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Book of Abstracts

The 4th International Workshop Advances on Photocatalysis including Environmental and Energy Applications

25th-28th July 2023
Hellenic Mediterranean University,
Heraklion, Crete Greece
Hybrid edition

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TOPICS

* Basic research on photocatalysis;
* Photocatalytic materials;
* Photo-electro-chemistry;
* Photocatalysis in life sciences;
* Photocatalysis in agro-food and aquacultures;
* Green chemistry;
* Modern trends in clean energy production and storage;
* Modern trends in environmental remediation and protection;

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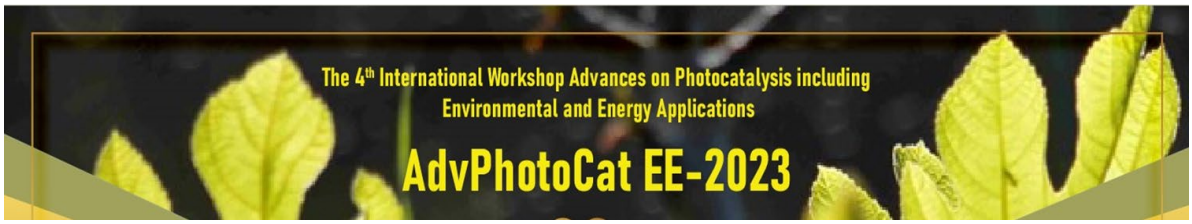
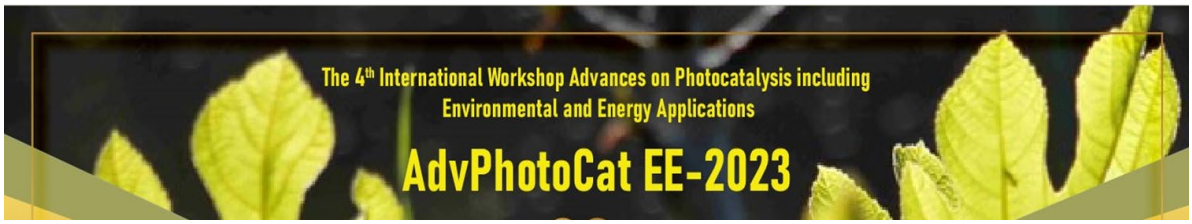


Book of Abstracts

Heraklion

2023



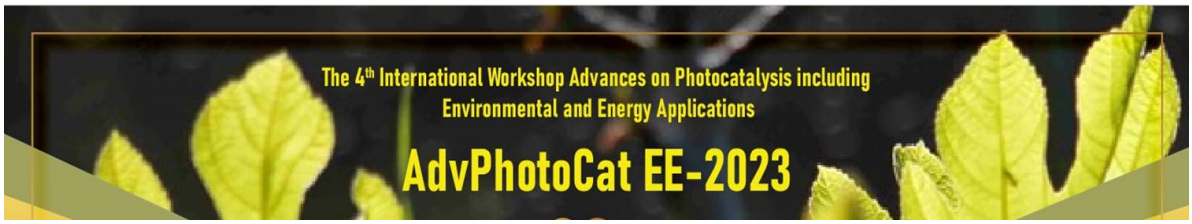
Program

Timezone Athens (GMT+3)

25th of July – final version – *Pdf format download here*

Day 1 – **25.07.2023**

25.07.2023	
10 am -14 pm	***Registration and Online connctivity trials***
14 pm - 15.30pm	**Openning Cermony Amfiteater Kamari (Chairs M Suchea, E Koudoumas)**
14:00-14:15	Welcome at HMU by The HMU Research Rector
	Organizers Presentations:
14:20-14:30	IMT General Director Adrian Miron Dinescu
	TUD Prof. Declan Mc Cormack
	AUO Prof Surresh Pillai
	Petru Poni Institute Dr Anton Airinei
	UPB Prof. Dr. Anton Ficai
	NRC Prof Hossam El Nazer
15:20-15:30	Northeastern University Dr. Muhammad Fahad Ehsan
15:30	**Session 1 *Chair Suresh Pillai*,**
15:30-16:00	**Prof. Dr. Declan McCormack,** *Crystallization Mechanisms in Closed Systems – A Zinc Oxide Study*
16:00-16:30	**Dr. Christos Sargentis,** *Analytical instruments portfolio of Helix Squared company*
16:00-16:30	**Cofee break**
16:30	**Session 2 *Chair M Suchea***
16:30-17:00	**Dr. Petronela Pascariu,** *Rare earth doped metal oxide nanostructures as photocatalysts for pollutants degradation*
17:00-17:30	**Dr. Eva Vasilaki,** *Composite coatings based on rGO modified TiO_2 nanoparticles and a natural polymer, with a strong antimicrobial activity under visible-light irradiation and stimuli-renewable properties*
17:30-17:50	**Prof. Emmanouel Koudoumas,** *Development of novel nanocomposite materials with tunable conductivity*
17:50-18:10	**Dr. Diana Gilea,** *Plasmonic gold supported on $ZnO/CuO/ZnAl_2O_4$ and $ZnO/ZnAl_2O_4$ mixed oxides for solar-driven catalysis of organic pollutants from water*
18:10-18:30	**Dr. Abdul Wafi,** *Preparation and photocatalytic activity of nano-spherical N-TiO_2 toward the degradation of salicylic acid, methyl blue, and rhodamine B*
18:30-18:50	**Dr. André Torres-Pinto,** *The impact of precursor on the preparation of carbon nitride catalysts for phenol degradation*
18:50-19:10	**Dr. Keerthi M. Nair,** *MIL-101(Fe) template-directed growth of NiFe LDH as an efficient catalyst for heterogeneous photo-Fenton process*



19:10-19:30	**Dr. Gabriela Toader,** *Photo-crosslinkable hydrogel films containing phthalocyanine for immediate decontamination of sensitive surfaces*
20:00	**Welcome cocktail and Poster Session 1** ***Chairs C. Pachiu and Yasser Mahmoud***
20:00-22:00	**8 Posters +streaming** **Drd. Valentin Tudose,** *Materials for fishnets: fabrication and their antifouling properties* **Dr. Ahmed A. Elnazer,** *Synthesis of Graphene from Graphite and its Environmental Applications* **Dr. Cristina Pachiu,** *Raman study of novel PVDF/TiO_2/graphene composite fibers for photocatalytic applications* **Drd. Cristina Postolachi,** *High pulsed laser energy to produce structural morphology of thin layers for green chemical processes* **Dr. Pascariu Petronela,** *Modified nanosized spinel ferrite based materials with highly proficient catalytic activity* **Drd. Andrianna Mpouranda,** Materials with ZnO for food packaging **Dr. Kyriakos Mouratis,** *V_2O_5 materials fabrication and properties for potential photocatalysis* **Dr. Oana Nedelcu,** *Material modelling for liquid polymer nanocomposites with potential applications in photocatalytic processes*

Day 2 – **26.07.2023**

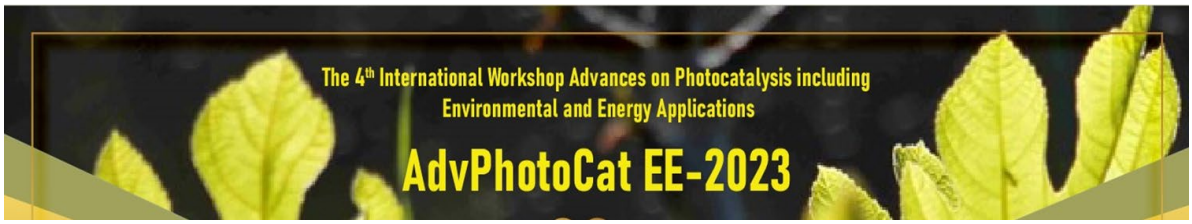
Optional excursion Agios Giorgos Selinari Monastry, Spinalonga Island, BBQ on the beach

19:30-20:30	**Project G5868: New germicide nanocomposites for biological protection and decontamination July 28th 2022 – July 28th 2025 Meeting**

Day 3 – **27.07.2023**

27.07.2023	
9:00	***Session 3 Chairs D. McCormack and Y. Mahmoud***
9:00-9:30	**Prof. Suresh Pillai,** *New Insights into Nanomaterials for Photocatalytic Applications*
9:30-10:00	**Dr. Maria Leonor Matias,** *Photocatalytic behavior of visible-light activated g-C3N4/TiO_2 heterojunctions*
10:00:10:20	**Dr. Morjène Latifa,** *TiO_2 Supported on Posidonia Oceanica fiber as low cost photocatalyst for phenol photodegradation*
10:20-10:40	**Dr. Niloofar Haghshenas,** *Tuning the visible-light-driven photocatalytic properties of multi-decorated TiO_2 by noble metals towards both propionic acid and NOx*
10:40-11:00	**Dr. Metwally Madkour,** *Novel multinary chalcogenide based nanoheterostructures: Solar active and eco-friendly nanocatalysts for photodegradation of pharmaceutical wastewater pollutants*
11:00-11:30	**Coffee break**
	Session 4 ***Chairs P. Pascariu and M L Matias***

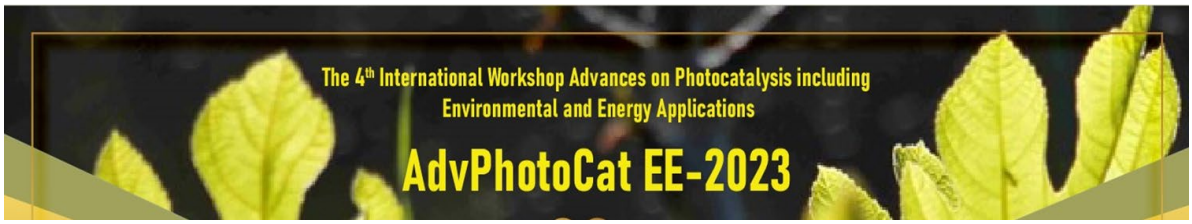
11:30-12:00	**Prof Dr. Sami Rtmi,** *Concomitant photocatalytic bacterial inactivation and pollutants removal on nanostructured sputtered surfaces*
12:00-12:30	**Prof. Dr. Anton Ficai,** *Chemical Approaches based on a Complex Surface Modification leading to antimicrobial/antibiofilm as well as degradative capabilities*
12:30-12:50	**Dr. Kourosh Nasr Esfahani,** *Mathematical Modeling and Simulation of Ozonation of Wastewater Containing Organic Matter*
12:50-13:10	**Dr. Kris O'Dowd,** *The Development of Polypropylene Transparent Jerry Cans as affordable photoinactivation reactors*
13:10-13:30	**Dr. Maali-Amel Mersel,** *The effect of the preparation conditions on the photocatalytic H_2 production of noble-metal-free ZnS-CdS semiconductors*
13:30-15:00	**Light lunch**
	Session 5 *Chairs A. Ficai and M. Suchea*
15:00-15-30	**Dr. Muhammad Tayyab,** *A binary dumbbell visible light driven photocatalyst for simultaneous hydrogen production with the selective oxidation of bezyl alcohol to benzaldehyde*
15:30-16:00	**Prof. Dr. Muhammad Fahad Ehsan,** *Self-Cleaning and Regenerative Cathode Materials for Cost-Effective and Sustainable Water Treatment*
16:00-16:20	**Dr. Cosmin Romanitan,** *Rietveld refinement of X-ray diffraction patterns in photocatalytic metal oxides*
16:20-16:40	**Dr. Manuela Manrique-Holguín,** *Modification of TiO_2 with nitrogen via sol-gel method and the role of ammonia. Not all that generating visible light absorption in TiO2 is doping*
16:40-17:00	**Dr. Marcela Frías Ordóñez,** *Ag-modified $SrTiO_3$ one-pot synthesis: combined effect of Ag-decoration and Ag-doping*
17:00-17:20	**Dr. Melissa Galloni,** *Photo- and piezo-catalysis as the winning pair for the fast and efficient mineralization of ibuprofen by bismuth oxybromide under solar light irradiation*
17:20	**Coffee break**
18:00-19:00	**Poster Session 2 *Chairs C. Romanitan and K. Mouratis***
	6 Posters **Dr. Lynda Golea,** *Synthesis and Characterization of Schiff base derivatives for efficient photodegradation of Methylene Blue* **Dr. Alexandru Cocean,** *Detection of IR vibration bands in environmental analysis using GAUSSIAN 6 software* **Drd. Georgiana Cocean,** Saccharomyces cerevisiae and Fourier Transform Infrared Spectroscopy technique used to identify photo-chemical processes during laser ablation of hemp stalk **Dr. Titus Sandu,** *Extracting physical parameters from dielectric spectra of doped ZnO/graphene nanocomposites* **Dr. Andreea Loredana Gavrila,** *Activating multiple vacancies defects by the structural memory of Zn-rich layered double hydroxides toward tailoring the photocatalytic degradation of organic pollutants from water* **Dr. Denis Cutcovschi** *Synergetic adsorption-photocatalytic degradation of organic pollutants on ZnAl and Ag_ZnAl layered double hydroxides and the derived mixed oxides*



20:00	**Festive Dinner Archanes Village**

Day 4 – **28.07.2023**

28 07.2023	
9:00	***Session 6 Chairs A. Mocanu and E. Koudoumas***
9:00-9:30	**Prof. Dr. Hossam El Nazer,** *Greenhouse gases mitigation by photocatalysis*
9:30-10:00	**Prof. Dr. Gabriela Carja,** *Engineering heterostructures of Zn-rich layered double hydroxides and gold nanoparticles for plasmon-enhanced catalysis*
10:00:10:20	**Prof. Dr. Yasser Mahmoud A. Mohamed,** *Implementation of Photocatalysts in Organic transformation and Environmental Applications*
10:20-10:40	**Dr. Nishanth Thomas,** *Effect of synthesis protocols in the photo-fenton activity of zinc ferrites for the degradation of acetaminophen pollutant*
10:40-11:00	**Dr. Shankramma Kalikeri,** *Nanotechnology in Wastewater Management: A New Paradigm for Wastewater Treatment*
11:00-11:30	**Coffee break**
	Session 7 ***Chairs A. Elnazer and H. El Nazer***
11:30-12:00	**Dr. Mocanu Alexandra,** *ZnO-polymer-based membranes for wastewater treatment and environment protection*
12:00-12:20	**Dr. Stephanie Sarrouf,** *Degradation of Ibuprofen in a flow-through system by the Electro-Fenton Process activated by two iron-sources*
12:20-12:40	**Dr. Mirela Suchea,** *New germicide nanocomposites for biological protection and decontamination*
12:40-13:00	**Dr. Martina Lenzuni,** *From trash to treasure: cotton waste transformed into photocatalytic carbon dots with antibacterial properties under Vis-NIR light*
13:00-14:00	**Poster Session 3 *Chairs M Suchea and R. Marinescu***
	7 Posters **Dr. Laura Clarizia** *A sustainable approach for green synthesis from biorefinery products: photooxidation of ethyl alcohol by employing cupric ion as oxidizing agent* **Dr. Mohamed El-Qelish,** *Preparation and characterization of novel composites for application in photocatalytic industrial wastewater treatment* **Dr. Mekdes Gerawork,** *Remediation of Textile Industry Organic Dye Waste by Photocatalysis Using Eggshell Impregnated ZnO/CuO Nanocomposite* **Dr. Heba K. El- El-Khollya,** *Surface Decoration of Zirconium Oxide with Bismuth sulfide Catalysts for Photocatalytic Degradation of Red dye 195* **Fatiha Siahmed,** *Synthesis And Characterization Of Starch-Based Nanocomposites Reinforced With Fesib Powder* **Dr. Elzahraa A. Elgohary,** *Insights into photocatalytic water disinfection using semiconductors – A review* **Aida María Díez Sarabia** *Radiation coupling as an alternative for the enhancement of Electrochemical Advanced Oxidation Processes*
14:00-15:00	***Light lunch over closing remarks***



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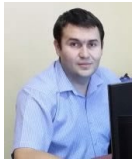

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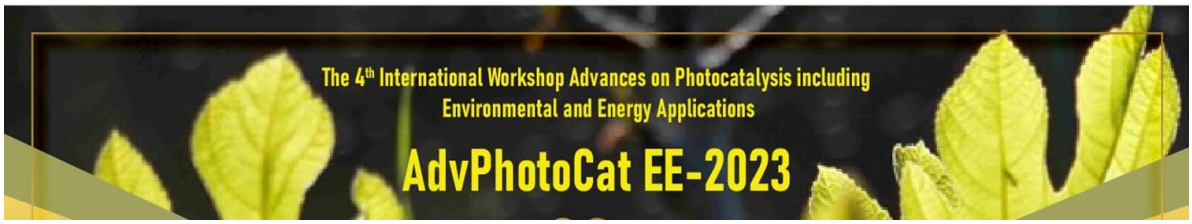

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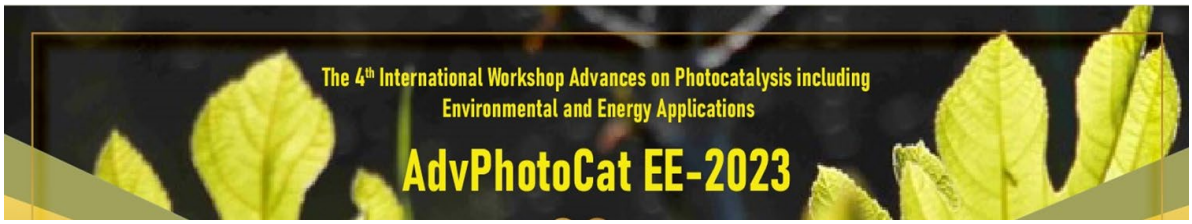

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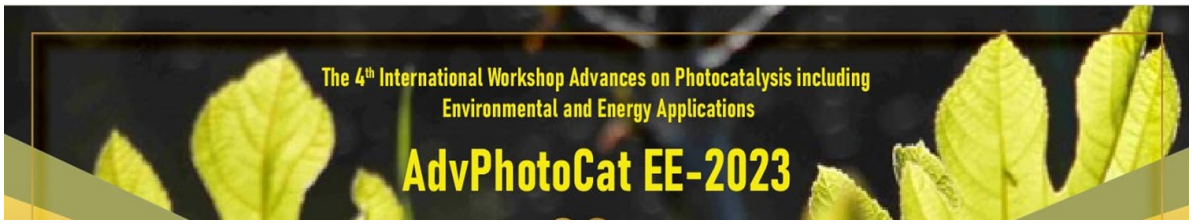

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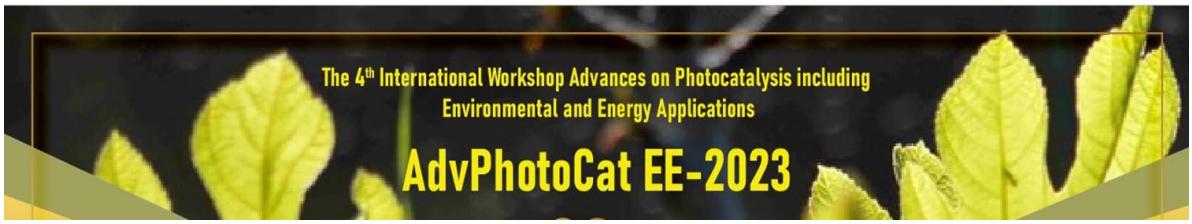

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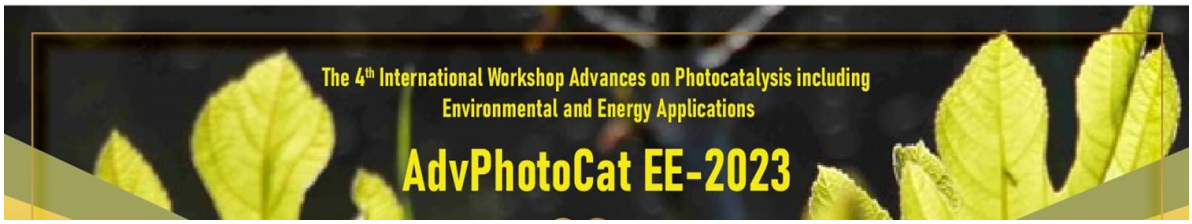

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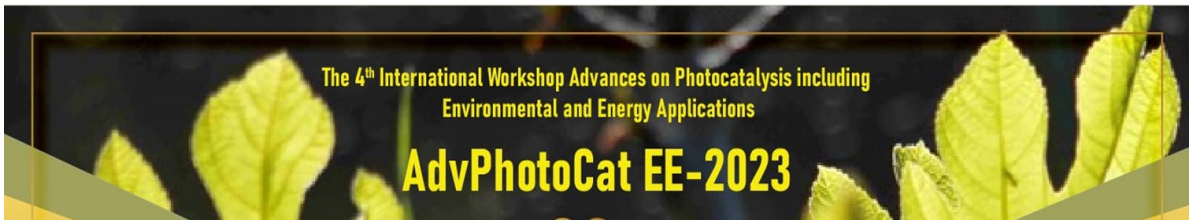


Crystallization Mechanisms in Closed Systems – A Zinc Oxide Study

***Declan E McCormack*[1], *Sibu C Padmanabhan*[2], *Suresh C Pillai*[3]**

[1]*School of Chemical and BioPharmaceutical Sciences, Technological University Dublin, Central Quad, Grangegorman, D07XH6K85 Ireland.*
[2]*School of Chemistry & Advanced Materials and BioEngineering Research (AMBER) Centre, Trinity College Dublin, College Green, Dublin 2, Ireland.*
[3]*Centre for Precision Engineering, Materials and Manufacturing Research (PEM), Atlantic Technological University, Sligo, Ash Lane, Sligo F91 YW50, Ireland.*

Crystalline zinc oxide presents many varied and useful characteristics both in relation to its chemical and physical properties. As a wide band gap semiconductor with a large excitation binding energy which also exhibits strong piezoelectric properties it has been proposed for many uses, ranging from antimicrobial activity to photoinduced degradation of pollutants to energy harvesting in solar cells.
This particular study concentrates on the use of microwave hydrothermal synthesis as a means of producing well-defined crystalline zinc oxide. In particular the specific mechanism by which nucleation and crystal growth in such closed systems has been studied by a variety of techniques including SEM, EDX, FTIR and XRD. Under such intense conditions of temperature (ca 120ºC) and pressure (ca 300kPa) the nucleation and growth processes are strongly influenced by the constituent ions and dissolved gaseous molecules in the local environment. Nucleation commences only when the microwave heating is terminated. The initial stage of crystal growth involves the irreversible expulsion of the dissolved gaseous molecules with the concurrent aggregation of prenucleation clusters (PNCs). Despite such forced conditions it is possible to synthesize well-defined crystalline zinc oxide rods in a straightforward manner using this approach.

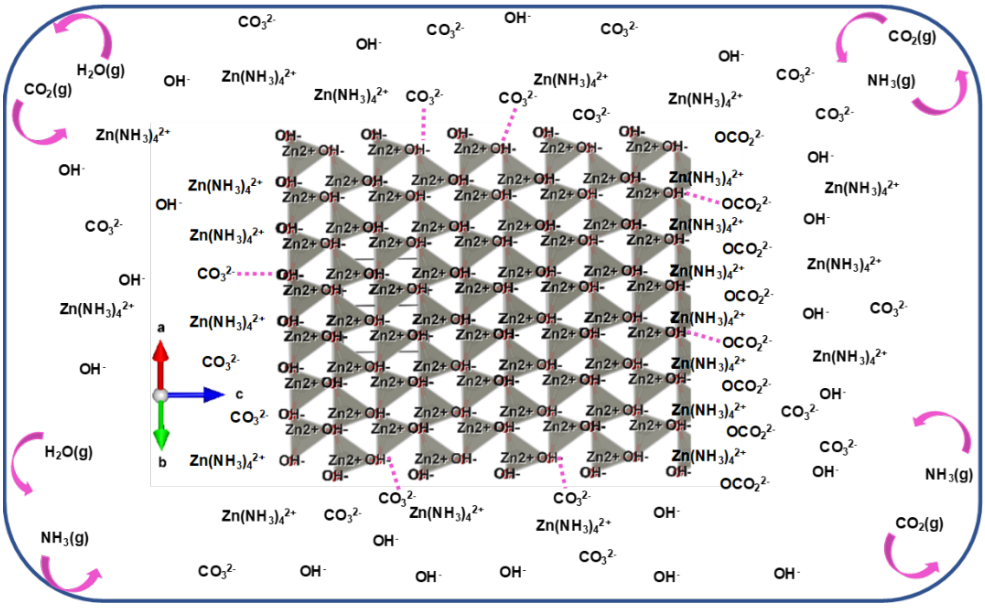
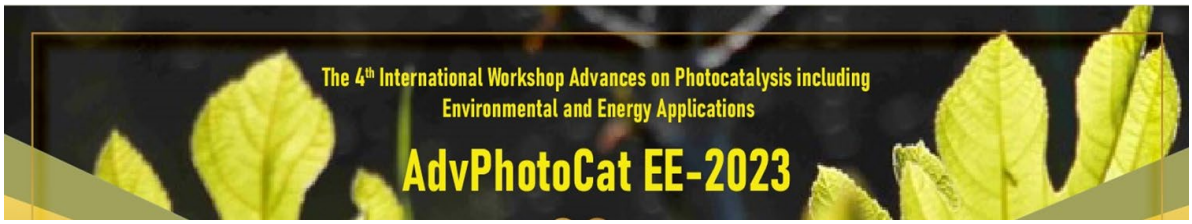


Fig 1. Schematic of a representative Prenucleation Cluster (PNC)

There will also be a short presentation on the development and recent construction of our new campus at Grangegorman in Dublin City including part of the new School of Chemical and BioPharmaceutical Sciences. Lessons learned through that process will be discussed.
Watch here and here.



Analytical instruments portfolio of Helix Squared company

Christos Sargentis

Analytical instruments Business Unit Director, Helix Squared P.C., Andrea Papandreou 5, 15127, Melissia

Abstract: In this talk we present our portfolio regarding analytical instruments of our company for research purposes. We focus on Scanning Electron Microscopy solutions (SEM), FE-SEM, FIB-SEM solutions with emphasis on nanoparticles observation, on Dynamic Laser Scattering (DLS) technic for size distribution of nanoparticles and Z-potential and on ALD, CVD equipment for fabrication of nanoparticles and thin layers.

Rare earth doped metal oxide nanostructures as photocatalysts for pollutants degradation

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Abstract

Recently, there is a significantly increased interest for the development of new oxide semiconductor materials due to their use in various applications such as photocatalysts, batteries, self-cleaning surfaces, fabrics, photovoltaics, cosmetics, antiseptic patches, drug delivery systems, components of sunscreen as well as ink and paints. Also, nanostructured oxide semiconductor materials are intensely used in environmental protection and purification. This work will focus on our recent achievements in the preparation and use of composite materials based on pure and rare earth (RE) doped ZnO and TiO_2 in photocatalytic degradation processes of various organic pollutants (dyes and drugs). Various composites developed by electrospinning followed by calcination at different temperatures and their properties will be presented and discussed. These nanostructures have been fabricated using low-cost and easily scalable methods, which lead to materials with remarkable photocatalytic activity for the degradation of a large number of common water pollutants. Typical results regarding the characterization of nanocomposite materials included: X-ray diffraction (XRD), scanning electron microscopy (SEM), and ultraviolet-visible spectroscopy (UV-Vis), as well as photocatalytic degradation of various organic pollutants under UV-Vis light irradiation, were performed. Moreover, the enhancement of photocatalytic activity by fine-tuning the morphology, structure and optical properties were also highlighted. Thus, it was demonstrated that the photocatalytic performances of these materials can be improved by doping with different rare earths [1-4]. These new materials showed remarkable photocatalytic activities under optimal photodegradation conditions with rate constants of 10^{-1} min^{-1}. In addition, the photocatalysts showed excellent reusability even after several cycles of use, tested under identical conditions.

Acknowledgment: HMU contribution to this work was partially supported by NATO Science for Peace and Security Programme, grant G5868.

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Composite coatings based on rGO modified TiO_2 nanoparticles and a natural polymer, with a strong antimicrobial activity under visible-light irradiation and stimuli-renewable properties

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Hybrid, polymer-inorganic, films exhibiting an effective antimicrobial action under visible-light irradiation and stimuli-renewable properties are presented [1]. The films were prepared using a chitosan derivative bearing permanent quaternary ammonium salt (QAS) groups along the polymer chains and photocatalytically active TiO_2 nanoparticles modified with reduced graphene oxide (rGO). An acid-degradable, acetal-based crosslinker was used to cross-link the polymer chains forming stable coatings on glass substrates. The hybrid films exhibited an effective biocidal activity in the dark for both Gram-negative and for Gram-positive bacteria, assigned to the biocidal QAS sites and a superior biocidal action upon visible light irradiation, due to the synergistic antimicrobial effect of the QAS moieties and radical oxygen species photocatalytically generated via the irradiation of the rGO modified TiO_2 nanoparticles. The stimuli-renewal behaviour of the hybrid films was verified by the gradual decrease of the film thickness upon immersion in neutral and slightly acidic aqueous media, attributed to the hydrolysis of the acetal-based crosslinker. Importantly, the hybrid films exhibited a high biocompatibility against mammalian cells, and retained their effective antimicrobial action even after self-polishing. The proposed approach underlines the facile development of highly functional polymer-based coatings, exhibiting strong and long-lasting bactericidal activity for prolonged use in a variety of applications.

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Development of novel nanocomposite materials with tunable conductivity

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Abstract

This is the first public presentation of the Project: "Development of novel nanocomposite materials with tunable conductivity for electromagnetic shielding and potential uses in electronics and optoelectronics applications". The CF23/ 14 11 2022 financed by the Ministry of Research, Innovation and Digitalization in *Development of a program to attract highly specialized human resources from abroad in research, development, and innovation activities within the – PNRR-III-C9-2022 - I8 PNRR/2022/Component 9/investment 8.* project regards the design, synthesis, and characterization of novel rare earth elements doped metal oxide-graphene nanocomposites materials with tunable conductivity suitable for the shielding of electromagnetic radiation in the >5GHz spectral range as well as for integration in novel electronics and optoelectronics. The findings of the project would promote high quality science and innovation in the fields of materials science and technology as well as of wireless communications and can lead to novel, low-cost products for the protection from the electromagnetic radiation as well as improved electronic and optoelectronic devices. Therefore, the present proposal addresses a very hot and important scientific and technologic subject with huge scientific, technological, socio-economic, environmental and health issues impact.

Acknowledgments.

This research was partially supported by CF23/ 14 11 2022 financed by the Ministry of Research, Innovation and Digitalization in *Development of a program to attract highly specialized human resources from abroad in research, development, and innovation activities within the – PNRR-III-C9-2022 - I8 PNRR/2022/Component 9/investment 8.*

„PNRR. Finanțat de Uniunea Europeană –UrmătoareaGenerațieUE". https://mfe.gov.ro/pnrr/
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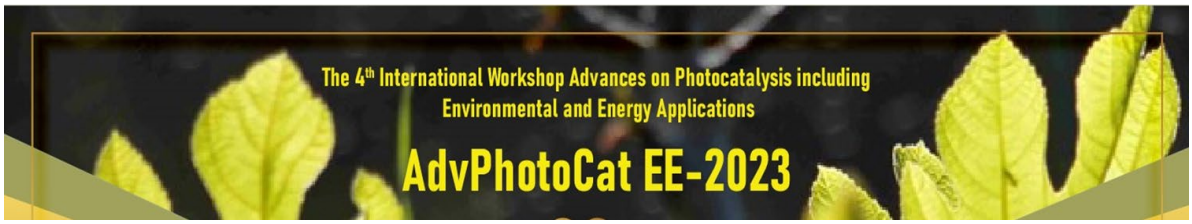

New Insights into Nanomaterials for Photocatalytic Applications

Suresh C. Pillai

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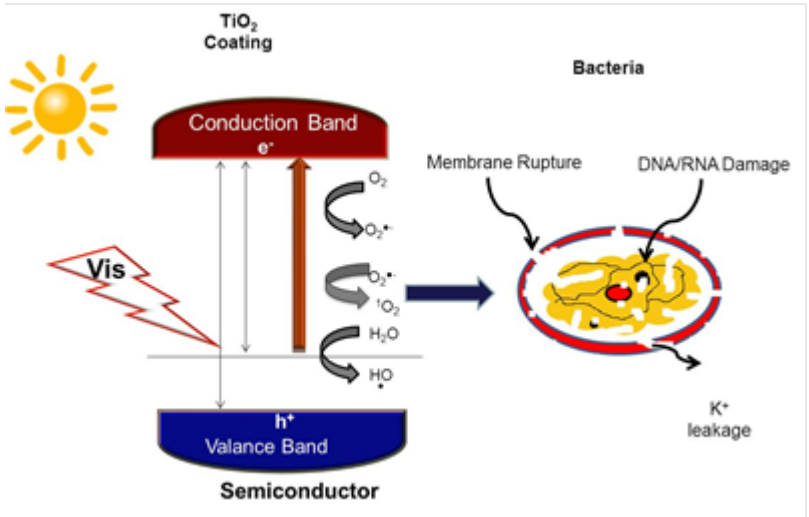
Nanomaterials-based semiconductors, which could exhibit photocatalytic activities under natural light (typically >400 nm) are preferred for commercial applications. As part of a project to develop an effective surface coating, our investigations were focused on the development of novel materials for anti-microbial applications. Photocatalysts, which are thermally stable up to the sintering temperature of the substrates (*e.g.*, bathroom tiles) are most desirable for building materials applications. Thermal stability of the Anatase phase of TiO_2 at elevated temperatures is one of the requirements for making such coatings on an industrial scale. The preparation of novel photo-catalytic materials by modifying the band-gap using various dopants such as F, S, N and C will be discussed.



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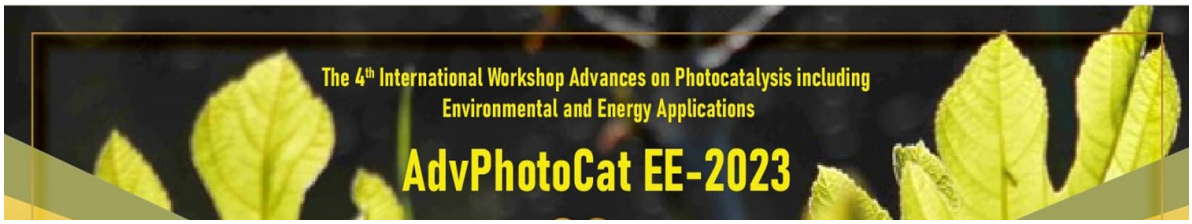

Photocatalytic behaviour of visible-light activated g-C_3N_4/TiO_2 heterojunctions

M.L. Matias[1], A. S. Reis-Machado[2], J. Rodrigues[3], T. Calmeiro[1], J. Deuermeier[1], A. Pimentel[1], E. Fortunato[1], R. Martins[1*], D. Nunes[1*]

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Abstract

This study reports the synthesis and characterization of g-C_3N_4/TiO_2 heterostructures considering a simple and fast microwave-assisted approach. Carbon nitrate (g-C_3N_4) was mixed with TiO_2 with different amounts (15, 30 and 45 wt. %) to understand the photocatalytic behaviour of such materials. The recalcitrant azo dye (methyl orange (MO)) was tested under solar simulating light. X-ray diffraction (XRD) revealed the anatase TiO_2 phase for all heterostructures produced. Scanning electron microscopy (SEM) showed that by increasing the amount of g-C_3N_4 in the synthesis, large TiO_2 aggregates composed of irregularly shaped particles were disintegrated and resulted in smaller ones, composing a film that covered the g-C_3N_4 nanosheets. Scanning transmission electron microscopy (STEM) analyses confirmed the existence of an effective interface between a g-C_3N_4 nanosheet and a TiO_2 nanocrystal. X-ray photoelectron spectroscopy (XPS) evidenced no chemical alterations to both g-C_3N_4 and TiO_2 at the heterostructure. The materials had their optical properties investigated using UV-VIS and it has been observed a visible-light absorption shift (red-shift in the absorption onset). The 30 wt. % of g-C_3N_4/TiO_2 heterostructure showed the best photocatalytic performance, with a MO dye degradation of 85 % in 4 h, corresponding to an enhanced efficiency of almost 2 and 10 times greater than that of pure TiO_2 and g-C_3N_4 nanosheets, respectively. Superoxide radical species were found to be the most active radical species in the MO photodegradation process. The superior photocatalytic activity was attributed to the synergy of g-C_3N_4 and TiO_2 materials. Finally, two possible photocatalytic degradation mechanisms of the heterostructure were proposed. This study is expected to effectively contribute to environmental remediation, decomposing a great source of water pollutants, that is the AZO dyes.

***Keywords**: g-C_3N_4/TiO_2; microwave synthesis; heterostructures; photocatalysis; pollutant degradation.*

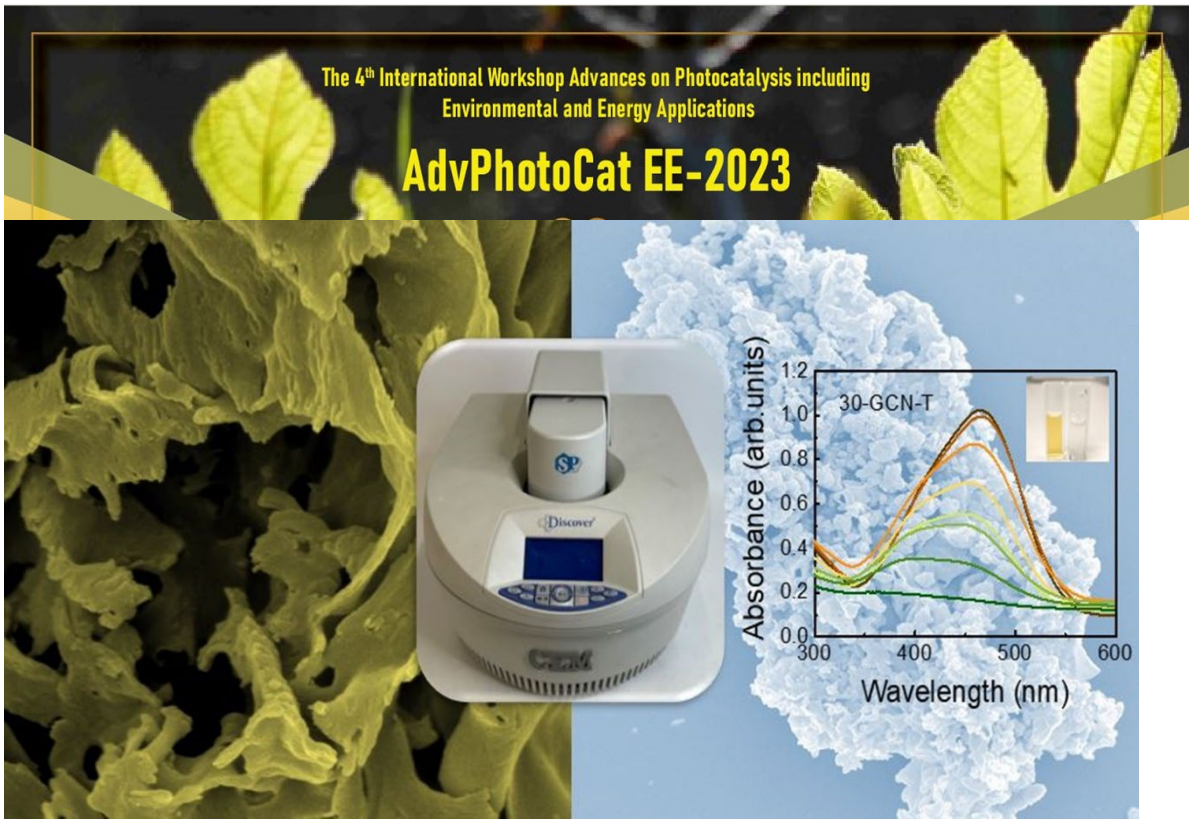

Figure 1. g-C_3N_4 nanosheets, together with the heterojunction produced using microwave irradiation [1].

Acknowledgement

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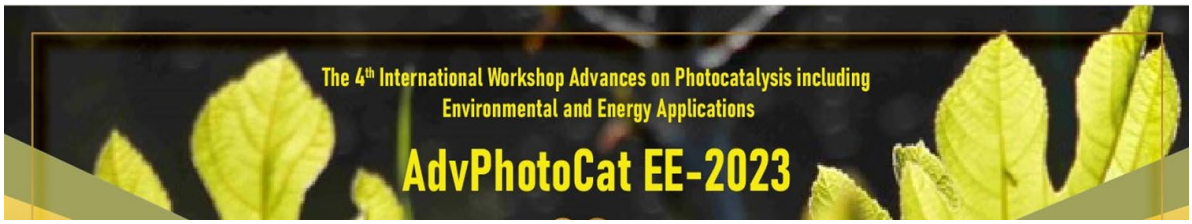

Concomitant photocatalytic bacterial inactivation and pollutants removal on nanostructured sputtered surfaces

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ABSTRACT

During the last few decades, pathogens expansion and emerging pollutants invaded the environment (water, air, soil, food…) leading to ecosystem disturbance and human health threats [1]. Many technologies have been applied during the last two decades. Advanced Oxidation Processes (AOPs) emerged as non-selective and effective solution to remove these harms. Photocatalysis under low-intensity light and/or solar light responded to the need for water and air remediation. Many methods were adopted to prepare these photoactive materials. During the last few years, supported photocatalysts have drawn attention as they allow reduced costs and labor to recover the used photocatalyst. Pioneering research groups showed the use of physical vapor deposition, namely magnetron sputtering, to prepare ultra-thin films of photocatalytic materials in the range of a few nanometers thick. Advanced antibacterial films presenting uniform particle distribution, high adhesion to the substrates, mechanical resistance and faster bacterial/biofilm inactivation under light or in the dark are needed due to health concerns [1-4]. TiO_2-Cu (Cu≥ 0.1%) films co-sputtered for 2.5 min led to bacterial inactivation < 10 min under actinic light (4mW/cm^2) [3-4]. The short-lived transient intermediates on the co-sputtered catalyst were followed by laser spectroscopy in the femto/picosecond region (fs-ps). For the study of solid-phase redox reactions, the electron mobility, the electronic relaxation times, transient absorption intensity (T-A) and excided states relaxation times in the fs to the ms range, has been a way to clarify the charge transfer to the acceptor states in the short time scale [5]. Excitation by 375 nm produced e^-/h^+ pairs in TiO_2 and CuOx in parallel with the formation of CuOx excitons. Femtosecond transient spectra showed predominantly the signal for CuOx.

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Chemical Approaches based on a Complex Surface Modification leading to antimicrobial/antibiofilm as well as degradative capabilities

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Dan Eduard Mihaescu[1,2,6], Anton Ficai[1-3,7], Ecaterina Andronescu[1-3,7], Mariana Carmen Chifiriuc[4,7,8]

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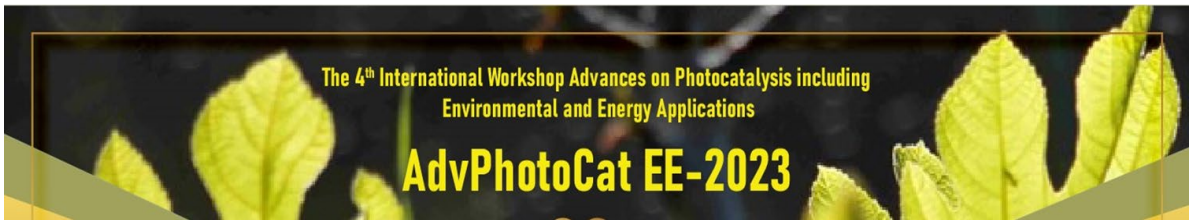
ABSTRACT: The presentation is based on several approaches based on the surface modification of multiple materials. Some of them are used to modify their surface and thus antimicrobial / antibiofilm surfaces are obtained. These surfaces can be further valorised many applications including civil engineering (especially wastewater plants) but also in the preservation and protection of the cultural heritage. The chemical approach is especially important because long-lasting effect is requested and also, it is important to avoid the leakage of these antimicrobial agents into the nature produce secondary pollution. The last approach is used to modify the mesoporous materials by the means of photocatalysts inside and outside of the pores. By short, the mechanism of action involves, the pollutants, especially antibiotics absorption followed by the degradation to more eco-friendly substances, which will not generate and nor enhance the antibiotic resistance. This approach can be extended to a wide range of wastewater treatment by minimal changes in the actual treatment plant. Comparing to the classical applied absorption technology where the sorption / desorption equilibrium is leading to a long-term release of the antibiotics, at low level, and thus generating resistance, this approach leads to the degradation of these pollutants and thus a lower risk of developing antibiotic resistance.

Keywords: chemical surface modification, antibiofilm activity, photo-degradative approach

Acknowledgment: The authors acknowledge the financial support of the project PN-III-P4-ID-PCCF-2016-0114 - RADAR.



A binary dumbbell visible light driven photocatalyst for simultaneous hydrogen production with the selective oxidation of bezyl alcohol to benzaldehyde

***Muhammad Tayyab*, *[1,2] Season Si Chen,[1] Kobe Man Chung Tang,[1] Liang Zhou, *[3] Juying Lei,[3] Jinlong Zhang*[2]**

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Abstract:

Photocatalytic H_2 production with selective oxidation of organic moieties is a fascinating reach area. However, rational design of photocatalysts and photocatalytic performance is still inadequate. In this work, we efficiently synthesized the MoS_2 tipped CdS NWs photocatalyst using soft templates via the two-step hydrothermal method for efficient H_2 production with selective oxidation of benzyl alcohol (BO) under visible light illumination. The optimized MoS_2 tipped CdS (20% MoS_2) photocatalyst exhibits the highest photocatalytic H_2 production efficiency of 13.55 mmol g^{-1} h^{-1} with 99% selective oxidation of BO. The directional loading of MoS_2 at the tips of CdS NWs is the key factor toward superior H_2 production with 99% selective oxidation of BO. The amazing enhancement in the photocatalytic performance and selectivity of optimized photocatalyst is due to the spatial separation of their photoexcited charge carriers through the Schottky junction. Moreover, the unique structure of MoS_2 flower at the tip of 1D CdS NWs offers separate active sites for adsorption and surface reactions such as H_2 production at the MoS_2 flower and selective oxidation of BO at the stem of CdS NWs. This rational design of photocatalyst could be an inspiring work for the further development of efficient photocatalytic system for H_2 production with selective oxidation of BO.

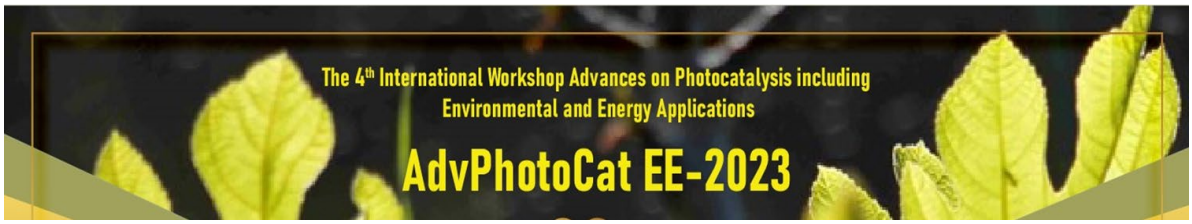
Acknowledgement: This study was partially supported by my PhD supervisor Prof. Jinlong Zhang at East China University of Science and Technology, Shanghai 200237, China and postdoc supervisor Prof. Kobe Man Chung Tang at Tsinghua Shenzhen International Graduate School, Tsinghua University, Shenzhen, Guangdong 518055, China.

Self-Cleaning and Regenerative Cathode Materials for Cost-Effective and Sustainable Water Treatment

Patrick Compton, Jong-Gook Kim, Stephanie Sarrouf, Muhammad Fahad Ehsan, Akram N. Alshawabkeh

Department of Civil and Environmental Engineering, Northeastern University, Boston 02115, MA USA

Abstract. We present an innovative electrochemical advanced oxidation process (EAOP) with great potential for the water treatment industry. By harnessing electrons as green reagents, our approach eliminates the need for additional chemicals. The robust and stable titanium/mixed metal oxide (Ti/MMO) anode facilitates in-situ oxygen production, while our focus on cost-effective and sustainable cathode materials with self-cleaning capabilities ensures continuous generation of reactive oxygen species (ROS) and prolonged activity. Among various carbon-based electrodes, granular activated carbon (GAC) stands out as a promising cathode material. GAC enables the two-electron oxygen reduction reaction (2e-ORR), facilitating in-situ generation of hydrogen peroxide (H_2O_2). Moreover, GAC's catalytic properties promote the decomposition of H_2O_2, leading to the formation of hydroxyl radicals (•OH). Alternatively, we explore the potential of biomass-derived granular biochar (GB) as a sustainable cathode material for in-situ ROS generation. Our findings reveal efficacy of GB in removing recalcitrant organic pollutants, including polyaromatic hydrocarbons, pharmaceuticals, pesticides, synthetic dyes, as well as the heavy metals. We have also investigated various approaches to enhance contaminant removal, including reactor configuration variations and polarity reversal. These techniques prove effective in improving contaminant removal efficiency. Overall, our cost-effective and sustainable Electro-Fenton (EF)-like approach offers an attractive solution for drinking water treatment in remote communities.



Greenhouse gases mitigation by photocatalysis

***Hossam A. El Nazer*, Yasser Mahmoud, Ahmed Elnazer, ElZahraa El-Gohary**

National Research Centre Egypt

Abstract

Climate change is one of the most important issues facing the world. One of the pillars of combating this phenomenon is the mitigation of greenhouse gases emissions. Environmental fixation of CO_2 through the reaction with aromatic epoxides to produce the corresponding cyclic carbonates under atmospheric pressure and ambient temperature, and photocatalytic oxidation of carbon monoxide (CO) and (NO_x) gases have been investigated under optimized conditions. The present investigation has also focused on preparation of photocatalysts that are possessing two desirable properties: large surface area and high crystallinity. The former property should increase the number of surface-adsorbed substrate(s) to enhance the capture of photogenerated electrons (e^-) and positive holes (h^+), and the latter, i.e., less defects acting as the recombination center, should suppress mutual e-–h+ recombination.

Keywords: Photocatalyst, NOx degradation, CO_2 fixation, Photo-oxidation of CO, TiO_2, MWCNT.

Engineering Heterostructures of Zn-rich Layered Double Hydroxides and Gold Nanoparticles for Plasmon-Enhanced Catalysis

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Abstract

Artificially designed heterostructures formed by close conjunctions of gold nanoparticles (AuNP) and (2D) lamellar nanostructures are receiving extensive interests. The synergistic interactions of the joined nanounits induce the manifestation of localized surface plasmon resonance (LSPR) of nanogold in the specific environment of the 2D-light absorbing matrix impacting their potential in plasmonic responsive catalysis. Specifically, layered double hydroxides (LDH) with the advantages of their unique 2D-layered structure, tuned optical absorption, ease of preparation, composition diversity and high surface area, have emerged as very promising candidates for obtaining versatile and robust catalysts. We present AuNP/Zn-rich LDH heterostructures mainly focusing on their synthesis strategies toward establishing a synergistic response of the coupled nanounits, their characteristics and specific applications as plasmonic responsive catalysts. We highlight here the synthesis strategies based on the structural reconstruction by memory effect of Zn-rich LDH and the emerging functionalities that enable the manifestation of the plasmon-induced charge separation effect (PICS), co-catalytic effect or nanoantenna effect applied in solar driven photocatalysis [1]. This results in the plasmonic response (see Fig.1) and functional versatility of AuNP/Zn-rich LDH heterostructures toward developing highly performant plasmonic driven catalysts for applications in advanced chemical processes.

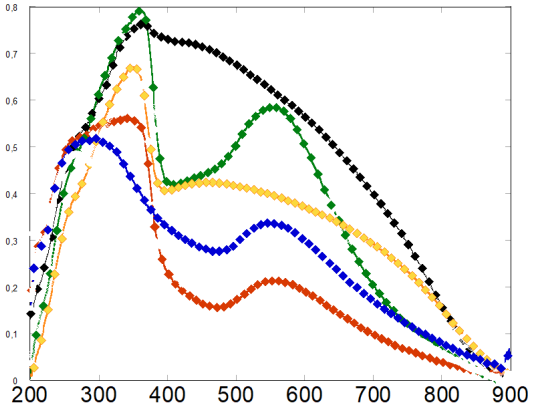

Fig. 1. UVVis spectra of UV-Vis spectra of (-)AuLDHZn; (-) AuLDHCu; (-) AuLDHZn550; (-) AuLDHCu550; (-).

[1] results submitted to publication.

Research and Highlights: plasmonic responsive heterostructures; layered double hydroxides; plasmonic catalysis

ZnO-polymer-based membranes for wastewater treatment and environment protection

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Since they can cause skin rashes, genetic abnormalities, disorientation, gastrointestinal problems, and respiratory allergies, organic pollutants and water contaminants continue to pose a serious threat to human health [1]. For instance, in textile industry, large amounts of organic dyes contaminate water[2]. This represent a tremendous hazard considering that some of the dye agents are rated as toxic compounds with carcinogenic effects and extremely low biodegradability [2]. Despite the fact that metal oxides like TiO2 and ZnO are greatly used in the photocatalytic degradation for wastewater decontamination due to their high natural abundance, semiconducting properties, and reduced toxicity a lot of attention was given to design new materials/composites to improve their photocatalytic and antimicrobial activity to enhance contaminated water sanitation processes [3, 4]. The main purpose of these studies involves the design of synthetic and natural-based polymer membranes modified with inorganic nanoparticles like ZnO for removal of organic water contaminants through photocatalytic/antimicrobial processes.

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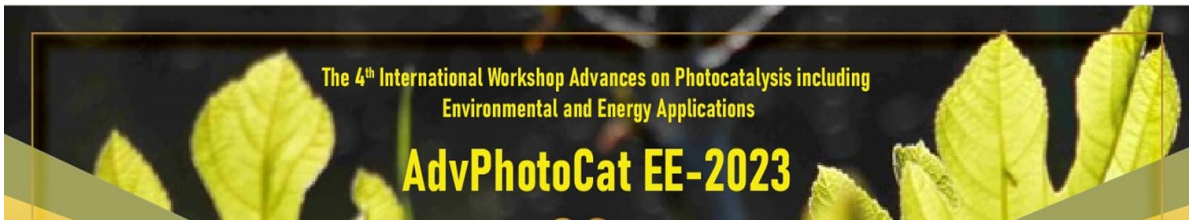

ORAL PRESENTATIONS

Plasmonic gold supported on ZnO/CuO/ZnAl2O4 and ZnO/ZnAl2O4 mixed oxides for solar-driven catalysis of organic pollutants from water

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Significant importance has been paid in recent years to address the development of novel catalytic systems for the destruction of dangerous contaminants from water by using the light energy. Nowadays plasmonic heterostructures are targeted as novel cost-effective solutions for obtaining high-performance catalysts for energy harvesting and environmental photocatalysis [1]. Extensive efforts have been taken to fabricate homogeneous multi/compositional heterostructures obtained by the close integration of the semiconducting mixed oxides and plasmonic nanounits. Herein, we report heterostructures of plasmonic Au with /ZnO/CuO/$ZnAl_2O_4$ and ZnO/$ZnAl_2O_4$ mixed oxides obtained by the calcination of ZnCu and ZnAl (M^{2+}/M^{3+}=4/1) layered double hydroxides (LDH) reconstructed in the aqueous solutions of Au(III) acetate [2],[3]. The novel materials show precise stoichiometry and we studied their structural and morphological features by a variety of techniques, including: XRD, FTIR, UV-VIS, TGA/DTG, XPS and SEM-EDX. Further, we tested the catalytic photodegradation of organic contaminants, such as p-nitrophenol and further the mixture of p-nitrophenol with phenol or p-dichlorobenzene under solar light irradiation. Results show that Au/ZnO/CuO/$ZnAl_2O_4$ and Au/ZnO/$ZnAl_2O_4$ exhibited better photocatalytic activity in comparison to the bare mixed oxides derived from the parent LDH, namely ZnO/CuO/$ZnAl_2O_4$ and ZnO/$ZnAl_2O_4$. Furthermore, we found that the photocatalytic activity is a function of their Zn/Cu molar ratio. Thus, Au/ZnO/$ZnAl_2O_4$ degraded 98% of p-nitrophenol in 150 min of solar irradiation while Au/ZnO/CuO/$ZnAl_2O_4$ reached a similar activity after 360 min of solar irradiation.

These results show that Au/ZnO/CuO/$ZnAl_2O_4$ and Au/ZnO/$ZnAl_2O_4$ are sustainable catalysts for degrading pollutants from water in the presence of solar light. This work highlights the potential of combining plasmonic nanoparticles and the LDH derived oxides for tuning the plasmonic photocatalysis of the specific pollutants.

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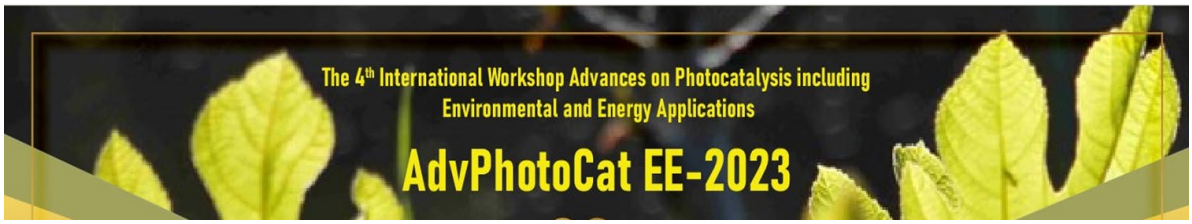

Preparation and photocatalytic activity of nano-spherical N-TiO_2 toward the degradation of salicylic acid, methyl blue, and rhodamine B

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Abstract

Pure titanium dioxide (TiO_2) can only be excited by ultraviolet (UV) light, due to their wide band gap, which is rather inefficient for photocatalytic applications utilizing solar energy. Therefore, considerable efforts have been made during the past decades, aimed to obtain visible-light-active materials through chemical modification of TiO_2. In this work, visible-light-active nitrogen-doped titanium dioxide (N-TiO_2) catalysts were successfully synthesized by using a facile sol-gel method with urea as the nitrogen source. The effects of urea concentration (0, 2, 4, 6 urea/TTIP mol ratio) on the morphological, structural, optical, and photocatalytic properties of the photocatalysts were investigated. SEM morphology revealed an aggregated nano-spherical shape in all samples, and the X-ray diffraction analysis showed a pure anatase phase, which transformed to amorphous for 6-N-TiO_2. The crystallite size declined from 14.16 nm to 9.76 nm upon increasing urea concentration. The band-gap energy of N-TiO_2 also shifted from 3.25 to 2.95 eV. Furthermore, the photocatalytic performance of the samples showed that 2-N-TiO_2 had an optimum efficiency for photocatalytic degradation of salicylic acid (74%), besides methyl blue (54.7%) and rhodamine B (90%), under UV-Vis illumination. The photoactivities of the N-doped catalysts were significantly higher than that of pure TiO_2. Therefore, our result suggests that crystallite size, urea (as an N dopant) concentration, as well as organic model pollutant were critical parameters in the photocatalytic performance of N-TiO_2 under UV-Vis illumination.

Keywords: Nitrogen-doped TiO_2, Crystallinity, UV-Visible illumination, photoactivity, decomposition, salicylic acid, methyl blue, rhodamine B.

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The impact of precursor on the preparation of carbon nitride catalysts for phenol degradation

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Carbon nitride (CN) materials have excellent photo-responsive properties and can be employed in various photocatalytic applications [1]. However, many aspects need to be addressed to obtain simple fabrication routes and obtain efficient catalysts. Microwave-assisted calcination is a novel cost-effective route for the preparation of nanomaterials, particularly for the synthesis of CN. In this work, we report the preparation of CN by using 6 different precursors: dicyandiamide (D), melamine (M), guanidine carbonate (C), guanidine hydrochloride (H), thiourea (T), and urea (U). The synthesised materials (CN) were then thermally exfoliated (CNX), yielding 12 distinct materials. A comprehensive study was performed to correlate the selected precursors with the obtained semiconductor features and photocatalytic performances. Morphology, surface texture and chemistry and photochemical properties were evaluated by different characterisation techniques, while the photoactivity was assessed by two overlapping applications: degradation of phenol in aqueous solution and hydrogen peroxide production (H_2O_2). H_2O_2 is an indicator of the formation of oxidative species in the photocatalytic process, as it can accelerate the removal of contaminants since H_2O_2 can be efficiently activated by CN materials [2]. In Figure 1 we show the mineralisation results, measured by total organic carbon (TOC) removal after 120 min of visible-light irradiation [3]. The characterisation of these materials may explain the obtained TOC results, as mineralisation increases with greater structural disorder and surface defects.

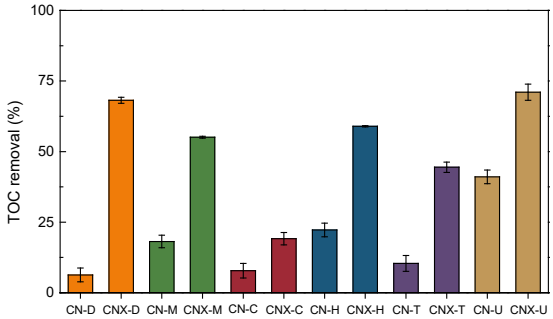

Figure 1. Photocatalytic conversion of phenol, in terms of TOC removal, after 120 min of visible-light irradiation (for labels, please see text).

Acknowledgements: This work was financially supported by LA/P/0045/2020 (ALiCE), UIDB/50020/2020 and UIDP/50020/2020 (LSRE-LCM) and by project 2022.08738.PTDC (DRopH2O) funded by national funds through FCT/MCTES (PIDDAC). A.T P. acknowledges Fundação para a Ciência e a Tecnologia (FCT) for his scholarship SFRH/BD/143487/2019.

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MIL-101(Fe) template-directed growth of NiFe LDH as an efficient catalyst for heterogeneous photo-Fenton process

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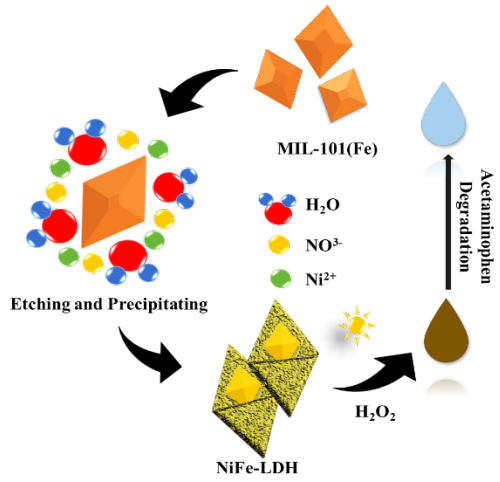
Advanced oxidation processes (AOPs) based on Fenton chemistry has been widely employed to treat contaminants of emerging concerns (CECs) in water sources [1]. The development of stable catalysts that offer a wide working pH range, high metal cycling ability, and reduced iron sludge formation is one of the main goals that has yet to be tackled. Layered double hydroxides (LDH) with an improved specific surface area and recyclability, compared to conventional Fenton catalysts have aroused much attention as catalysts in pollutant degradation. Traditional synthesis techniques of LDHs are complicated and have poor control of the morphology. Therefore, template-based synthesis where the growth of the LDH layers is centered around uniformly dispersed metal nodes, generating evenly expanded two-dimensional layers has gained recent importance [2]. Herein a template-based conversion of an iron-based metal-organic framework (MOF), MIL-101(Fe), to generate NiFe LDH as an efficient catalyst for photo-Fenton (PF) degradation of Acetaminophen is reported. A simple template etching method at different etching times is adapted for the synthesis hence, limiting the degree of template etching and controlling the LDH morphology. The XRD pattern showed a complete conversion of MIL-101(Fe) to NiFe LDH with the increased hydrolysis time, and peaks at 11.6°, [2]23.2°, 34.5°, and 59.9° corresponding to (003), (006), (012), and (110) of NiFe were observed. The major diffraction peak of MIL-101(Fe) at 8.9° was also observed at lower hydrolysis time suggesting the formation of a core-shell MOF/LDH composite. The chemical and physical properties of the samples are probed using UV-vis, FTIR, Raman, SEM, XPS, and TEM. The catalytic properties and the organic pollutant degradation efficiency of the LDH derived at different etching times are compared *via* PF reactions. The CEC degradation pathway, the interaction of H_2O_2 with the active Fe sites, and the different radicals generated during the PF reaction will be further assessed, and as such this study will provide new practical insights into the development of MOF-derived LDH catalysts for Fenton-like systems.



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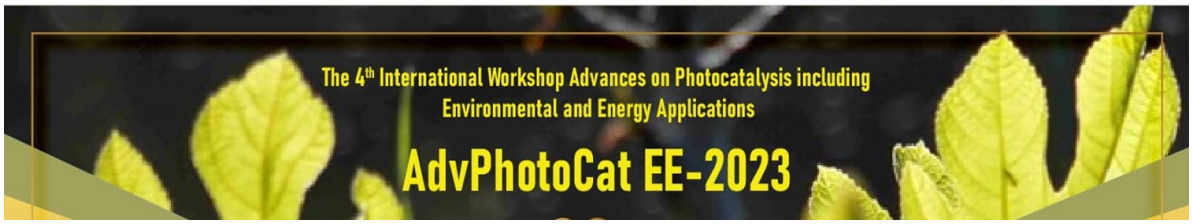

Photo-crosslinkable hydrogel films containing phthalocyanine for immediate decontamination of sensitive surfaces

***Gabriela Toader*[1], *Aurel Diacon* [1,2], *Alice Podaru*[1,2], *Raluca Elena Ginghina*[3], *Adriana Elena Bratu*[3], *Traian Rotariu*[1], *Edina Rusen* [2,*]**

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Abstract: This study aimed to develop novel photo-crosslinkable hydrogels designed to entrap and neutralize chemical warfare agents and their degradation products from various types of surfaces. UV-cured interpenetrated polymer network (IPN) hydrogel films were synthesized in the presence of zinc(II)2,9,16,23-tetra(carboxy)phthalocyanine which was employed as the photoactive decontaminating agent. The resulting materials were characterized through scanning electron microscopy (SEM), Fourier-transform infrared spectroscopy (FTIR), and mechanical investigations (shear, tensile, and compression tests). Experiments performed revealed that the Zn-phthalocyanine increased the mechanical resistance and decontamination performances of the hydrogel films. Gas chromatography-mass spectrometry (GC-MS) was utilized for the monitorization of the decontamination efficiency. The UV-synthesized IPN hydrogels successfully neutralized and entrapped the persistent and hazardous blistering agent, mustard gas, for which a 99.92% decontamination efficacy was obtained.

Keywords: *Zn-phthalocyanine, photocatalyst, photocrosslinkable, hydrogel, decontamination*

Funding: This work was financially granted by the Ministry of Research, Innovation and Digitalization (UEFISCDI) through PN-III- program − ctr.no. PD69/2022 and ctr.no. 672PED/2022.

TiO_2 Supported on *Posidonia Oceanica* fiber as low cost photocatalyst for phenol photodegradation

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Abstract

Environmental Protection includes programs that are aimed at reducing water pollution from contaminants such as hazardous materials and wastes, fuels, and oils. These programs address pollution prevention measures and regulatory compliance by providing procedures for safely working with these materials, inspecting the storage vessel, and designating preventative maintenance procedures. Also all the countries of the world are concerned by the safeguard of water resources soft, either because they lack water, or because they pollute it. The disparity between the needs and the availability of water requires us to imagine new means of routing and processing to increase the availability of resources. It is essential to protect the water and it is necessary to be able to supply the quantity necessary for domestic and industrial consumption, recycle water as much as possible waste and limit polluting discharges into the natural environment. Some methods are attempted for the removal from wastewater including coagulation, floculation, adsorption and photocatalysis. Among the mentioned, methods, photocatalysis is one of the most important technologies for treating water pollutants effectively. Photocatalytic degradation uses semi-conductor materials like titanium dioxide (TiO_2) to mineralize organic contaminants. In this paper, we report the valorization of lingo-cellulosic fibers of the marine plant from Tunisia's beach called *Posidonia oceanica* (*POF)*. We investigated the synthesis of a new and original hybrid material from the fibers and the well-known semiconductor photocatalyst titanium dioxide TiO_2P25 (*POF*/TiO2) by the sol-gel method as well as its efficiency in the photocatalytic degradation of phenol as a model compound. The composite material and the photocatalyst were characterized by different methods. SEM images show a TiO_2 layer formed on top of the fibers. Diffuse reflectance UV-vis spectroscopy shows that the layer has the same optical properties (Eg = 3.0 eV) as bulk P25. Results show the successful removal of phenol from water by photodegradation. The photocatalytic activity of phenol reaches from 0% to 62% for 240 min under UV-C light (254 nm). POF and POF/TiO_2 were characterized by using XRD, SEM and x-ray (EDAX) to see the total destruction of the amorphous structure to crystalline structure dominate anatase. BET showed the enhancement in the specific surface area of this new hybrid POF/TiO_2 from 2.72 m^2/g before modification to 45.80 m^2/g after modification structure. The efficiency on phenol degradation revealed that under sunlight the degradation was 24.63% in comparison between other types of light as Xenon light which made the photocatalytic process economically more efficient.

Keywords: 'Environment', 'Modification', 'Posidonia Oceanica Fibers', 'TiO_2', 'Phenol' ,' Degradation'.

Tuning the visible-light-driven photocatalytic properties of multi-decorated TiO_2 by noble metals towards both propionic acid and NOx

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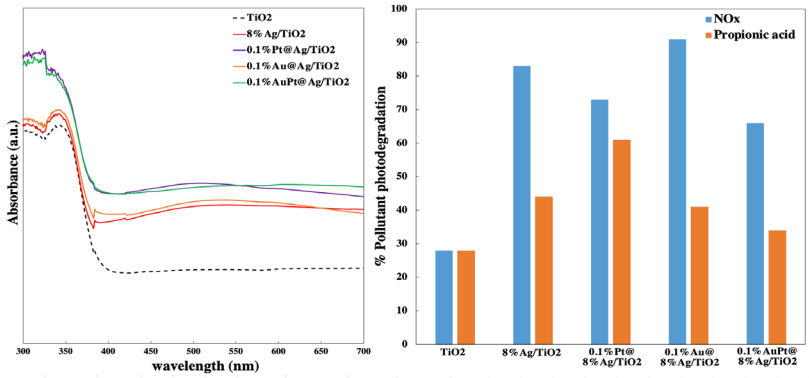
Propionic acid (PA), as one of the leading organic compounds responsible for odors-polluted areas, and NOx, with various environmental and health impact, have been one of the main reasons for the poor air quality in outdoor and indoor areas. Semiconductor-assisted photocatalysts permit to degrade different types of pollutants without secondary pollutants production. In this work, PA and NOx degradation has been investigated in the presence of both primary (Ag) and secondary (Au, Pt, and AuPt) noble metals-modified micro-sized TiO_2 photocatalysts under LED irradiation [1]. The synthesis has been done through cheap and sustainable approach, based on the use of noble metals-enriched wastewaters. It was demonstrated that the synergistic effect between the metals in multi-decorated photocatalyst, as well as the presence of metallic impurities (mainly copper) in the wastewater used for the preparation of the photocatalysts, have a beneficial effect on the materials' photoactivity, as they prevent e^-/h^+ recombination, and enhance the lifetime of the photogenerated charges. The decoration with 8%(wt) Ag NPs (primary decoration) leads to a significant increase of the materials' photoactivity, reaching 40% and 80% of PA and NOx decomposition, respectively, thanks to the strong light absorption behavior of noble metal due to its localized surface plasmon resonance (LSPR).[2] Properly tuning the secondary metal decoration step, the material's photoactivity was optimized. The 0.1%Pt@Ag/TiO_2 photocatalyst showed a promising results, up to 60% of PA removal, due to the synergistic effect between Ag/Pt promoting the separation of photogenerated e^-/h^+ through trapping electrons and improving the quantum efficiency, whereas the 0.1%Au@Ag/TiO_2 showed the highest photoactivity in the NOx decomposition (90%) due to the high tolerance of Au to HNO_3 produced on the catalyst surface [2].



UV-Visible absorbance spectra and photoactivity graphs of PA and NOx under LED irradiation

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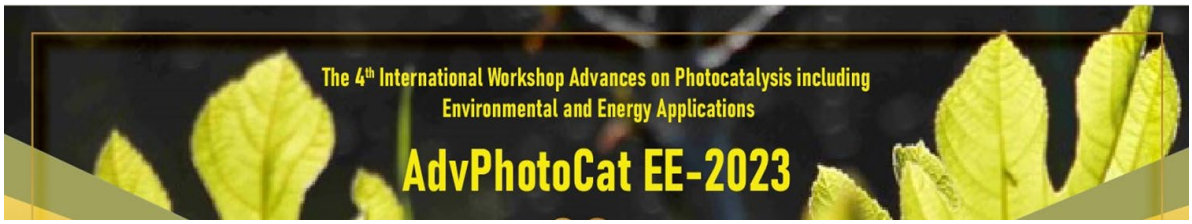

Novel Multinary Chalcogenide based Nanoheterostructures: Solar active and Eco-friendly Nanocatalysts for Photodegradation of Pharmaceutical Wastewater Pollutants

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Wastewater treatment regarded as one of the most challenges to overcome worldwide water threats. As a result, great efforts were devoted for finding alterative solutions to maximize the usage of wastewater in industries or agriculture which consumes 70 % of water resources. Interestingly, the utilization of solar energy as a renewable, green and costless energy source is the ideal sustainable solution for wastewater treatment. Therefore, the application of efficient approaches such as solar photocatalysis to remove pollutants from wastewater effluents has been increasing during the last decades. In this context, Chalcogenides based nanoheterostructures such as $AgIO_3/Cu_2SnS_3$ were prepared via simple, cost-effective and large-scale methods then utilized as visible light active photocatalysts for wastewater treatment. Transmission electron microscopy (TEM), X-ray powder diffraction (XRD), N_2 sorpometry, X-ray photoelectron spectroscopy (XPS), ultraviolet–visible spectroscopy (UV-Vis), and dynamic light scattering (DLS) were used to analyze the characteristics of nanoheterostructures. The photocatalytic activity of the nanoheterostructures towards photodegradation of pharmaceuticals waste was investigated under natural solar radiation. Also, the effect of operational parameters in terms of catalyst dose, pollutant concentration, pH and reusability were studied, and a proposed mechanism have been investigated. The prepared nanoheterostructures were tested as solar active photocatalysts for amoxicillin photodegradation. The $AgIO_3/Cu_2SnS_3$ (20ACS) photocatalytic results exhibited a high photodegradation efficiency (93.5 %) after 60 min.

Keywords: nanoheterostructures; solar irradiation; photocatalysis; ternary chalcogenide.

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The 4th International Workshop Advances on Photocatalysis including Environmental and Energy Applications
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Mathematical Modeling and Simulation of Ozonation of Wastewater Containing Organic Matter

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Abstract

Ozonation is an effective advanced oxidation process commonly employed in combined wastewater treatment to remove organic pollutants from secondary effluent. The complex interactions of biological treatments and ozonation processes as well as the limitations of the classical ozonation models such as oversimplification or neglecting the presence of other organic and inorganic compounds call a new model. The approaches to modeling ozonation and biotreatment differ, including their nomenclature and the selection of lumped parameters to describe the system. Hence, a crucial step is first to establish consistent connections between the variables employed in both biological and chemical modeling approaches. Next, this study consisted on developing a kinetic model for the ozonation process, mapping aggregated parameters such as reduced inorganic compounds, organic matter, etc, aiming at the future exploitation in model-based integration with the biotreatment. The simulations were conducted using Simulink® (a block diagram environment), which provides a comprehensive framework for modeling and simulating complex environmental systems. These results provide valuable insight into the planning of the subsequent modeling phase of this research aimed at providing a reliable model of the integration of ozonation and biotreatment processes.

Table 1. The proposed model for the ozonation

Reaction rate		Reaction expressions
$r_1 = k_{RIC}.[O_3][RIC]$	(1)	O_3 + Reduced Inorganic Compounds (RIC) ⟶ Products
$r_2 = k_{SD}.[O_3]$	(2)	$O_3 \longrightarrow O_2$
$r_3 = k_{OMf}.[O_3][OMf]$	(3)	O_3 + Organic Matter Fast Decompose (OMf) ⟶ Products
$r_4 = k_{OMs}.[O_3][OMs]$	(4)	O_3 + Organic Matter Slow Decompose (OMs) ⟶ Products
$r_5 = k_{RFC}.[O_3][RFC]$	5)	O_3 + Radical Forming Compounds (RFC) ⟶ $HO^•$
$r_6 = k_{RS}.[HO^•][RS]$	(6)	$HO^•$ + Radical Scavengers (RS) ⟶ Products
$r_7 = k_{TC(OH)}.[HO^•][TC]$	(7)	$HO^•$ + Target Contaminant (TC)⟶ Products
$r_8 = k_{TC(O_3)}.[O_3][TC]$	(8)	O_3 + Target Contaminant (TC)⟶ Products

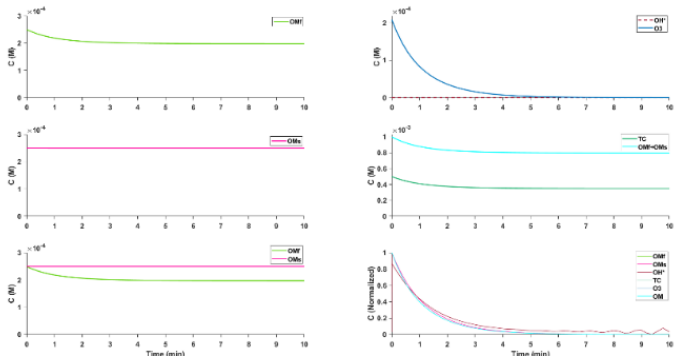
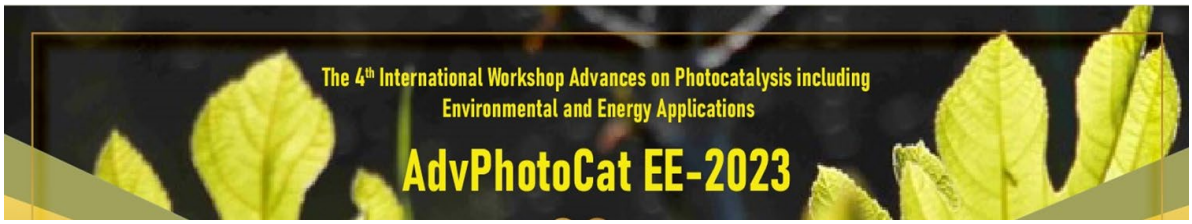


Fig 1. Profile of model variables, I.C: $[O_3]$= 208 µM; [RIC]= 208 µM; [OMf]=0.25 mM; [OMs]=0.25 mM; [RFC]=3.16×10^{-3}; [RS]=1×10^{-13} $[HO^•]$=0 mM; [TC]=0.5 mM



Solar Disinfection: The Development of Polypropylene Transparent Jerry Cans as affordable photoinactivation reactors

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Solar disinfection (SODIS) has been categorized as a relatively affordable and effective method for water disinfection in low to medium income counties by the World Health Organization (WHO) [1-3]. Here we examine the development of a 10L Transparent Jerry Can (TJC) for use as a method of collecting and treating drinking water. Typically, PET plastic has been used for SODIS vessels, we have opted to examine Polypropylene as an alternative as it has 2 majors benefits: It is cheaper than PET and it offers the ability of UVB transmission that can aid in the inactivation of certain viruses and protozoa. To ascertain the TJC inactivation abilities it was assessed as per the WHO household water treatment and safe storage (HWTS) guidelines for its ability to eliminate 3 known pathogens that cause diarrhea. In this case we examined *E. coli* for a bacterium, MS2 for a virus and *C. parvum* for protozoa a obtained a 6 log decrease after 105 minutes, a 3 log decrease after 5 hours and 3 log decrease after 5 hours and 3 log decrease after 48 hours respectively. According to the WHO HWTS the PP TJC obtained a 2 star or compressive protection against 3 known pathogens that can cause diarrhea[4]. The plastic was analysed for its structural integrity by weathering the plastic as per ISO 4892-2, subjecting it UV and visible light and weathering cycles. Weathering of plastic caused a drop in molecular weight from 459700 g/mol to 158900 g/mol after 8 weeks, and there was an increase in absorbance in the carbonyl region from 0.43 absorbance to 1.46 in the same time period indicating photodegradation of the plastic has occurred. This photodegradation was seen to have an impact on the UVA and UVB transmission with them both decreasing to 20% and 5% respectively but stabilizing at this after 5 weeks of treatment. Elongation at break showed that the plastic became brittle decreasing from 570% to 10% after 2 weeks of treatment indicating the photodegradation was compromising the structural integrity of the plastic. To ensure the PP TJC did not produce leachates or photodegradation compounds that may be harmful the plastic was examined for biocompatibility as per ISO-10993-5 using the MTT assay with MCF-7 and Caco-2 cells lines. To replicate a worst case scenario the TJC were filled with water and left in the sunlight for 9 months in Platform Almeria in Spain, with samples being taken at intervals over the time period. All time points across three replicates obtained a cell viability of no lower than 81.43% with he MCF-7 cell line and 80.80% for the Caco-2 cell lines. As per ISO 10993-5 this indicates that the samples are non-toxic showing that photodegradation of the plastic did not form any toxic compounds. The PP SODIS TJC showed good inactivation of pathogens, it was nontoxic to human cells after 9 months of use but photodegradation was impacting the structure of the containers making it unfit for use, future work will examine the addition of UV stabilizers to enhance the plastics lifetime.

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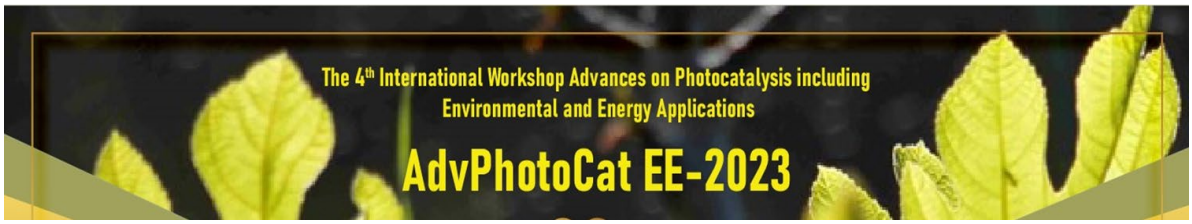

The effect of the preparation conditions on the photocatalytic H_2 production of noble-metal-free ZnS-CdS semiconductors

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Photocatalytic H_2 production utilizing H_2S, an industrial side-product, is regarded as an environmentally friendly process to produce clean energy through direct solar energy conversion. For this purpose, sulfide-based materials as photocatalysts, have been widely used due to their good solar response and high photocatalytic activity. In the first part of our work, a $Zn_{0.75}Cd_{0.25}S$ composite was studied, and special attention was dedicated to the influence of the preparation parameters on its H_2 production activity. The second part of our study rather focused on metal-modified composites and how their activity is affected by the modification method, Ni content, HTT, and use of a complexing agent (ammonia) during the preparation. The composition, optical, and structural properties of the prepared photocatalysts were determined by ICP, SEM, DRS, XRD, TEM, and STEM-EDS. The $Zn_{0.75}Cd_{0.25}S$ catalyst with enhanced photoactivity for H_2 production was synthesized from ammine complexes of metal ions and then hydrothermally treated. The ammonia content and the HTT were found to strongly influence the RHP in this system. The different characterizations and quantum efficiency measurements proved the dependence of the photoactivity of these catalysts on the structural and morphological properties determined by the preparation conditions. However, in the case of metal-modified samples, Ni-modification was more efficient for untreated composites precipitated from ammonia-containing media than Ni-free ones. The best efficiency, achieved by surface modification with 0.1–0.3% Ni(II), was 15% and 20% better than those for hydrothermally treated catalysts and similarly prepared Pt-modified one, respectively. Structural characterization of the composites confirmed that the Ni(II) ions were not embedded into the $Zn_{0.75}Cd_{0.25}S$ crystal lattice but were enriched on the surface of particles of the original catalyst in the form of NiO or $Ni(OH)_2$.

In a separate work, we also investigated the surface modification of the $Zn_{0.5}Cd_{0.5}S$ catalyst. Besides the two previously mentioned methods, impregnation was also applied, which is a simple but unconventional modification technique for the CdS-type catalysts. Among the catalysts modified with 1% Ni(II), the impregnation method resulted in the highest activity. The catalysts were characterized by DRS, XRD, TEM, STEM-EDS, and XPS analyses, which also confirmed that Ni(II) is mainly present as $Ni(OH)_2$ on the surface of the CdS-ZnS composite. The promising photocatalytic efficiency achieved with the application of these catalysts encourages further investigations to enhance the rate of H_2 generation by optimization of the reaction conditions and the Ni(II) modification methods for practical utilization.

Rietveld refinement of X-ray diffraction patterns in photocatalytic metal oxides

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Photocatalysis which it is defined as "the acceleration of a photo-generated electron in the presence of a catalyst" represents a well-known technique with promising applications in the degradation of organic pollutants [1,2]. So far, the scientific community was carried out an intensive effort to reduce this problem, using metal oxides. Among these, titanium dioxide (TiO_2) aroused a great interest, due its wide band gap above of 3 eV, being located at the boundary between UV and visible range (< 410 nm). At the same time, the possibility to tune the morphology and microstructure of these oxides, from the synthesis procedures and doping open new effective strategies for enhancing the photocatalysis under the visible-light irradiation. In this paper, we investigate a series of copper (Cu) and tin (Sn)-doped TiO_2 composites prepared by electrospinning and then calcinated at high temperatures. An in-depth microstructural analysis is performed using the Rietveld refinement of the whole powder XRD pattern. In addition to the Scherrer's equation, this approach affords a more accurate determination of the actual microstructure. Our findings showed that the dopant and calcination temperature play a fundamental role in enhancing the removal efficiency, as well as in inducing visible light activity in Cu-doped and Sn-doped TiO_2 [3,4].

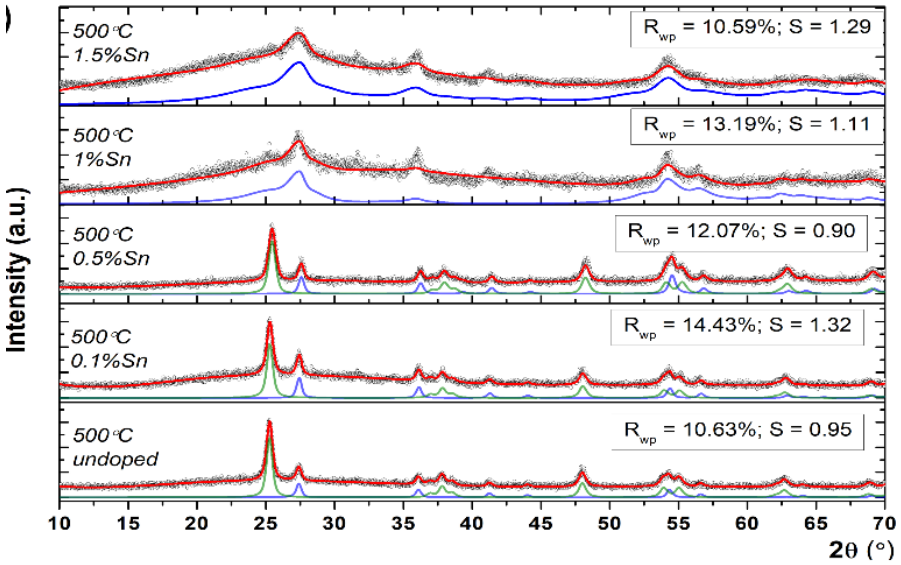
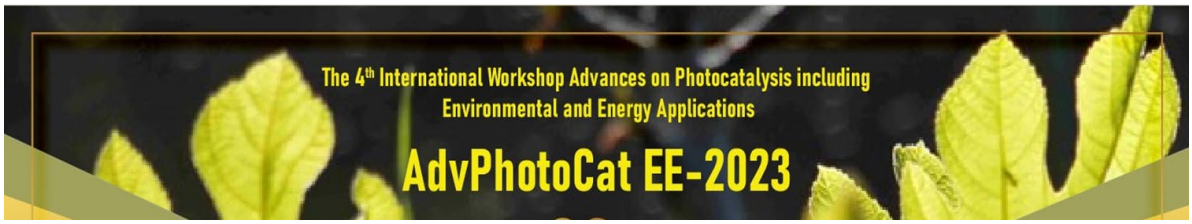


Figure 1 Rietveld refinement (red) of XRD patterns (black) for undoped and Sn-doped TiO_2 at 0.1%, 0.5%, 1% and 1.5%.

Acknowledgements



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Modification of TiO_2 with nitrogen via sol-gel method and the role of ammonia. Not all that generating visible light absorption in TiO_2 is doping.

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Abstract

A multi-technique characterization of nitrogen-modified TiO_2 materials synthesized by sol-gel method (wet synthesis) using urea and ammonia as precursors at annealed at 450 and 550 °C was realized. It was found that the synthesis led to the visible light absorption in TiO_2 but did not generate nitrogen doping but rather presence of oxygen vacancies (V_o) and heterojunctions of graphitic carbon nitride (g-C_3N_4)/TiO_2, and presence of V_o and NO-TiO_2 surface complexes when urea and ammonia were used as precursor, respectively. Ammonia thermal degradation generated in both synthesis procedures could be related with the formation of oxygen vacancies while urea would be precursor of g-C_3N_4 structures. By electronic spin resonance spectroscopy (ESR) using PNBO as spin trapper, it was detected the presence of hydroxyl radicals (•OH) only under UVA irradiation.

Ag-modified $SrTiO_3$ one-pot synthesis: combined effect of Ag-decoration and Ag-doping

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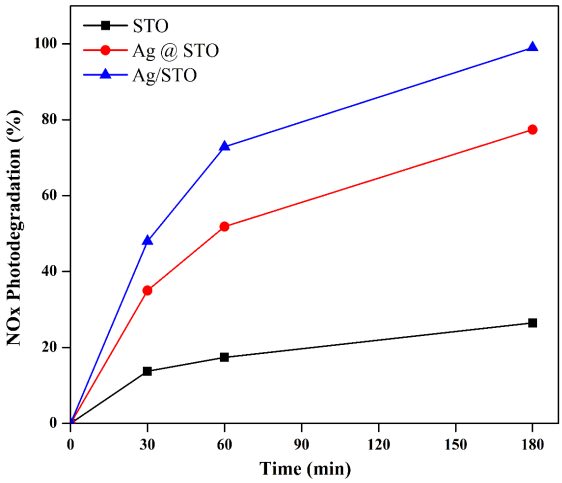
Air pollution has become a worldwide public health and ecological concern over the past decades. Within the vast variety of air pollution sources, nitrogen oxides (NO and NO_2) are key primary pollutants responsible for numerous respiratory diseases and environmental disasters such as acid rain and photochemical smog [1]. Among common techniques (e.g., Selective Catalytic Reduction and Selective Non-catalytic Reduction), photocatalysis has emerged as an ecofriendly, cost-effective, and sustainable alternative, where the degradation of inorganic pollutants is conducted on semiconductors' surface under ambient conditions by exploiting natural or artificial light [2]. For environmental remediation application perovskite oxide based photocatalysts have been recently investigated without outstanding results compared to their performance in other fields (e.g., water splitting and energy conversion). Strontium titanate ($SrTiO_3$) is a cubic-like perovskite well-known for its high thermal stability and limited photocatalytic efficiency under UV irradiation due to its wide energy bandgap (3.2 eV). As a result, strategies for enhancing light harvesting like metal-doping and metal-decoration have been well explored [3]. In this work, a rational design for the development of Ag-modified $SrTiO_3$ materials active under LED light towards the degradation of nitrogen oxides (NO_x) was carried out. By modifying $SrTiO_3$ surface with silver nanoparticles (NPs) via a sustainable two-step process, Ag-decorated $SrTiO_3$ photocatalyst achieved 77% NOx photodegradation after 180 min. On the other hand, through a straightforward, and sustainable one-pot synthesis $SrTiO_3$ was doubly modified: within lattice and onto the surface. This photocatalyst reached the complete photodegradation of NO_x under LED after 180 min. The photocatalytic enhancement was associated to the combined effect between Ag doping and Ag decoration. Its performance was 4 times higher than pristine $SrTiO_3$ (26%) and 1.3 times more active than Ag-decorated $SrTiO_3$. Finally, after 5 recycling tests the best material demonstrated high stability without decreasing significantly its photocatalytic efficiency.



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The 4th International Workshop Advances on Photocatalysis including Environmental and Energy Applications
AdvPhotoCat EE-2023

Photo- and piezo-catalysis as the winning pair for the fast and efficient mineralization of ibuprofen by bismuth oxybromide under solar light irradiation

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In recent years, the water crisis and continuous contamination of water basins have posed a serious threat to water resources and society well-being. Pharmaceutical and personal care products, steroids, and hormones are just some pollutants found in water [1]. Among these, the most well-known pharmaceutical category is that of non-steroidal anti-inflammatory drugs (NSAIDs), whose ibuprofen (IBU) belongs. Recently, it has been demonstrated that IBU can be found in untreated municipal wastewater and in hospital or industrial production waste [2]. Accordingly, researchers have addressed efforts in developing new methods for its abatement. Among the different approaches, heterogeneous photocatalysis has emerged because it uses semiconductors and a source light to produce oxidants (*i.e.*, $OH\cdot$, $O_2^{-\cdot}$, $HO_2\cdot$ radicals) to mineralize organic contaminants to carbon dioxide and water [3]. However, the fast photo-induced electron-holes recombination limits its practical use, since it leads to the diffusion of the produced charges at the photocatalyst surface, strongly reducing the photocatalytic activity. The urgency to identify more performant photocatalysts able to reach complete and fast mineralization of ibuprofen by sustainable approaches is thus evident. In this context, piezophoto-catalysis can be a valuable solution: the use of ultrasound vibrations promotes electric charges at the photocatalyst surface, enhancing the photoinduced charge separation by the piezoelectric effect. In this way, redox reactions involved in organic pollutants degradation are promoted by the free charges accumulated on the material surface [4]. Herein, we have investigated for the first time the photo- and piezo-photocatalytic properties of bismuth oxybromide nanosheets (BiOBr, Figure 1a) in the IBU degradation in different water matrices (ultrapure and simulated drinking water) to evaluate the potential application of the piezo-photocatalyst in real environments [4]. Figure 1b resumes some results in terms of mineralization capacity values obtained in the presence of different BiOBr dosages.

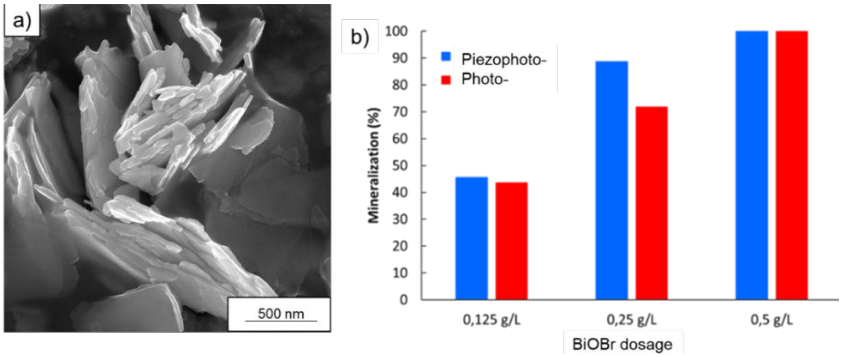

Figure 1: a) FESEM micrographs of BiOBr nanosheets; b) Mineralization results of photo-, and piezophoto-degradation of IBU (50 $mg\cdot L^{-1}$) in the presence of different BiOBr dosages in ultrapure water obtained at the process end (30 min dark *plus* 180 min under solar irradiation, 35 $W\cdot m^{-2}$).

In general, the higher is the BiOBr dosage, the higher is the mineralization capacity. Complete mineralization is obtained when 0.5 $g \cdot L^{-1}$ BiOBr dosage is used. The main results obtained in terms of the identification of the main active species involved in the degradation process by trapping holes/radicals using proper scavengers and transformation products will be also discussed.

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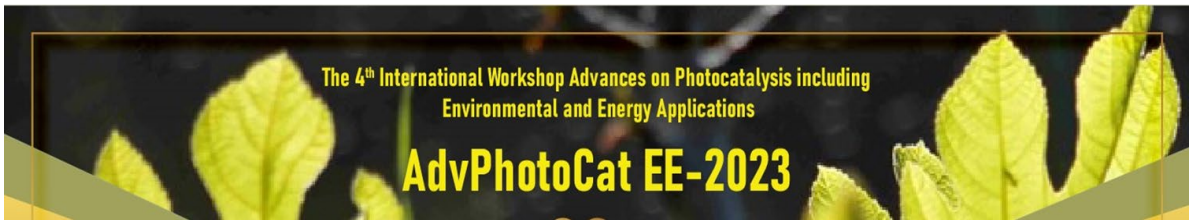

Implementation of Photocatalysts in Organic transformation and Environmental Applications

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Abstract

The implementation and design of heterogeneous photocatalysts in different disciplines such as organic transformation for producing high valued products and in environmental remediation has been investigated greatly in the last decade as a result of the increasing demand for the use of green approaches and through the availability of visible light source. The activity of the photocatalysts could be explained as follows; the production of overall neutral radical as the reactive species as a result of leaving group in compound expel could lead to initiate a chemical transformation under visible light irradiation conditions. Herein, the presented results highlight that the basic concepts of photocatalysis and the applications of these catalysts in various photocatalytic processes. A visible-light-responsive 2D nanomaterialds or polymeric-based nanomaterials had been developed in our group for practical application organic transformation and in treatment of wastewater contaminated with organic dyes or heavy metal ions.

Keywords: Photocatalysts, Organic transformation, Environmental application, 2D nanomaterials, Polymeric-based nanomaterials

Effect of synthesis protocols in the photo-Fenton activity of Zinc Ferrites for the degradation of Acetaminophen pollutant

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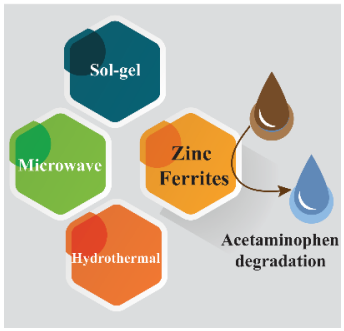

The photo-Fenton technique is a promising method for the degradation of contaminants of emerging concern (CEC) owing to its excellent capacity to produce highly oxidising hydroxyl radicals. In the presence of H_2O_2, iron-based catalysts are capable of performing photo-Fenton (PF) reactions. Different heterogeneous catalysts such as magnetite, ferrites, layered double hydroxides (LDHs), perovskites, metal-organic frameworks (MOFs) and zero-valent iron (ZVI) are reported for PF-related applications. [1] The ferrite group of materials are popular among the heterogeneous photo-Fenton catalysts because of the possibility of magnetic recovery of the catalyst after the reaction and their narrow band gap, which lies in the visible region. $ZnFe_2O_4$ (Zinc Ferrite, ZF), with a band gap of ~1.9 eV, is an excellent material for absorbing light in the visible region. Numerous studies have described the synthesis of Zinc Ferrites (ZFs) by various synthesis techniques, including hydrothermal, co-precipitation, microwave, sol-gel, etc. [2] However, a systematic study that compares the effect of PF activity of ZF catalysts prepared through different synthesis protocols is lacking in the literature. Magnetically separable ZF catalysts were synthesised using hydrothermal (HT-ZF), microwave (MW-ZF) and sol-gel (SG-ZF) synthesis techniques. Detailed characterisation and validation of the synthesised materials were carried out through XRD, FTIR, Raman, XPS, TEM and UV-DRS measurements. The activity of the prepared catalysts was explored by monitoring their PF degradation efficiency of Acetaminophen *via* reverse-phase HPLC with UV detection. Among the three ZF catalysts evaluated, SG-ZF was the most effective at degrading acetaminophen, followed by MW-ZF and then HT-ZF. The correlation of the catalytic activity with the crystallinity and Fe^{2+} content of the catalyst is explored. The low level of iron leaching from ZF catalysts (< 0.1 mg/L) concludes that the reaction could be classified as a heterogeneous PF reaction. In conclusion, this study provides an in-depth understanding of the synthesis parameters that affect the degradation activity of a heterogeneous PF catalyst.

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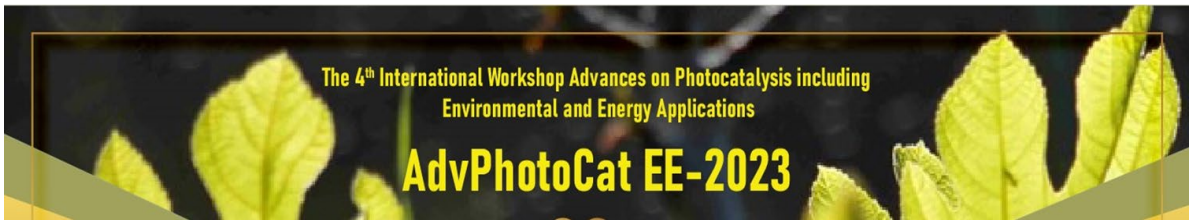

Nanotechnology in Wastewater Management: A New Paradigm for Wastewater Treatment

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Abstract:

Clean and safe water is a basic human requirement for the multifaceted development of society and a thriving economy. Rapid population growth, expanding industrialization, urbanisation, and extensive agricultural practises have resulted in the generation of wastewater, which has rendered the water not only dirty or polluted, but also lethal. Every year, millions of people die as a result of diseases transmitted through the consumption of contaminated water. Although various methods for wastewater treatment have been investigated in recent decades, their use is limited by a number of constraints, including the use of chemicals, the formation of disinfection by-products, time consumption, and cost. Nanotechnology, defined as the manipulation of matter at the molecular or atomic level in order to create new structures, devices, and systems with superior electronic, optical, magnetic, conductive, and mechanical properties, is emerging as a promising technology that has demonstrated remarkable feats in a variety of fields, including wastewater treatment. Nanomaterials have a high surface-to-volume ratio, high sensitivity and reactivity, high adsorption capacity, and ease of functionalization, making them ideal for wastewater treatment. We reviewed the techniques being developed for wastewater treatment using nanotechnology, including adsorption and biosorption, nanofiltration, photocatalysis, disinfection, and sensing technology. This extends talk, we will discuss the fate of nanomaterials in wastewater treatment, as well as the risks associated with their use.

Keywords: Nanomaterials, Wastewater, Treatment and Management

Degradation of Ibuprofen in a flow-through system by the Electro-Fenton Process activated by two iron-sources

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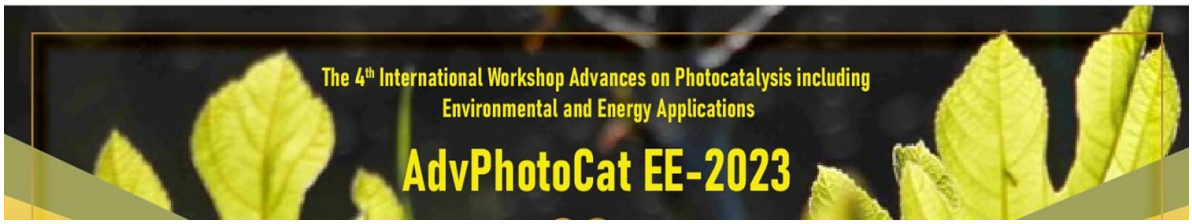
Abstract

Efficient and steady electrogeneration of H_2O_2 and its activation into hydroxyl radicals($^{\cdot}OH$) is an important step in the Electro-Fenton water treatment process. This study focused on the electrochemical degradation of ibuprofen (IBP) in a flow through reactor to evaluate the performance of two different iron sources, sacrificial cast iron anode and $FeSO_4$ salt. Different operating parameters were assessed, including initial IBP concentration, cast iron anode location, initial $FeSO_4$ concentration, applied current, the split current on the iron anode, solution pH, and flow rate on the efficacy of the process was evaluated. The cathode consisted of a graphite felt coated with polytetrafluoroethylene (PTFE) and polydimethylsiloxane (PDMS) damp-proof coating for the generation of H_2O_2. It was found that the sequence of the electrodes influences the ibuprofen removal. When the cast iron was used as an anode, placing the anode upstream provided the best IBP degradation rate. Also, the split current of 3 mA out of 120 mA total applied on the iron anode is the most efficient current for the removal of 1mg/L of IBP under a flow rate of 3 mL/min. A linear correlation was demonstrated between the applied current and the Fe^{2+} concentration of the $FeSO_4^-$ system. The flow rate had an influence on the degradation efficiency since a higher flow rate dilutes the concentration OH radicals. However, the $FeSO_4^-$ system was less affected by the flow rate compared to the iron-anode system since the concentration of Fe^{2+} was regenerated. Both systems achieved higher efficiency in the acidic system rather than the basic and alkaline conditions. These findings are a basis for understanding the electro-Fenton process under different flow conditions, iron source and cathodic modifications to serve as a basis for designing electrochemical reactors.



Nanostructured photocatalysts materials with germicide activity

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Abstract:

Photocatalysis is a versatile and effective process that can be adapted for use in many applications for disinfection in both air and water matrices due to the superior ability of photocatalysis to inactivate a wide range of harmful microorganisms. Photocatalytic surfaces are being developed and tested for use in the context of "self-disinfecting" materials. Studies on the photocatalytic technique for disinfection demonstrate this process to have potential for widespread applications in indoor air and environmental health, biological – agricultural and aquaculture applications, medical applications, pharmaceutical and food industry, wastewater, and effluents treatment, and drinking water disinfection [1,2]. Studies on photocatalytic disinfection using a variety of techniques and test organisms were published with an emphasis on various end-use applications of developed technologies and methods. This presentation would particularly focus on our recent achievements on fabrication and use of pure and doped TiO_2 nanostructured photocatalysts based composite materials with antibacterial, antifungal, and antifouling properties [3-5]. Various composites fabricated by electrospinning and electrospinning calcination techniques and their properties would be presented and discussed.

Acknowledgement

HMU contribution to this work was partially supported by NATO Science for Peace and Security Programme, grant G5868 and the Operational Program Fisheries and Maritime 2014–2020 in the framework of the project "Innovative materials for nets for fish farming with environmentally friendly antifouling action", MIS 5029684. IMT contribution was partially supported by the Romanian Ministry of Research, Innovation and Digitalisation thorough „MICRO-NANO-SIS PLUS" core Programme and MicroNEx, Contract no. 20 PFE from 30.12.2021.

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From Trash to Treasure: Cotton Waste Transformed into Photocatalytic Carbon Dots with Antibacterial Properties under Vis-NIR Light

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Abstract

Cotton waste is a growing global concern, with millions of tonnes being discarded every year. Sustainable solutions are highly requested that can turn this waste into a valuable resource. In the current study, we generated carbon dots from non-woven cotton waste following a scalable, environmental-friendly strategy. Carbon dots are fluorescent nanomaterials with interesting physicochemical properties and good biocompatibility that make them ideal for use in various industries, including photocatalysis and healthcare. They can be fabricated from many carbon sources. Our fabricated carbon dots possess strong photoluminescence, and are chemically very stable and biocompatible. On the top, upon light absorption they generate reactive oxygen species, which can degrade organic pollutants and kill bacteria. We used the Gram-negative bacterium *Escherichia coli (E. coli)* as a model cell to study the photocatalytic properties of the developed carbon dots under visible and near-infrared light irradiation and, consequently, they antibacterial properties under these conditions. The carbon dots from cotton waste were revealed promising systems to combat infections and provide a sustainable solution to healthcare challenges, like the bacterial resistance to antibiotics, reducing the need for traditional antibiotics.

Finally, we fabricated a proof-of-concept paper sensor by functionalizing laboratory filter paper with the fabricated carbon dots using polyvinyl alcohol as a binder. Analysis of digital photographs of paper sensors under UV light shows that the photoluminescence of carbon dots is quenched in the presence of *E. coli*, expanding the potential application of carbon dots to paper-based bacterial sensors.

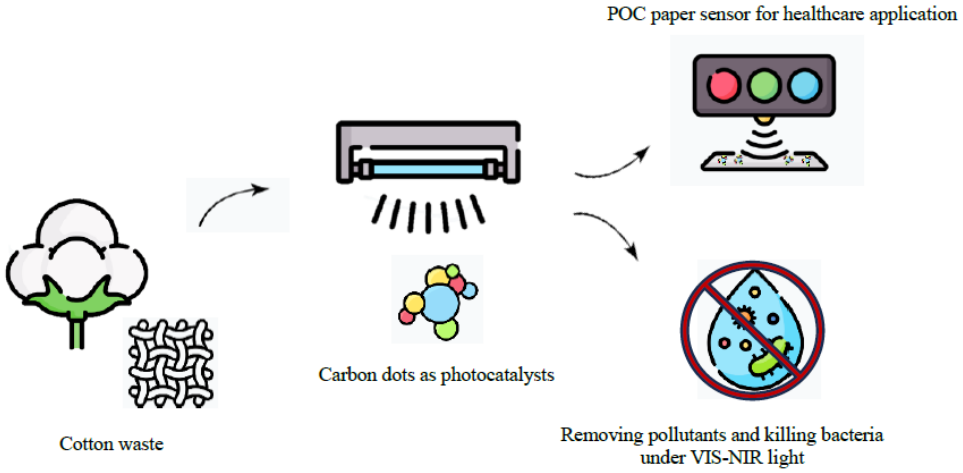
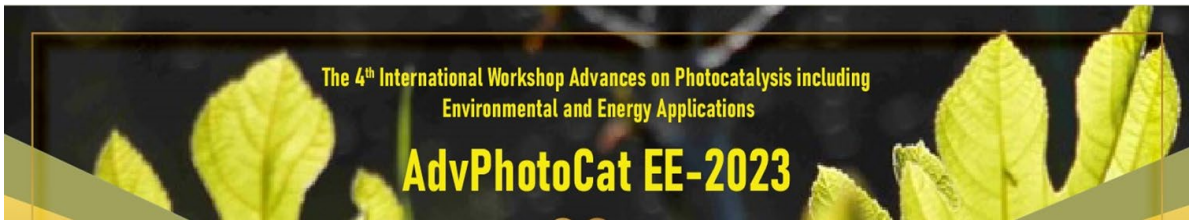


Figure 1. *Schematic illustration of the potential of the proposed carbon dots producted from non-woven cotton waste.*



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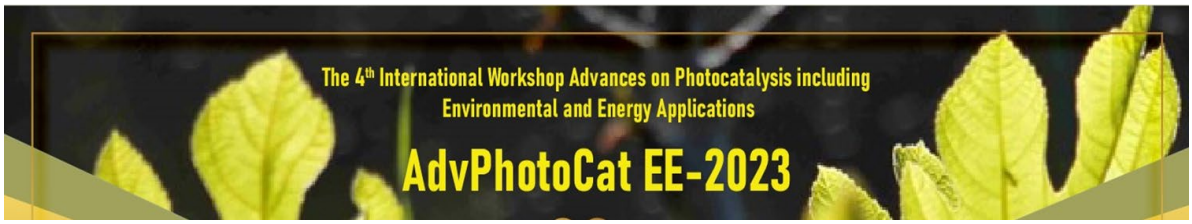

Materials for fishnets: fabrication and their antifouling properties

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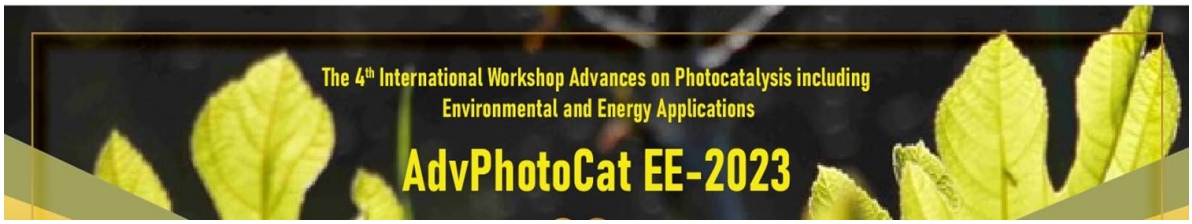
Abstract

The purpose of this work is to develop alternative materials, which are environmentally friendly and combine low cost and efficiency for aquaculture applications. Pure and Cu doped TiO_2-HDPE composite materials were successfully fabricated and used to fabricate special grids by 3D printing. we report on the development of new composite materials for aquaculture nets, using High-Density Polyethylene (HDPE)/pure and doped TiO_2 with different metal oxide contents, so that the final material has antifouling properties, but also suitable mechanical behavior. The sample nets were developed employing extrusion for filaments fabrication and 3D printing, the obtained materials being characterized by SEM, XRD and Raman Spectroscopy, while, their antifouling properties were also evaluated. The coexistence of pure and doped TiO_2 phases in the composites indicated that the particles had been successfully embedded in the HDPE polymeric matrix. The filament presents a uniform and homogeneous structured surface with large fibrillar features while after printing the surface of material become smoother with much smaller features onto it. Using 10% Cu doped TiO_2 leads to composites with rougher surface and the apparition of the fibrillar features observed on the filament but with smaller size while the use of Cu doped TiO_2 has a radical change on the surface morphology consisting on presence of much larger fibrillar features and clusters. The morphology is important to achieve antifouling properties since the microorganism adhesion depends on it. The antifouling response was determined by monitoring the growth of *Navicula* diatoms and the unicellular algae chlorella. Also, the materials were photographed with a stereoscopic camera and we estimated the percentage of phytoplankton adherence to the total surface**.** The results so far have shown that the HDPE/TiO_2 are quite good candidates for antifouling nets. An excellent antifouling ability was achieved for 10% pure and Cu doped TiO_2 for time being.

Acknowledgement: This work was funded by the Operational Program Fisheries and Maritime 2014–2020 in the framework of the project "Innovative materials for nets for fish farming with environmentally friendly antifouling action", MIS 5029684.



Synthesis of Graphene from Graphite and its Environmental Applications

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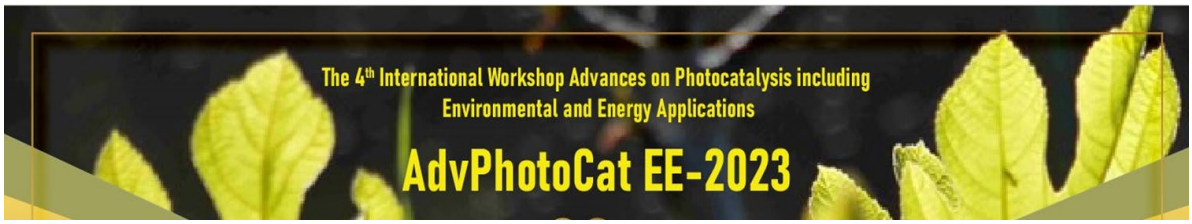
Abstract

Graphite is a mineral consisting of carbon and is usually common in graphite schist. In general, the graphite has its specific properties. Therefore, both natural and synthetic graphite is of great importance in different industries. It uses in the production of crucibles, retorts, refractory laboratory vessels, lubricants, insulation of buildings, electrodes, pump sealants, anti-corrosion paints and many others. In the Eastern Desert (ED) of Egypt, several granite occurrences were recorded including Abu Fanani, Meatiq, Al-Baramiya, Wadi Sikait and Wadi Lawi areas. This graphite schist is metamorphic rock and belongs to Neoproterozoic rocks of the Arabian-Nubian shield (580-800 Ma). It forms layers or lenses within the metamorphic rocks that was once a sedimentary rock. In this study, the design parameter of 2D nanosheet for water treatment was investigated. The present study aims to develop a new advanced methodology for production of graphene from cheap precursor. The new photoactive hybrids were prepared for wastewater treatment and was examined at the laboratory scale for the removal of pollutants from water.

Keywords: Graphite, Graphene, Photoactive hybrids, Wastewater treatment, Environmental application.



Raman study of novel PVDF/TiO2/graphene composite fibers for photocatalytic applications

***C. Pachiu*[1], *P. Pascariu, I.V.Tudose*[2,3], *C. Romanitan*[1], *M. Popescu*[1], *E. Koudoumas*[2,3], *M.P. Suchea*[1,2,3]**

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PVDF/TiO2/graphene composite fibers are an innovative class of materials with promising applications in photocatalysis. Each component contributes unique characteristics that enhance the overall performance of the composite for photocatalytic applications: PVDF is a polymer with excellent mechanical strength, chemical resistance, and thermal stability; TiO2 is a semiconductor material with outstanding photocatalytic properties and Graphene is a remarkable material with high electrical and thermal conductivity, large surface area, and excellent electron mobility.

Raman spectroscopy can detect interactions and alterations in molecular vibrations resulting from the presence of multiple components in the composite. For example, shifts in Raman peaks or variations in peak intensities can signify interactions between PVDF, TiO2, and graphene, influencing their bonding and electronic characteristics.

In this study, we will present the PVDF/TiO2/graphene composite fabricated using the electrospinning technique, and we will explore their unique properties and characteristics by Raman spectroscopy. The shifts and broadening of Raman peaks indicate the formation of new chemical bonds or intermolecular interactions, revealing how the components interact and influence each other's properties.

This information is in important to tailoring the composite's properties for enhanced photocatalytic performance and paves the way for the development of efficient and multifunctional materials in various applications such as water purification, air filtration or energy conversion.

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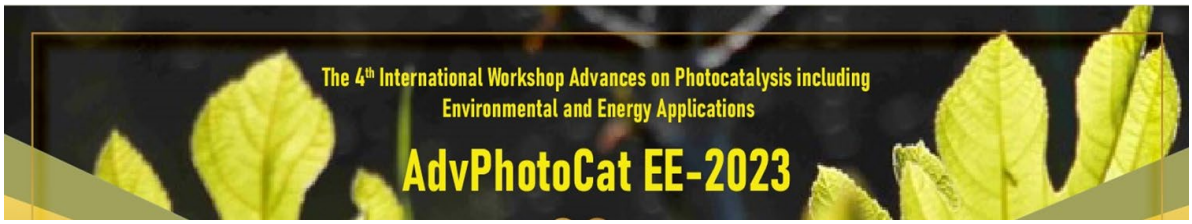

High pulsed laser energy to produce structural morphology of thin layers for green chemical processes

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Abstract

High pulsed laser energy of 180 mJ/pulse with a pulse width of 10 ns and repetition rate of 10 Hz, 532nm wavelength, spot radius of 350 μm, angle of incidence of 45^0 was applied on silver and copper targets placed in the deposition chamber (p=3·10-2 Torr) to produce morphologically structured thin films with an accentuated hill and valley topography on glass slabs placed at 2 cm distance from the target. Three types of thin films were obtained: silver (P6); Copper (P8) and Silver/Copper (P10). The morphology, topography, elemental composition and crystalline state of the thin films was studied by Scanning Electron Microscope coupled with Energy Dispersive X-Ray (SEM-EDS), profilometry (DektakXT) and X-Ray Difraction (XRD) techniques. Tests performed with Aqueous solution of Reactive Blue 21 dyestuff (10 g/L) and $NaHCO_3$ (10 g/L) showed chemical processes of decomposition of the RB 21 dyestuff for all the thin films. The silver thin films were not affected by the chemical processes on their surface, meaning that they acted as chatalyst in both P6 and P10 samples. The copper thin film of sample P8 was consumed during the chemical process that took place in the solution poured on its surface. The physico-chemical processes induced on the surface of the three samples of thin films were analyzed with SEM-EDX, FTIR (Fourier Transform Infrared Spectroscopy) and profilometry techniques.

Funding:

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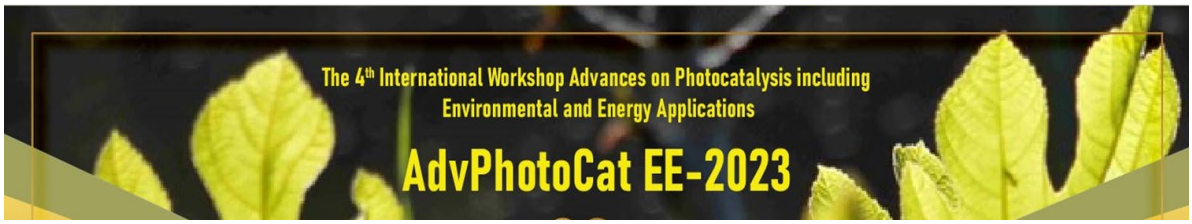

Modified nanosized spinel ferrite based materials with highly proficient catalytic activity

Pascariu Petronela*[1], Grecu Ionela[1], Andra-Cristina Enache[1], Samoila Petrisor[1], Cojocaru Corneliu[1], Ignat Maria[1,2], Lupei Mihai[1], Harabagiu Valeria[1]

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The issue of wastewater becomes a concern to every individual on earth since there is a clear link between water quality and the prosperity of future generations. In this regard, during the past few decades, there has been an increased demand for novel methods and/or materials for water purification [1]. As an affordable and effective substitute for conventional wastewater treatment methods, advanced oxidation processes and especially photocatalysis currently challenging the research community [2]. In recent years, materials such as nanoscale ferrites have been in the limelight for sustainable water treatment applications. The narrow band gap of these materials facilitates the migration of electrons between the valence and conduction bands and also the production of hydroxyl radicals (HO•) that convert organic pollutants into carbon dioxide and water [3]. This class of mixed oxides has a variety of restrictions when employed as photocatalysts in powder form, requiring additional decanting and filtering methods. To overcome these limitations, researchers developed complex inorganic-organic composites by introducing photocatalysts (as fillers) into polymer matrices. Thus, it was established that materials with both organic and inorganic components have superior properties than unmodified polymer materials in terms of structural, mechanical, and photocatalytic features. In addition, these photocatalytic systems are easy to recover and reuse in a practically fashion. Polymeric supports are known for their low manufacturing costs, inertness, chemical and structural resilience. Previous works showed that membranes based on polyvinylidene fluoride (PVDF) exhibit good thermal stability, outstanding chemical and mechanical capabilities [1].

In this respect, the current study describes the preparation, characterization and photocatalytic testing of innovative electrospun spinel ferrite-based composite membranes. For the purpose of facilitating the recovery of the photocatalytic active component from the reaction environment, Zn-Al ferrite nanoparticles doped with Sm ($ZnAlFe_{1.94}Sm_{0.06}O_4$) have been inserted into the PVDF polymer matrix. The electrospinning technique was used to prepare composite membranes by varying the filler quantity. The structural properties of the developed composite materials were investigated using such techniques as Fourier transform infrared spectroscopy (FT-IR) and X-Ray diffraction (XRD). To examine the morphology of the materials, transmission electron microscopy (TEM) was used and the magnetic properties were studied by means of a vibrating sample magnetometer (VSM). Finally, the photocatalytic effectiveness of the composites was evaluated by using a model organic pollutant (methylene blue).

Acknowledgement: This work was supported by a grant from the Ministry of Research, Innovation and Digitization, CNCS-UEFISCDI, project number PN-III-P1-1.1-TE-2021-0030, within PNCDI III.

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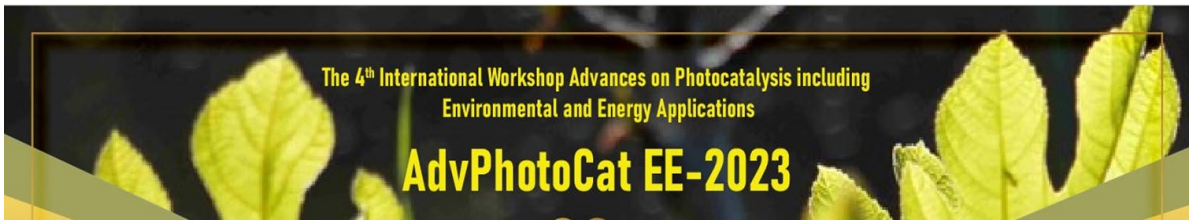

Material modelling for liquid polymer nanocomposites with potential applications in photocatalytic processes

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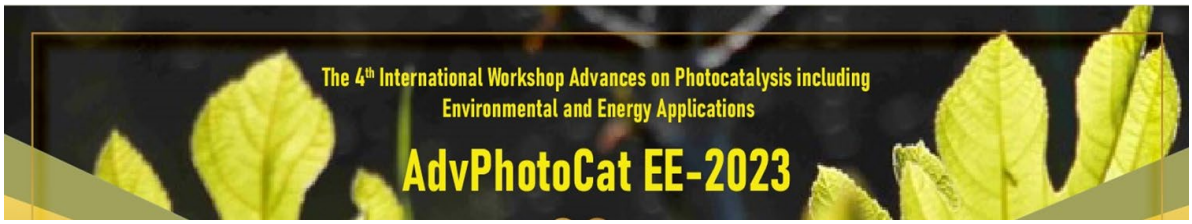
New generation of bionanocomposites can ensure improved properties for a large domain of applications together with eco-friendly attributes. In this work, a computational method is proposed for virtual evaluation of liquid nanocomposites properties. Various types of inclusions are introduced in polymers in liquid state to further processing toward solid products in order to enhance specific properties, particularly for potential applications in photocatalysis. Since the shape, size, concentration and uniform distribution are essentially for the final material properties, the developed model allows computation of the viscosity inside the reactor as function of these parameters. The modelling steps include generating representative volume, simulating with an appropiate multiphysics tool, extracting viscosity matrix and data analytical postprocessing to obtain homogenized viscosity values. The results are useful to find the optimal set of processing parameters and to obtain the expected enrichment of the composite material qualities for dedicated purposes.

Acknowledgement: This work was finnacially suported from H2020 project "Open Innovation Test Bed for Developing Safe Nano-Enabled Bio-Based Materials and Polymer Bionanocomposites for Multifunctional and New Advanced Applications BIONANOPOLYS" Grant agreement ID: 953206 and National Core Project "Advanced research in micro-nano-electronic devices, photonics, sensors and microsystems for societal applications - μNanoEl", Contract nr. 8N/3.01.2023



Materials with ZnO for potential food packaging applications

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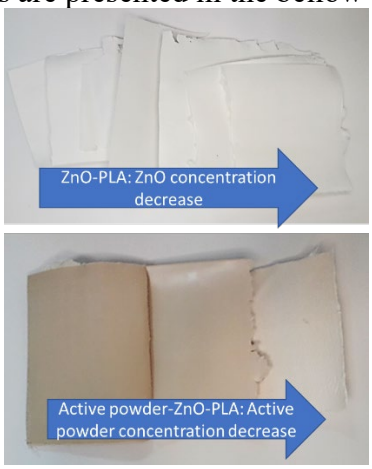
ZnO-PLA and Active powder-ZnO-polylactic acid composite materials were fabricated by hot roll milling. Hot roll milling is the usual mixing polymers technique.
To prepare the composite materials all the process parameters had to be optimized for the specific materials. Accordingly, various trials were made in order to achieve the optimal conditions (temperature, relative rolls speed and nip, etc) for ZnO-PLA pellets processing. It was found that 180C is the proper processing temperature to achieve the desired mechanical properties for mixing of polymer with the ZnO powder. To prepare the mixing the PLA pellets were placed on the mill followed by gradual addition of the powder component in the melted polymer. This approach proved to be suitable for achieving of homogeneous mixtures. Another optimization factor was to determine the maximum ZnO powder concentration that can be included in a PLA quantity conserving reasonable mechanical properties of the final material. It was found out that the concentrations over 15% ZnO leads to non-desired mechanical properties of the mix in hot form as well as to rigid and fragile cold product almost impossible to be processed. The vest processing properties were obtained for 10% ZnO. This composition was used for further addition of Active powder in the composite. Optimum processing vas achieved for 5% active powder. Some examples of the obtained materials are presented in the bellow images.



Acknowledgement

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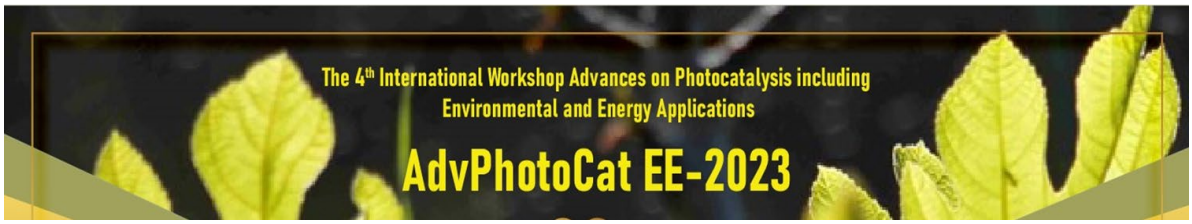

V2O5 materials fabrication and properties for potential photocatalysis

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Abstract:

Due to the material's distinct chemical, physical, and electrochemical properties, there is a growing interest in the production and characterization of vanadium pentoxide (V_2O_5) materials for possible photocatalysis applications. Spray pyrolysis has proven to be effective and adaptable among a variety of fabrication procedures (including hydrothermal, sol-gel, electrospinning, etc.), making it a preferred technique for producing high-quality V_2O_5 materials. As a simple, scalable, low-cost method enables the creation of thin films with precise morphologies and compositions. This technique, applied to thin films of V_2O_5 formed on heated glass substrates at 500 °C, was studied by Mrigal et al. (2019). Similar to this, Ingole et al. (2020) demonstrated the adaptability of spray pyrolysis by tuning the supercapacitive performance of V_2O_5 by varying the precursor solution content. This method was further investigated by Rai et al. (2020), who looked at how Zn doping affected the structural, morphological, and optical characteristics of V_2O_5 nanostructures. Flame spray pyrolysis, electrodeposition, and other noteworthy processes are used to create V_2O_5. Stathi et al. (2021) show that flame spray pyrolysis provides precise control over lattice and doping levels. By using this technique, they were able to create $BiVO_4$ nanoparticles that considerably improved the effectiveness of the photocatalytic O_2-evolution. Spray pyrolysis was used by Moustafa et al. (2020, 2021) to create effective inverted polymer sun cells and long-term stable organic solar cells, respectively, in the field of thin-film electronics. These results highlight the potential of spray pyrolysis for the creation of photovoltaic and energy storage systems. Although higher W or Zr doping can worsen photocatalytic O_2 production, Rai et al.'s study from 2021 sheds light on how enhanced doping can improve film development and crystallite size. According to the results, a precise balance between doping levels is required to maximize photocatalytic effectiveness. As a result, spray pyrolysis stands out as a successful, flexible, and economical method for producing V_2O_5 materials for future photocatalysis applications. It is a potential strategy for improving the development of V_2O_5-based devices for energy and environmental applications since it allows for the manipulation of material properties while maintaining simplicity and scalability. Understanding and refining this technique is spurring additional research and innovation.

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A sustainable approach for green synthesis from biorefinery products: photooxidation of ethyl alcohol by employing cupric ion as oxidizing agent.

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The employment of sustainable feedstocks as raw materials for industrial applications is an attractive solution for the depletion of fossil sources. Bioethanol production via biomass fermentation is a significant example of conversion of renewable feedstocks into useful products. Bioethanol is employed as fuel, fuel additive, or feedstock to produce higher-value commodity chemicals. Acetaldehyde, acetic acid, butadiene, and ethylene are typical conversion products of ethanol. Acetaldehyde production is strictly related to the demand for acetic acid, acetic anhydride, vinyl acetate resins, acetate esters, cellulose acetate, pentaerythritol, etc. Acetaldehyde can be produced by means of traditional processes, such as partial oxidation of hydrocarbons, dehydrogenation or oxidation of ethanol, and addition of water to acetylene [1]. All such processes employ non-renewable energy sources, high operating pressure and temperature, and remarkable overall process costs. In this scenario, solar photocatalytic processes using solar radiation as energy source, mild operating conditions, and low cost and non-toxic photocatalysts (e.g., titanium dioxide) represent a fascinating green alternative for acetaldehyde production. Highly selective photocatalytic oxidation may be ensured by replacing oxygen with selected metal ions (i.e., Cu, Pd, Ag, Au) acting as oxidizing agent and trapping photoelectrons, while organic species are oxidized by photogenerated holes.

In this study, the possibility to oxidize ethanol to acetaldehyde in aqueous solutions using a Cu/TiO_2 photocatalytic system at low concentrations of ethanol and cupric ions under UV-A irradiation has been firstly investigated. The reduction of cupric ions to zerovalent copper has been recorded, while ethanol has been converted to acetaldehyde and acetic acid. In a second stage, the production of acetaldehyde has been investigated by feeding the oxidation process with highly concentrated ethanol solutions, as expected for real applications. The effect of different starting cupric ion concentrations on acetaldehyde production has been evaluated. As the oxidation process proposed has been carried out in liquid phase, the possibility to recovery acetaldehyde by stripping it from aqueous solutions through an inert gas (N_2) bubbling has also been tested. The resulting gaseous stream (nitrogen gas, acetaldehyde, and water vapours) can be easily fed to a recovery and purification section, as for traditional processes. After acetaldehyde recovery, an in-situ regeneration of the oxidative photocatalytic system has been assessed by reoxidizing, through air bubbling, zerovalent copper reduced during the oxidation process. As at such stage the solution may still contain non-converted ethanol, a careful flammability analysis of the ternary gaseous mixtures made of ethanol, oxygen, and nitrogen, has been attempted to avoid accidental explosions. In addition, a mathematical model capable of simulating the system behaviour and estimating kinetic parameters not previously available in the literature review has been developed.

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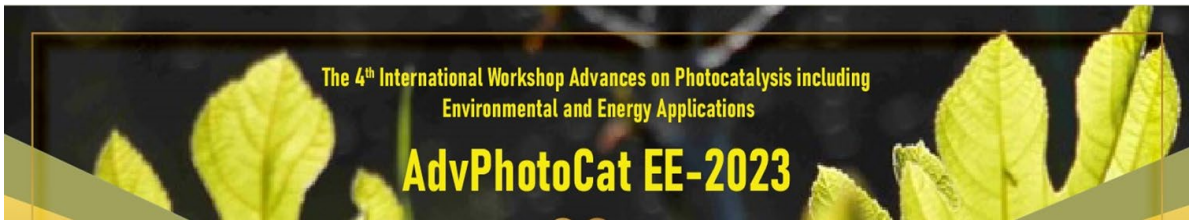

Synthesis and Characterization of Schiff base derivatives for efficient photodegradation of Methylene Blue

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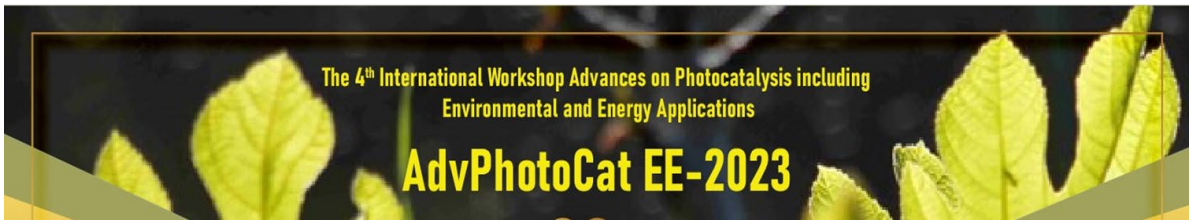
Abstract

Schiff bases are considered to be an important class of organic compounds containing imine groups (C=N). They can be prepared by condensing ketones or aldehydes with primary amines, first described by Hugo Schiff in 1864. In the past few decades, Schiff bases have attracted much attention due to their facile synthesis and wide applications in analysis, biology, and inorganic chemistry. Due to their special structures, SB derivatives exhibit various biological activities, such as antibacterial, antitumor, antifungal, anti-inflammatory and antiviral properties. In this work, benzamide-Schiff base derivatives were prepared by a condensation reaction in an alcoholic medium. In addition, the characterization of this prepared compounds was carried out by measuring melting points, UV-vis spectra, FT-IR spectra, ^{1}H and ^{13}C NMR spectra. A photocatalytic activity of benzamide-Schiff base derivatives on the photodegradation of methylene blue (MB) with sunlight in water was examined both before and after 30-180 nm sunlight irradiation on the mixture. The percentage degradation of dye using compounds were found to be 75 %.

Keywords: Schiff base, Benzamide, ^{1}H and ^{13}C NMR spectra.



Detection of IR vibration bands in environmental analysis using GAUSSIAN 6 software

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Abstract

Environmental analysis implies the need to identify compounds in complex mixtures of substances. For the analysis of organic compounds, it would be necessary to separate them, but at the level of small quantities and not knowing what these compounds could be, it is necessary to find other methods.Following a pollution event consisting of rainwater that presented a consistent and persistent foam, the respective foam was collected and dried and Scanning Electron Microscope coupled with Energy Dispersive X-Ray (SEM-EDS) and Fourier Transform Infrared Spectroscopy (FTIR) analyzes were performed. Since the FTIR spectrum of the foam shows the presence of bands specific to amides similar to urea, simulations were performed in GAUSSIAN 6 for a better assignment of them.

Funding:

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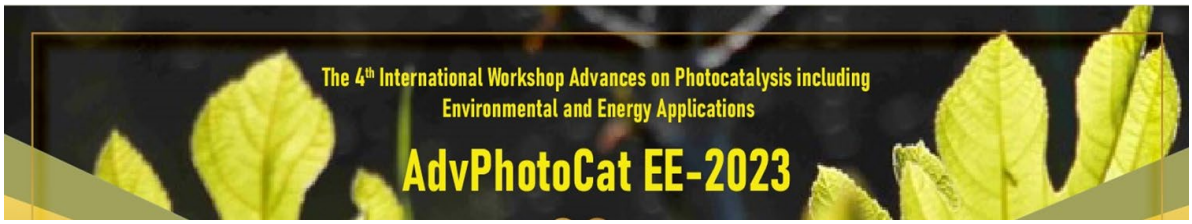

Saccharomyces cerevisiae and Fourier Transform Infrared Spectroscopy technique used to identify photo-chemical processes during laser ablation of hemp stalk

Georgiana Cocean[1,2], Alexandru Cocean[1,3], Cristina Postolachi[1], Silvia Garofalide[1,3], Daniela Angelica Pricop[1,4], Bogdănel Silvestru Munteanu[1], Iuliana Cocean[1] and Silvius Gurlui[1]

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Abstract

The interaction and effects induced by yeast cells (Saccharomyces cerevisiae) on the thin layers deposited by the PLD technique applied to the hemp stalk according to the method of Cocean et al, 2023 [1], using analysis with Fourier Transform Infrared spectroscopy were analyzed. The evolution over time of the structural changes of the thin layer obtained from the hemp stalk associated with enzymatic processes developed by yeast cells in the presence of cellulose and sugars was highlighted by this experimental study. This fact is an indication in addition to those mentioned by Cocean et al, 2023 [1] on the transfer of biocomponents from the hemp stalk using the laser process.

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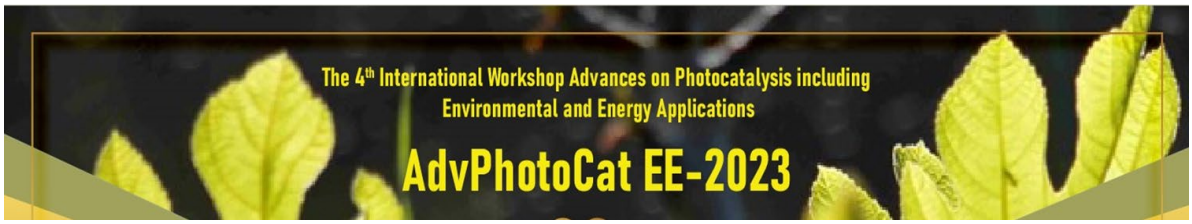
This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CNCS - UEFISCDI, project number PN-III-P1-1.1-PD-2021-0208, PD 53, within PNCDI III; Ministry of Research, Innovation and Digitization, project FAIR_09/24.11.2020, the Executive Agency for Higher Education, Research, Development and Innovation, UEFISCDI, ROBIM, project number PN-III-P4-ID-PCE2020-0332, and Operational Program Competitiveness 2014–2020, Axis 1, under POC/448/1/1 research infrastructure projects for public R&D institutions/Section F 2018, through the Research Center with Integrated Techniques for Atmospheric Aerosol Investigation in Romania (RECENT AIR) project, under grant agreement MySMIS No. 127324.



Extracting physical parameters from dielectric spectra of doped ZnO/graphene nanocomposites

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Abstract

ZnO is an interesting compound because it is low cost and with proven activity in several photochemical and photoelectrochemical processes. Its band gap is direct and similar to TiO_2 (about 3.2 eV) and possesses greater quantum efficiency. To enlarge the area of interest for this material, novel doped ZnO were synthesized with rare earth dopants: Er, La, Sm [1]. Furthermore, the new compound was mixed with graphene to obtain a nanocomposite for intended applications in EMI shielding and energy storage devices.
These nanocomposite samples were probed by measuring the real and imaginary part of their dielectric constant as a function of frequency and temperature. The measurements were performed between 1Hz and 1MHz and between -150º C and 200º C.
We developed a numerical procedure that relates the results of impedance measurements to an equivalent circuit [2]. In addition, following a two-stage homogenization procedure like [3] and [4], we were able to extract the electric properties of doped ZnO and graphene.
As main results we have found that: (a) graphene filler (1%) behaves like a metal below 0º C and as semiconductor above that temperature; (b) the dielectric and conductivity behavior of the doped ZnO matrix has two parts identified as a (crystalline) core and a grain boundary; (c) doped ZnO exhibits a polaron mediated conductivity.

Acknowledgments.
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Activating multiple vacancies defects by the structural memory of Zn-rich layered double hydroxides toward tailoring the photocatalytic degradation of organic pollutants from water

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Environmental pollution is a pressing issue the modern society is facing. Nowadays, the pollutants released from textile industry, pharmaceutical and leathering manufacturing are threats to water safety and the high prevalence of contaminated waters requires the development of new strategies for environmental remediation. Layered double hydroxides (LDHs) and their derived mixed oxides may offer fast and effective solutions for environmental clean-up [1]. Here we reveal that the memory effect of LDHs, realized by exploiting the structural memory effect of the calcined LDHs intermediates, promoted the formation of oxygen and metal vacancies to the LDH catalysts, thus enabling a tailored performance to degrade specific organic pollutants from aqueous solutions. The photocatalytic performances were tested towards photocatalytic degradation of ibuprofen and diclofenac, under solar light irradiation. Results revealed that the degradation of the pollutants is entangled to the formation of the oxygen vacancies and metal defects by the memory effect strategy during the structural reconstruction of the LDHs. Such a facile method provides a new pathway to the realization of inexpensive and efficient catalytic systems for challenging environmental clean-up technologies.

1. *Chem. Eng. J., 392 (2020) 123684.*

Synergetic adsorption-photocatalytic degradation of organic pollutants on ZnAl and Ag_ZnAl layered double hydroxides and the derived mixed oxides

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ZnAl-layered double hydroxides (Zn/Al = 2/1 molar ratio) were prepared by a coprecipitation method. The catalysts were obtained by calcination at 350, 550 and 750 °C (labeled as ZnAl_350, ZnAl_550 and ZnAl_750), as well as by doping with 7% Ag, followed by calcination at same temperatures (notes Ag_ZnAl_350, Ag_ZnAl_550 and Ag_ZnAl_750, respectively). The structural features were studied by XRD while their surface area and porous properties were determined by N2 adsorption at -196 °C. XRD analysis confirmed the double layered structure of the precipitated sample, while mixed oxide phases derived after the calcination treatment. The increase of the calcination temperature resulted in more intense and narrower maxima, indicating higher crystallization. BET analysis indicated that the isotherms were of type II, with small hysteresis loops, indicating that the irregular porosity is due to the loose of packing of plate-like particles. The optical response under light irradiation were monitored by UV-VIS.
The photocatalytic tests were done under UV irradiation, using an Osram UV-A lamp of 9W (with wavelength range 350–400), for the degradation of Congo Red (CR) dye. The results (Fig. 1) point out that 93% of the dye was removed on ZnAl_750, while 98% of the dye was degraded on Ag-ZnAl_350. The adsorption processes are dominating the dye removal on ZnAl- type catalysts while the adsorption and photocatalytic processes compete for the dye removal on Ag-ZnAl- type catalysts.
The photocatalytic reactions performed at a dose of 0.2 g/L solid in dye solutions of 50 ppm showed that the adsorption potential of the photocatalysts increased.

a b

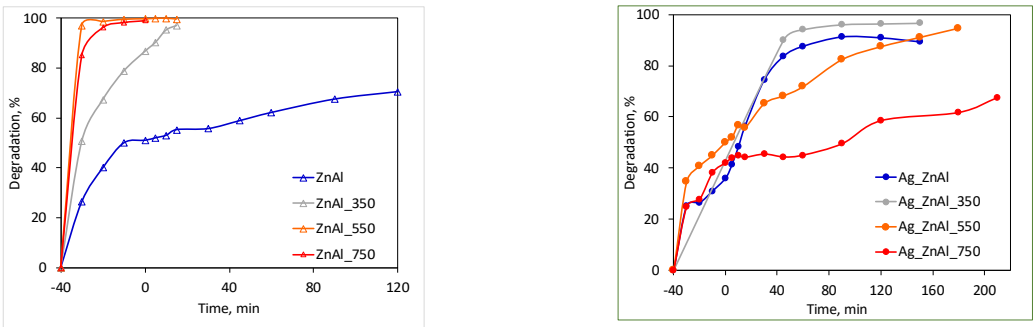

Figure 1. Congo Red removal on ZnAl-LDHs and Ag-doped ZnAl-LDHs

Preparation and characterization of novel composites for application in photocatalytic industrial wastewater treatment

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Abstract

Photocatalysis is a cutting-edge research field that employs the use of light to drive chemical reactions. At its core, the process involves the activation of a catalyst material by light, which then facilitates reactions that would otherwise be difficult or impossible to achieve using traditional chemical methods. The concept of photocatalysis has its roots in the field of photochemistry, which studies the interactions between light and matter. However, photocatalysis takes this concept to the next level, using light to not only trigger chemical reactions but also to enhance them. This is achieved through the use of specialized catalyst materials that are designed to absorb light and transfer the energy to the reactants, leading to highly efficient and selective reactions. The mechanism of photocatalysis is complex and depends on a variety of factors, including the properties of the catalyst material, the wavelength of light used, and the nature of the reactants. In general, the process involves the absorption of light by the catalyst material, which then generates electron-hole pairs that can be used to drive chemical reactions. These reactions can take place on the surface of the catalyst material or in the surrounding solution, depending on the specific application. The potential applications of photocatalysis are vast and varied. One of the most promising areas of research is in environmental remediation, where photocatalysis can be used to break down pollutants and toxins in air and water. It has also been explored as a possible solution for energy production, with researchers investigating the use of photocatalytic materials to convert sunlight into usable energy. Beyond these applications, photocatalysis also has potential in fields such as medicine, where it could be used to develop new drugs and therapies. It has even been used in the development of self-cleaning surfaces, such as those found in hospitals and other high-traffic areas. Despite the many potential benefits of photocatalysis, there are still challenges to be addressed, such as the need for more efficient and cost-effective catalyst materials. However, with continued research and innovation, the future of photocatalysis looks bright, with the potential to revolutionize a wide range of industries and applications.

Keywords: Photocatalysis, Composite, Industrial wastewater, Cost benefit analysis

Remediation of Textile Industry Organic Dye Waste by Photocatalysis Using Eggshell Impregnated ZnO/CuO Nanocomposite

Mekdes Gerawork,
Debre Berhan University, College of Natural and Computational Sciences, Department of Chemistry

Abstract
Heterogeneous photocatalysis using nanocomposites is of great research interest in the treatment of industrial wastewater. The impregnated photocatalyst was produced by liquid state reaction of ZnO/CuO nanocomposite with extracted eggshells. The structure, functional group, metal composition, bandgap, and photocatalytic activity of the nanocomposites were characterized by using X-ray diffraction, Fourier-transform infrared spectroscopy, atomic absorption spectrometry, and UV–Vis spectroscopy, respectively, in the absence and presence of eggshells. Photocatalytic degradation activities of the nanocomposites under UV light irradiation have been tested for a real sewage sample taken from Debre Berhan Textile Industry. From the results, XRD data revealed the hexagonal wurtizite structure of ZnO and monoclinic structure of CuO. And FTIR results has shown the presence of targeted functional groups also from AAS results, only Cu, Zn & Ca metals were detected without any contaminations. The optimized degradation efficiency of the dye was 97.95% with 0.4g dose of the photocatalyst, 120 min irradiation time, 1200C temperature, and pH of 6.7. The results revealed that eggshell impregnated nanocomposite had better catalytic activity than the naked nanocomposite. This is due to the highly porous structure of eggshell biomasses and their sorption characteristics. In conclusion, when nanocomposites are supported by eggshell biomasses, they are excellent photocatalysts and can minimize the contamination of organic dyes from textile effluents.
Keywords: Industrial waste water, Irradiation, Nanocomposites, pH, Photocatalysis

Biograpghy: Mrs. Mekdes Gerawork, has Master of Science Degree in Inorganic Chemistry from Arba Minch University, Ethiopia and she is an Assistant Professor of Inorganic Chemistry. Regarding her professional career, she has more than eight teaching experience at higher institutions. Currently, teaching different Chemistry courses for undergraduate and master's degree students which widen her capacity in conducting research and analytical thinking. To that end, she has published five articles as corresponding author. Furthermore, she is actively involving in research and community based activities in her home institutions.

Surface Decoration of Zirconium Oxide with Bismuth sulfide Catalysts for Photocatalytic Degradation of Red dye 195

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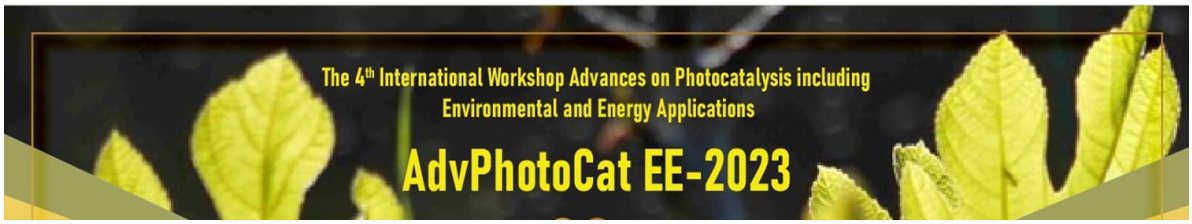
Abstract
Recently, solar energy has been considered the most vulnerable source to resolve environmental pollution and energy scarcity problems. Researchers have made intense research efforts to convert solar energy into chemical energy through photocatalysis processes as it is a green, clean, and renewable energy source. Numerous discovered photocatalysts show absorption in the ultraviolet–visible (UV~5% and visible ~43%) region. Zirconia based material is a noteworthy metal oxide because of its characteristics. It can be implemented in different applications; photocatalytic oxidation for dye degradation. The main focus of this research was to synthesize Bi_2S_3@ZrO_2 from low cost and locally available materials, zircon, in addition to preparation of ZrO_2 bismuth catalyst of different concentration. Characterization of prepared materials was performed using X-ray diffraction (XRD), Fourier transform infrared spectra (FTIR), and scanning electron microscope (SEM). The results confirmed that the homogeneous spherical particles were produced. Moreover, different ratios, 5% Bi_2S_3@ZrO_2, 7% Bi_2S_3@ZrO_2, and 10% Bi_2S_3@ZrO_2, were investigated against removal of Red dye using adsorption and photocatalytic activities. As obtained, the removal adsorptive capacity for red dye 195 was decreased in the range from 144 to 88 mg/g using 0.2 g/L of prepared hybrids. However, 5% Bi_2S_3@ZrO_2 showed the highest photodegradation of Red dye. Meanwhile, red dye was removed with rate constant of 0.132 - 0.324 h^{-1} under solar simulator. Kinetic studies indicate that the removal efficiency depends on the dye concentration. This work opens the way for high efficient adsorbents and photocatalysts for wastewater treatment.

***Keywords*:** Zirconium oxide; Bismuth sulfide; Red dye; Photocatalysis; Degradation



Synthesis And Characterization Of Starch-Based Nanocomposites Reinforced With Fesib Powder

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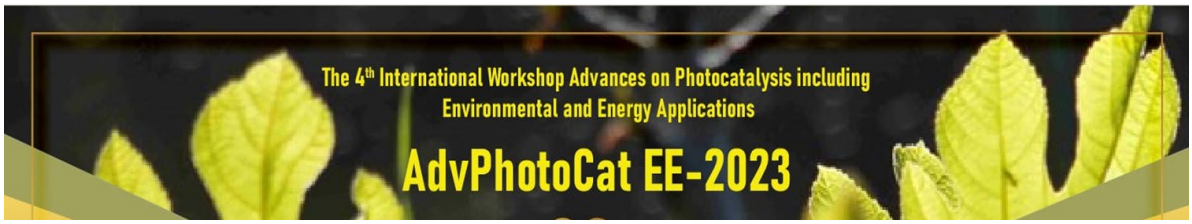
Synthesis and characterization of starch-based nanocomposites reinforced with FeSiB powder is a relatively new area of research. For this study, we have synthesized starch-based nanocomposites with and without reinforced by FeSiB powder.
Starch-based nanocomposite powder was reinforced with FeSiB using two distinguished processes. (Grinding process and solid-solid mixture in a fluidized bed under an inert atmosphere process).
The tensile strength, thermal stability; X-ray diffraction (XRD) and Atomic force microscopy (AFM) of the starch-based nanocomposite reinforced with or without FeSiB powder was carried
The grinding process and fluidized bed under an inert atmosphere process reveal that processes are effective for dispersing the FeSiB powder in the starch matrix, resulting in a nanocomposite with improved tensile strength and thermal stability.
The reinforcement of bioplastic synthesized from corn starch by a nanocomposite FeSiB powder is a promising approach to improving the mechanical and thermal properties of bioplastics.

- **Keyword** : FeSiB, Starch, Nanocomposites, XRD, AFM, FTIR



Insights into photocatalytic water disinfection using semiconductors – A review article

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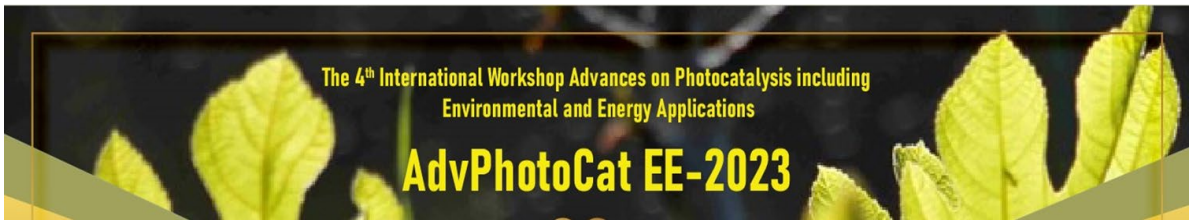
Abstract:

The global challenge of getting pure and safe water free of pathogenic microorganisms has encouraged various techniques to be investigated. Photocatalysis is one of these techniques, which has attracted attention lately due to its ability to effectively remove or inactivate microorganisms using semiconductors as photocatalysts. The photocatalytic processes are regarded as a green alternative for traditional water disinfection techniques, due to their high efficiency, cheapness, non-toxicity, and ability to disinfect wide range of microbes under visible and UV irradiation. In this review article, various inactivation mechanisms of waterborne pathogenic microbes by semiconductor photocatalysts are explained, with special focus on titanium dioxide. As well, the different strategies to improve the photocatalytic efficiency of titanium dioxide are explored. An overview of the antimicrobial effects of a wide range of nano titania-based photocatalysts is summarized, with brief discussion for the future prospects and obstacles regarding research in photocatalytic water disinfection.

Keywords: photocatalyst; water disinfection; semiconductor photocatalysts; inactivation mechanisms; titanium dioxide; nanomaterials.



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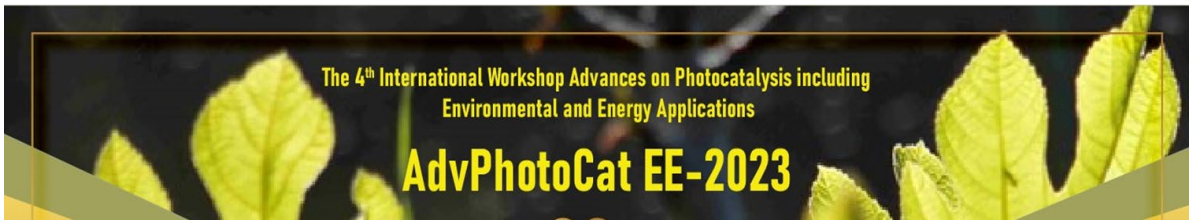

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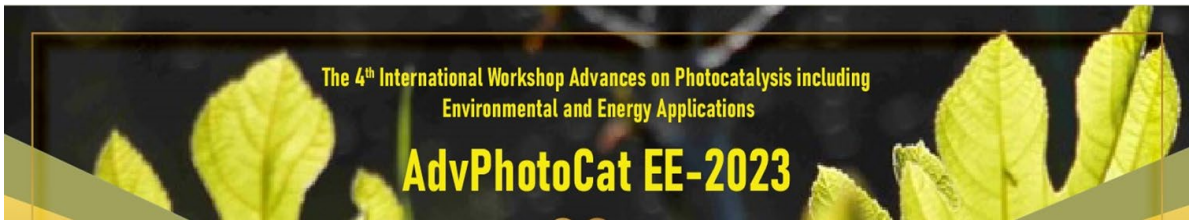

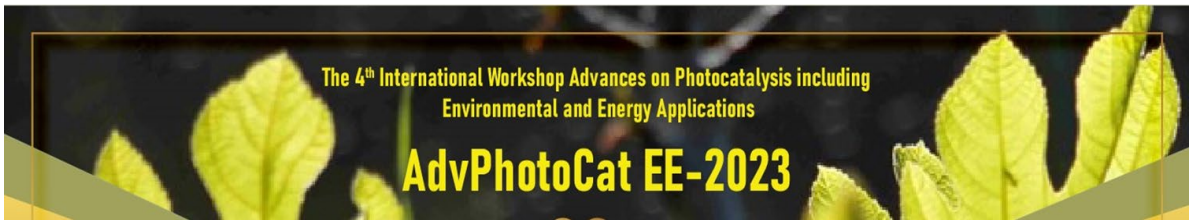
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