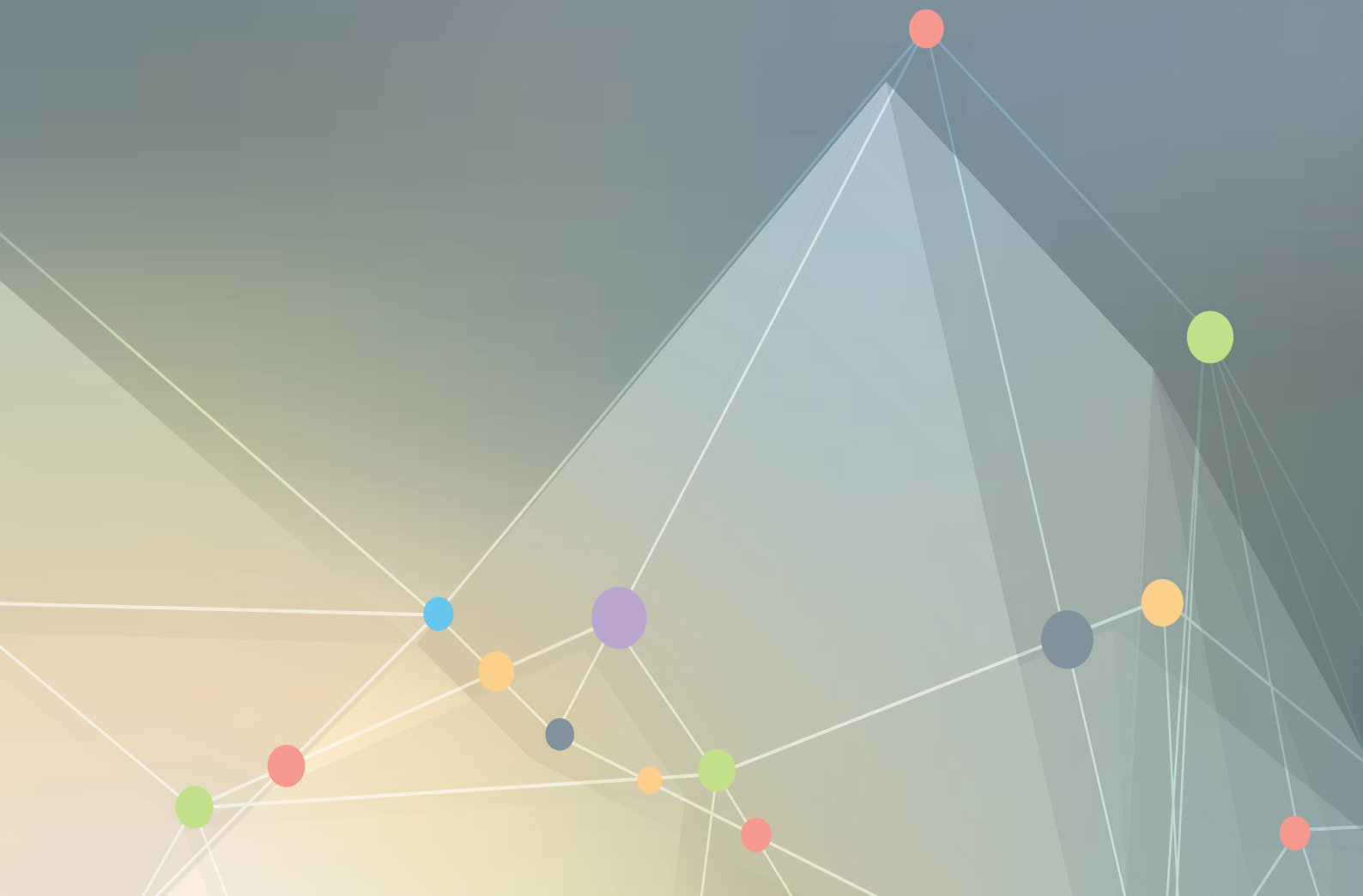
BOOK OF ABSTRACTS

Oral Presentations



C'Nano
THE NANOSCIENCE MEETING
2023
Poitiers
March, 15, 16 and 17

Nanotechnology for cleaning environment

(Last update: October 5th, 2022)

Description

This session aims to highlight the development of nanomaterials for pollution control of air, water and soil. Nanomaterials exhibiting high specific surface areas are suitable for pollutant adsorption and (photo)catalysis. Tunable microporosity and texture as well as functionalization by metals, oxides or organic moieties lead to very large ranges of acid/basic and redox behaviors. Additionally, some nanooxides (TiO2, WO3…) are able to absorb the natural light to promote photocatalysed reactions. The targeted pollutants may be heavy metals (adsorption), volatile organic compounds (VOC's) (oxidation in gas phase), residual drugs or other organic contaminants (oxidation in liquid phase), gaseous pollutants from combustion exhaust gases (NOx reduction, HC oxidation)…

Keywords

Adsorption, catalysis, photocatalysis, remediation, nanomaterial

Scientific committee

Lavinia BALAN (CNRS – CEMHTI, Orléans)
Isabelle BATONNEAU-GENER* (Univ. Poitiers – IC2MP, Poitiers)
Xavier COURTOIS* (Univ. Poitiers – IC2MP, Poitiers)
Philippe VERNOUX (CNRS – IRCELYON, Lyon)

** Session Coordinator*

Friday March 17th

10.30 am – 12.30pm

Amphi 150

Program of the session

Chairs: Conchi O. ANIA & Isabelle BATONNEAU-GENER

NANOTECHNOLOGY FOR CLEANING ENVIRONMENT		
10:30	**Unravelling the critical role of surface hydroxyls in the total oxidation of formaldehyde : case of silica-supported Pt nanoparticles and birnessite-type MnO2 catalysts**	**Jean-François LAMONIER** • *Univ. Lille – UCCS, Lille – France*
11:00	Mesostructured ZrO2-CeO2 catalysts for total degradation of VOCs	**Jean-Luc BLIN** • *Univ. Lorraine - L2CM, France*
11:15	Grafting photocatalytic metal oxides (ZnO, TiO2) on mesoporous silica via metalorganic route for air depollution	**Ons EL ATTI** • *Univ. Toulouse Paul Sabatier - LCC, France*
11:30	Synthesis and characterization of high surface CaTi1-xFexO3-δ (0	**Xavier COURTOIS** • *Univ.Poitiers - IC2MP, France*
11:45	Ton-scale synthesis of ZnO-based nanosuspension for industrial environnemental applications	**Stéphane DANIELE** • *Univ. Claude Bernard - CP2M, France*
12:00	Optimal architecture for enhancing the photocatalytic activity of ZnO nanowire arrays using a direct comparison with ZnO single crystals	**Adrien BAILLARD** • *Grenoble INP - LMGP, France*
12:15	Some factors affecting the photocatalytic effect of CeO2	**Damir MAMEDOV** • *Univ. Poitiers - IC2MP, France*

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Jean-François LAMONIER

University of Lille I Professor

Unit of Catalysis and Solid State Chemistry

https://uccs.univ-lille.fr/index.php/en/34-english/personal-pages/482-lamonier-jean-francois-en

Biography

Jean-François LAMONIER is a full Professor in Department of Chemistry and Deputy Director of the Laboratory "Unit of Catalysis and Solid State Chemistry". His research addresses the catalytic oxidation technologies for Volatile Organic Compounds emissions removal and the catalytic pyrolysis of plastic waste. His research comprises (i) the development of supported noble metal and transition metal oxide catalysts with emphasis in the elucidation of the structure-chemical properties and catalytic activity relationship and (ii) the coupling of abatement technologies such as non-thermal plasma and heterogeneous catalysis. For this last-mentioned topic Jean-François Lamonier heads the International Associated Laboratory "Plasma & Catalysis" between Lille University and Ghent University (Belgium). His research activity is documented in more than 140 refereed publications in international scientific journals.

Unravelling the critical role of surface hydroxyls in the total oxidation of formaldehyde : case of silica-supported Pt nanoparticles and birnessite-type MnO2 catalysts

Formaldehyde (HCHO) is a dominant indoor air pollutant, harmful to human health even at a very low concentration. Various approaches have been developed to reduce indoor HCHO pollution, among which the catalytic oxidation stands out since it is environmentally friendly and cost-effective [1]. Up to date, a variety of metal oxide and noble metal catalysts have been developed for HCHO total oxidation.

Among noble metal catalysts, Pt based catalysts stabilized by different supports (TiO2, CeO2, MnO2 …) have attracted much attention due to their excellent catalytic performance at room temperature [2]. Due to its irreducibility SiO2 has been considered as a poor support for low temperature HCHO oxidation. However the critical role of surface hydroxyls in the formaldehyde oxidation inspires the possibility to take advantage of the silanol groups of the silica as support for HCHO oxidation. Amoung metal oxide catalysts, birnessite-type MnO2 was recognized to be the most noble-metal-free catalyst active catalyst in HCHO oxidation and various strategies to improve the activity of MnO2 has been recently reported [3]. The hydrated alkali cations (Na+, K+) restricted in the interlayer region of the birnessite-type MnO2 are suspected to enhance the surface oxygen activity facilitating the regeneration of surface hydroxyls by activating H2O, present in the interlayer region [4].

In the first part of the lecture the results of the effect of the silanol content, in Pt/SiO2 with very low Pt loading, will be discussed through a rational design of the catalyst. The silanol content significantly affected the interaction behaviours of HCHO, H2O, CO and CO2 with the catalyst surface. The silanol-rich Pt/SiO2 even with low Pt loading is highly efficient in HCHO oxidation at room temperature under different humid conditions. In a second part, the results of the effect of the low Ce loading on birnessite-type MnO2 will be discussed as a function of the calcination temperature. The Ce incorporation and the calcination temperature allow the tuning of adsorbed/interspaced water, Mn3+/Mn4+ and Ce3+/Ce4+ atomic ratios. Many active oxygen and formation of active OH groups by adding water in the feed provide a very active and stable Ce-birnessite-type MnO2 catalyst in HCHO oxidation.

Keywords:

Formaldehyde total oxidation; Pt NPs; Silica; Birnessite; OH

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Keywords: Nanostructured materials; Soft templating; Solid solution; Catalyst; Toluene oxidation

Disciplinary fields involved : Physical Chemistry, Materials Chemistry

Mesostructured ZrO_2-CeO_2 catalysts for total degradation of VOCs

B. Lebeau[1,2], S. Siffert[3], L. Michelin[1,2], L. Josien[1,2], L. Vidal[1,2], F. Jonas[4], C. Poupin[3], R. Cousin[3], J.-L. Blin[4]

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Because of their carcinogenic and toxic effects[1], the European legislation has imposed more strict objectives for Volatile organic compounds (VOCs) emission levels, in particular by industrial effluents. Indeed, VOCs emission should be reduced by 52% in 2030 in France in comparison to 2005. As BTEX and oxygenated VOCs are important industrial air pollutants, the development of an effective process to treat them is therefore of great and continuous interest. To reach this goal the heterogeneous catalytic oxidation appears as a promising technology[2]. Zirconia doped by ceria (ZrO_2-CeO_2) is one of the best supports for the VOC oxidation[3]. Introducing controlled mesoporosity in such solids can have beneficial for heterogeneous catalysis applications since it increases specific surface area for a better accessibility to active site and improves mass transport[4]. Here, mesostructured zirconia materials with high specific surface area and thermal stability have been used to design CeO_2-ZrO_2 catalysts. To limit the cerium amount, the cerium content was varied from to 0 to 10 mol.% compared to Zr content. The obtained catalysts have been tested for the toluene oxidation, used as a model VOC. Regarding the catalytic activities, it appears that the preparation method strongly affects the toluene conversion. While the bare ZrO_2 material is almost not active for the total oxidation of toluene, ZrO_2-CeO_2 prepared with by wet impregnation on calcined ZrO_2 presented a good conversion of toluene and is almost as efficient as pure commercial ceria[5]. A correlation between the surface Ce^{4+} quantity and the catalytic activity has been established.

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5. F. Jonas, B. Lebeau, S. Siffert, L. Michelin, C. Poupin, R. Cousin, L. Josien, L. Vidal, M. Mallet, P. Gaudin, J.-L. Blin ; ACS Appl. Nano Mater. 4(2) (2021) 1786 DOI: 10.1021/acsanm.0c03212

Acknowledgment:

We would like to thank the platform "Spectroscopies et Microscopies des Interfaces" and Aurélien Renard (LCPME) for XPS analyses. The platforms "X-ray diffraction", "Electronic microscopy" and "Spectroscopies FTIR and Raman" of IS2M are also acknowledged. Florian Jonas thanks the « Region Grand-Est » for the financial support of his PhD [grant number RPHPHXAS-D-AOT17-TITAN].

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Keywords: Mesoporous silica, metalorganic precursors, TiO_2, ZnO grafting, photocatalysis
Disciplinary field involved: Chemistry
Sustainable Development Goals eventually involved in your research: This project aims to improve indoor air quality by reducing the concentration of NOx.

Grafting photocatalytic metal oxides (ZnO, TiO_2) on mesoporous silica via metalorganic route for air depollution.

Ons El Atti[1,2,4], Katia Fajerwerg[1], Andrey Ryzhikov[5], Bénédicte Lebeau[5], Philippe Menini[4], Myrtil L. Kahn[1], Christian Lorber[1], Julie Hot[2], Pierre Fau[3].

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Photocatalytic materials based on metal oxides semi-conductors (MOS) like TiO_2 or ZnO have shown antibacterial, air and water purification, and self-cleaning properties[1]. The application of these materials to building surfaces is a promising way to improve indoor and outdoor air quality by reducing the concentration of gaseous pollutants in urban areas[2]. Our research work targets the grafting of MOS on high specific surface mesoporous silica (SBA-15) in order to achieve a high amount of MOS on the silica surface[3,4]. Here we present chemical strategies based on the liquid decomposition of metalorganic precursors to obtain unprecedented TiO_2 or ZnO decorated SBA-15. Tetrakis(ethylmethylamido) titanium (TEMAT), titanium tris-amidinate (TiAmd), and dicyclohexyl zinc ($Zn(Cy)_2$) metalorganic precursors have
been studied. The performances of the hybrid TiO_2 and ZnO mesoporous silica for the air depollution will be soon assessed for 400 ppb of NOx (NO or NO_2) under UV-Visible radiation.

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2023

Keywords: methane treatment, perovskite, iron, oxygen activation
Disciplinary field involved: Chemistry

Synthesis and characterization of high surface $CaTi_{1-x}Fe_xO_{3-\delta}$ ($0 \leq x \leq 0.4$) perovskites for methane abatement.

M. Delporte[1,2], F. Can[1], N. Bion[1], H. Kaper[2*], X. Courtois[1*]

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The catalytic treatment of residual traces of methane in the exhaust gas from automotive NGV engines involves the use of expensive catalysts with high precious metal loading. In order to develop precious metal-free catalysts, perovskite materials are attractive due to their tunable redox behavior, but they often suffer from a limited surface area. In this study, $CaTi_{1-x}Fe_xO_{3-\delta}$ materials with $0 \leq x \leq 0.4$ were synthetized with various chelating agent (ethylene glycol, glycerol and 1.6-hexanediol). The perovskite structure was obtained for all samples after calcination at 600°C (XRD analysis). Best surface areas were obtained with hexanediol (until 49 m^2/g) but surface area did not drive the catalytic activity. Iron substitution for titanium led to oxygen vacancies in the perovskite structure. Various iron species were identified by Mössbauer spectroscopy (Fe^{III}-6CN (CN: coordination number), Fe^{III}-5CN, Fe^{III}-4CN, Fe^{IV}-6CN) which allows the determination of the oxygen vacancy stoichiometry (δ in $CaTi_{1-x}Fe_xO_{3-\delta}$). The oxygen activation behaviours was examined by isotopic ^{18}O-exchange experiments. Results indicated that almost all oxygen atoms were exchangeable, indicating that the oxygen exchange did not only take place at the surface, but also in the bulk. Indeed, the oxygen exchange behaviour appeared correlated to the amount of oxygen vacancies (δ). However, catalytic tests revealed that the oxygen activation was not the driving force for the methane oxidation, but results showed that the methane conversion appears correlated with the Fe^{III}-6CN species.

Acknowledgment:
The authors acknowledge financial support from the French National Research Agency (SMARTCAT project, ANR-18-CE07-0040), the European Union (ERDF) and Région Nouvelle Aquitaine

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Keywords: ZnO, nano-dispersion, formulation, self-cleaning
Disciplinary field involved : Chemistry

Sustainable Development Goals* eventually involved in your research: Industry, Innovation, and Infrastructure (Goal 9)

Ton-scale synthesis of ZnO-based nanosuspension for industrial environnemental applications

Stéphane DANIELE[1], Marion RUEL[2], Claude STOCK[2]

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Almost all objects in our daily life are coated to provide additional properties of anti-abrasion, anti-fouling, anti-fingerprint etc... Transparent coatings (on glasses for example), associating different polymers with organic or inorganic additives, require the use of very well-dispersed sub-micron size additives to avoid light scattering (depending on their refractive index) and therefore haze formation. In the case of ZnO, which is an extremely used additive for its numerous physico-chemical properties, none fully transparent and colorless industrial nano-dispersion of ZnO is currently available. Stable ZnO nanosuspensions are then needed to consider a formulation and application combining performance and aesthetics. This is where our know-how on the synthesis of aqueous hybrid nano-ZnO nanosuspensions (7-8 nm) allows a technological breakthrough and to meet new needs in the photocatalytic and/or antimicrobial coating market. Our patented technology **[1]** allows to obtain at room temperature and pressure and from commercial products, ton-scale aqueous ZnO nanosuspensions in a reproducible and stable way at basic pH (8-10) commonly used for varnish (transparent coatings) or paint formulations.
This presentation will address its elaboration and its implementation for the development of commercial formulations allowing the elaboration of transparent photocatalytic (anti-fouling) and antimicrobial (bactericidal and virucidal) coatings.

Reference:
[1] Patent PCT/FR2015/052434 extended in Europe and USA

Acknowledgment:
Authors thank the CNRS Innovation for funding of a "pré-maturation" project

C'Nano
THE NANOSCIENCE MEETING
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2023

Thematic Session: Nanotechnology for cleaning environment
Keywords: Photocatalysis, ZnO, nanowires, single crystals
Disciplinary fields involved: Chemistry, materials
Sustainable Development Goals* eventually involved in your research: Clean water and snanitation (Goal 6)

Optimal architecture for enhancing the photocatalytic activity of ZnO nanowire arrays using a direct comparison with ZnO single crystals

Adrien Baillard[1], Estelle Appert[1], Alexandre Dieulesaint[1], Laetitia Rapenne[1], Jean-Michel Chauveau[2], and Vincent Consonni[1]

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In one century, fresh water world demand has been multiplied by six[1] and hence new accessible and eco-efficient water treatment processes are needed. Advanced oxidation processes including heterogeneous photocatalysis are high of interest to address this challenge. Since zinc oxide (ZnO) offers a wide band gap energy (3.37 eV at room temperature) that is favourable for electron and hole generation under UV light, it is considered as a relevant solution. In addition, its non-toxicity and bio-compatibility along with its relative abundancy make it a potentially sustainable candidate. To increase the surface area of ZnO, the nanowires (NWs) grown by chemical bath deposition, as an inexpensive, low-temperature and green chemistry compatible method, have emerged as highly promising. However, ZnO as a polar and piezoelectric semiconductor crystallizes into the highly anisotropic wurzite phase,[2] exhibiting the possible formation of polar, semi-polar, and non-polar planes when grown as NWs which can affect the photocatalytic behaviour[3]. The topic has been investigated in the case of ZnO powder[4], but much less in the case of ZnO NWs. In the present work, the nature of surface planes in ZnO NWs is identified by transmission electron microscopy. The influence of each ZnO surface plane on the photocatalytic activity is further studied in detail by comparing the dye degradation processes occurring on the ZnO single crystals and ZnO NWs. Several contributions to the photocatalytic activity are discussed, including the effect of the nature of the surface plane, its chemical reactivity as well as the dye diffusivity in the arrays.

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Keywords: Adsorption, photocatalysis, remediation, nanomaterial, photoelectrochemistry
Disciplinary fields involved: Chemistry, Physics.
Sustainable Development Goals* eventually involved in your research: Clean Water and Sanitation (Goal 6)

Some factors affecting the photocatalytic effect of CeO_2

D. Mamedov[1,2], S. Zh. Karazhanov[2], N. Alonso-Vante[1]

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The efficiency of the photocatalysis process is controlled by the physicochemical properties of the semiconductor. While the value of the band-gap determines the threshold of photon absorption; their energetic positions determine the driving force of vectorial charge transfer occurring at the surface with the photogenerated pairs of electrons and holes. The energetic position of the semiconductor oxide bands can be controlled by changing the pH of the medium. The effect of pH also affects the charges at the semiconductor-electrolyte interface. This fact is essential for the coordination of the active species on the surface of the semiconductor material.
In this work, CeO_2 powders, as a model photocatalyst, with different morphologies, were used for the decolorization of methylene blue dye. In these materials, the structural and optical properties are associated with the non-stoichiometry (Ce^{3+} versus Ce^{4+} ratio), determined by the direct dissolution method. The adsorption of the dye on the surface of the semiconductor powder presents a correlation with the zeta potential. The photoelectrochemical study of CeO_2 reveals an increase of the surface activity with pH in alkaline medium. Thus, it is shown that the species adsorbed on CeO_2 can modify the photocatalytic performance by varying the pH of the suspension. This influence should be considered in the photocatalytic processes with CeO_2. However, this observation also extends to TiO_2.

Acknowledgment: This work was supported by the Research Council of Norway. Project No. 309827 (COOL-LONGBOAT).

Friday March 17th

2.00 pm – 3.45pm

Room 11/12

Program of the session

Chairs: Xavier COURTOIS & Jean-François LAMONIER

NANOTECHNOLOGY FOR CLEANING ENVIRONMENT		
14:00	**Degradation of Water Pollutants using Advanced Oxidation Processes: from laboratory to large scale case studies**	**Conchi O. ANIA** • CNRS – CEMHTI, Orléans – France
14:30	Graphitic carbon nitride/SmFeO3 composite Z-scheme photocatalyst with high visible light activity	**Bilel CHOUCHENE** • *CNRS - LRGP, France*
14:45	Photocatalytic activity of carbon/carbon heterojunctions for the degradation of emerging pollutants	**Tingwei SUN** • *China Scholarship Council - CEMHTI, France*
15:00	Design of magnetic graphene/iron oxide nanocomposites for efficient removal of toxic organic pollutants from water	**Joana VAZ-RAMOS** • *Univ. Strasbourg - ICPEES / IPCMS, France*
15:15	Functionalized Iron oxide for wastewater depollution	**Carolyne BYUN** • *Univ. Bourgogne - ICB, France*
15:30	Carbon dots-based composites: from elaboration to study of their properties for adsorption of pollutants	**Enrique MANSO CASTILLO** • *Univ. Paris Cité - MSC, France*

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Ania CONCHI

CNRS I Research director

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Biography

he received her PhD degree in 2003 (Univ. Oviedo, Spain) and performed postdoctoral stays in USA and France. In 2009 she became Tenured Scientist at Agencia Estatal CSIC, and in 2017 she joined CNRS as Directrice de Recherche. She received the national L'Oreal-Unesco Research Fellowship "For women in Science" (2008) and the Excellence Research Award by Univ. Granada (2008). She is a grantee of the European Research Council (2016-22) and editor of Carbon journal (Elsevier) since 2022.

Current research interests focus on developing nanoporous materials for high-tech applications: water treatment (photo-/electrocatalysis), gas adsorption/separation, solar energy conversion. She is co-inventor of two patents (one transferred to industry for 2 years). She has an H-index of 47 with over 6000 citations.

Degradation of Water Pollutants using Advanced Oxidation Processes: from laboratory to large scale case studies

Current challenges in wastewater treatment are linked to the need for developing effective solutions to face emerging pollutants, capable of assuring a feasible economic upgrade of existing plants. Conventional biological treatments are assisted with tertiary processes such as adsorption on nanoporous adsorbents to improve the efficiency of the treatments, However, despite being mature technologies, the cost associated to the regeneration of the spent carbon (energy consumption, transportation) still represents a major limitation for massive implementation. On the other hand, advanced oxidation processes (e.g., based on electrochemical and photocatalytic approaches) have become an interesting alternative for the simultaneous removal and degradation of pollutants. Furthermore, when coupled with adsorption, they can also provide the on-site regeneration of the saturated adsorbents.

This communication will focus on some examples about the application of advanced electrochemicla and photocatalytic oxidation processes based on nanomaterials and renewable energies, for the degradation of emerging pollutants in water. Examples will cover our research activities at lab-scale, as well as various case studies at pilot scale on the application of these technologies and materials to wwasztewater from industrial and treatment plant facilities origins.

These research activities have received funding from the European Union's Horizon 2020 research and innovation program under the grant agreement Nº 776816, and Région Centre Val de Loire (grant MOSAIK).

Keywords:

Nanoporous materials; water treatment; advanced oxidation processes; electrochemistry; photocatalysis

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Keywords : graphitic carbon nitride; $SmFeO_3$; heterostructured photocatalyst; pollutant photodegradation; Z-scheme mechanism
Disciplinary fields involved : Chemistry, Nanotechnology
Sustainable Development Goals* eventually involved in your research: Clean Water and Sanitation (Goal 6)

Graphitic carbon nitride/$SmFeO_3$ composite Z-scheme photocatalyst with high visible light activity

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Novel heterostructured photocatalysts associating graphitic carbon nitride (g-CN) and $SmFeO_3$ were prepared via a mixing-ultrasonication process [1]. Structural, optical and morphological characterizations demonstrate that the interfacial junction between g-CN and $SmFeO_3$ is well established for all g-CN/$SmFeO_3$ composites prepared with g-CN:$SmFeO_3$ weight ratio of 20:80, 50:50 and 80:20. The g-CN/$SmFeO_3$ (80:20) composite exhibits the highest photocatalytic activity for the degradation of pollutants like the Orange II dye and the tetracycline hydrochloride antibiotic under visible light irradiation. This high photocatalytic activity originates from the enhanced light absorption over the whole visible region compared to pure g-CN and from the improved separation and transfer of photogenerated electron/hole pairs as demonstrated by photoluminescence and photocurrent measurements [2]. A Z-scheme charge carrier transfer mechanism was demonstrated for the photocatalytic reactions [3]. The g-CN/$SmFeO_3$ (80:20) catalyst was also demonstrated to be stable and can be reused up to six times without significant alteration of the activity.

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Acknowledgment: This work has received the financial support from the Institut Carnot ICEEL.

C'Nano THE NANOSCIENCE MEETING 2023
Poitiers March, 15, 16 and 17

Keywords: photocatalysis; advanced oxidation processes; carbon materials; water pollution.
Disciplinary field involved: Chemistry
Sustainable Development Goals eventually involved in your research: Clean Water and Sanitation (Goal 6) , Sustainable Cities & Communities (Goasl 7), Good Health & Well-Being (Goal 3)

Photocatalytic activity of carbon/carbon heterojunctions for the degradation of emerging pollutants

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The occurrence of endocrine disruptors (e.g. pesticides, pharmaceuticals, hormones, etc.) in the aquatic environments has become a great danger to both the ecosystems and human health, as these compounds may alter the endocrine system. Parabens are a part of this family, and their consumption is related to use in cosmetics, skin creams, foods, and pharmaceuticals [2]. The discharge of domestic and industrial wastewater and the inefficient treatments in wastewater treatment plants are the main routes of entry of parabens in the environment. On the other hand, advanced oxidation processes have gained attention in wastewater remediation [2]. In photocatalytic processes, carbon materials have revealed to be efficient for the generation of radical species capable of promoting degradation of organic pollutants in solution [3,4]. In this study, carbon-based photocatalysts have been prepared and characterized to explore their photocatalytic activity for the degradation of parabens from solution. A series of binary carbon/carbon heterojunctions has been prepared by blending carbons with different properties (e.g., hydrochars, GO, rGO, polymeric carbons, activated carbons). The adequate balance between the π-electron density, structural defects and electronic conductivity of the carbon/carbon heterojunctions has demonstrated an improved charge separation efficiency of photogenerated electron-hole pairs. The efficiency of the catalysts will be discussed in terms of the degradation efficiency of the pollutants in water under artificial solar and UV light. Possible photocatalytic degradation pathways are analyzed through the identification of degradation intermediates and the use of radical scavengers.

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Acknowledgment: The financial support from Region Centre Val de Loire (grants MOSAIK, PRESERVE), is acknowledged. TS thanks the funding of the China Scholarship Council for a PhD fellowship in France (grant 202006460009).

C'Nano THE NANOSCIENCE MEETING 2023
Poitiers March, 15, 16 and 17

Keywords: graphene; iron oxide; composites; adsorption; organic pollutants
Disciplinary fields involved: Chemistry, Physics
Sustainable Development Goals eventually involved in your research: Clean Water and Sanitation (Goal 6)

Design of magnetic graphene/iron oxide nanocomposites for efficient removal of toxic organic pollutants from water

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As the world population continues to grow and industrialization increases, environmental pollution is a major concern. A lot of different pollutants exist in water, air and soil that can be harmful both to human health and the environment, such as polycyclic aromatic hydrocarbons (PAHs), and their extraction and quantification remain a challenge. Thus, it is of the upmost importance to develop new strategies to efficiently remove and quantify them. In the past years, adsorption processes have attracted a lot of attention for depollution practices, especially with the development of nanotechnologies. In that context, we designed graphene/iron oxide nanocomposite materials for the removal of toxic organic pollutants, particularly PAHs, from water. Graphene is known to be highly efficient in adsorption of organic pollutants and iron oxide nanomaterials allow an easy magnetic separation of the adsorbent. So, magnetic graphene-based nanocomposite materials were prepared in a one-step polyol synthesis by introducing few-layers graphene (FLG) coated with tannic acid (TA) in the reaction media of iron oxide nanostructures. The incorporation of magnetic nanostructures in graphene-based materials was successful and reproducible. The adsorption on these composites of benzo[a]pyrene (BaP), one of the most carcinogenic PAHs, was then studied and the nanomaterials were found highly effective for BaP removal. The composite showed very promising results: high and fast adsorption of BaP (removal >99.9%) using a very small amount of adsorbent. Other PAHs, particularly fluorene, were also tested and good removal efficiencies were obtained (>85%), confirming the potential of these adsorbents for PAHs removal from the environment.

Acknowledgment:
This research project was co-funded by Institut Carnot MICA through the CAPTALL project and Region Grand Est and ANR through the FIGHTVIRUS project (Resilience Grand Est project).

C'Nano
THE NANOSCIENCE MEETING
Poitiers
March, 15, 16 and 17
2023

Keywords: Nanomagnet, Wastewater depollution, Nanofiltration

Disciplinary field involved: Chemistry

Sustainable Development Goals eventually involved in your research: Clean water and sanitation (Goal 6)

Functionalized Iron oxide for wastewater depollution

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This scientific contribution is part of the field of sustainable chemistry, in particular on the depollution of wastewater. Today, the management of wastewater is not sufficiently controlled at nanoscale, especially for the last residues of heavy metal or microplastics etc., and is becoming a strategic field of activity for international society. Our objective is to take advantages of using nanoparticles to perform nanofiltration among the different techniques existing on an industrial scale[1,2].
In this context, our company SON with expert knowledge on the design of functionalized superparamagnetic iron oxide (SPIO)[3], is developing selective nanomagnets for water pollution control. For this purpose, different steps of synthesis are carried out on the synthesized nanomagnets: a grafting step in order to increase the surface reactivity and then a chelating agent functionalization step. The choice of chelating agents will depend on the elements to remove from wastewater.

The long-term objective of this study is to develop functionalized nanomagnet that can be reused. A study is being carried out to set up a release system and thus recycling process. This concept makes possible to reduce production costs and make the processes less energy-consuming.

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Acknowledgment: Plan de Relance France

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2023
Poitiers
March, 15, 16 and 17

Keywords: carbon dots, chitosan, composites, rheology, depollution
Disciplinary fields involved: Physics and Chemistry
Sustainable Development Goals* eventually involved in your research: Ensure access to water and sanitation for all. (Goal 6)

Carbon dots-based composites: from elaboration to study of their properties for adsorption of pollutants

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Carbon dots (CD) are zero-dimensional carbon nanostructures with a size in the range of nanometers that present photoluminescent properties, a wide variety of functional groups and excellent biocompatibility and nontoxicity [1]. As a new type of fillers, CD has been incorporated in different polymer matrices to design advanced structural and multifunctional materials with significantly improved properties allowing their use in a wide range of applications [2]. However, their properties, depending on many parameters as reported in the literature, are scattered. Key-challenges faced by CD/polymer composites involve in particular the method of purification of CD, the control of aggregation, limiting the release of CD from the polymer matrix to water media and establishing a relationship between the synthesis of CD and elaboration of composites with their properties in regard of applications.

In this context we present, in a first step, results on the synthesis of CD from glucose using a one-step ultrasonic method and the comparison of two purification methods: dialysis and the change of continuous phase from water to ethanol to separate glucose and salts by precipitation. Structural, optical and rheological properties were studied as a function of concentration, temperature and pH, observing higher purity and properties on dialysed CD. In a second step, CD were introduced in aqueous solutions of chitosan crosslinked covalently by the addition of glyoxal. The effect of the CD concentration on rheological and structural properties of CD/chitosan composites was investigated. Composite hydrogels were dried to obtain membranes which applicability for adsorption of pollutants was studied.

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