometric Luminescence**

Zein El Abidine Aly Taleb[1], Kamel Saidi[1]*, Mohamed Dammak[1], Dominika Przybylska[2], Tomasz Grzyb[2]

[1] Laboratoire de Physique Appliquée, Groupe des Matériaux Luminescents, Faculté des Sciences de Sfax, Université de Sfax, Tunisie [2] Department of Rare Earths, Faculty of Chemistry, Adam Mickiewicz University, Poznań, Poland ,

Corresponding author: zeinelabdnmedmoctar@gmail.com

**P4. Green Synthesis and Characterization of Polymer Matrix Nanocomposites (Co5%/ZnO95%/Chitosan) via Co-Precipitation Method**

Sellemhe Brahim Salem1, Mohammed Ould M'hamed1*, O.M. Lemine2 and Mohamed Said Mohamed Sidya1

1Unit of Green Chemistry, Bioresources and the Environment (UC2VBE), Department of Chemistry, Faculty of Science and Technology, University of Nouakchott, Mauritania.

2Magnetic Materials Lab (MML), Department of Physics, College of Sciences, Imam Mohammad Ibn Saud Islamic

**P5. Non-Linear Optical properties of Inorganic–Organic Hybrid compound based on [CoBr4]**

Zghouma El hadj Amar[1], Teyeb Mohamed Mahmoud[1], Dah Memoune[1], Ali Ben Ahmed[2,3*]

[1]University of Nouakchott, Faculty of Sciences and Technics, Mauritania

[2]University of Sfax, Faculty of Sciences of Sfax, Laboratory of Applied Physic, Sfax-Tunisia.

[3]Department of Biomedical, Higher Institute of Biotechnology of Sfax, University of Sfax, Sfax, Tunisia.
*Corresponding author: zgouma.gha@gmail.com

**P6.AI-Driven Nanotechnology for Sustainable Agriculture in Mauritania**

Cheikh Abdelkader Ahmed Telmoud
*Scientific Computing, Computer Science and Data Science Research Unit (CSIDS), Computer Sciences Department, Faculty of Sciences and Techniques (FST), University of Nouakchott (UN), Nouakchott, Mauritania*
***Corresponding Autor's Email: cheikhahmedtelmoud@gmail.com***

**P7. Membrane bioreactor in aerobic and anoxic conditions for advanced treatment of secondary effluents for potential reuse**

Haby Mamadou Diallo[1,2], Fatima Elazhar[2,3,4], Mohamed Taky [2,4]

*[1] Water, Pollution and Environment Research Unit, Department of Chemistry, Faculty of Science and Technology, University of Nouakchott Al Aasriya, BP 880, Nouakchott, Mauritania*
*[2] Laboratory of Advanced Materials and Process Engineering, Faculty of Sciences, Ibn Tofail University,*
*PO Box: 1246, Kenitra, Morocco*
*[3] National Higher School of Chemistry, Ibn Tofail University, PO Box: 1246, Kenitra, Morocco*
*[4] International Water Research Institute IWRI, Mohammed VI Polytechnic University, Lot 660, Hay Moulay Rachid, Ben Guerir, 43150, Morocco*

November 24-26
Nouakchott - Mauritania