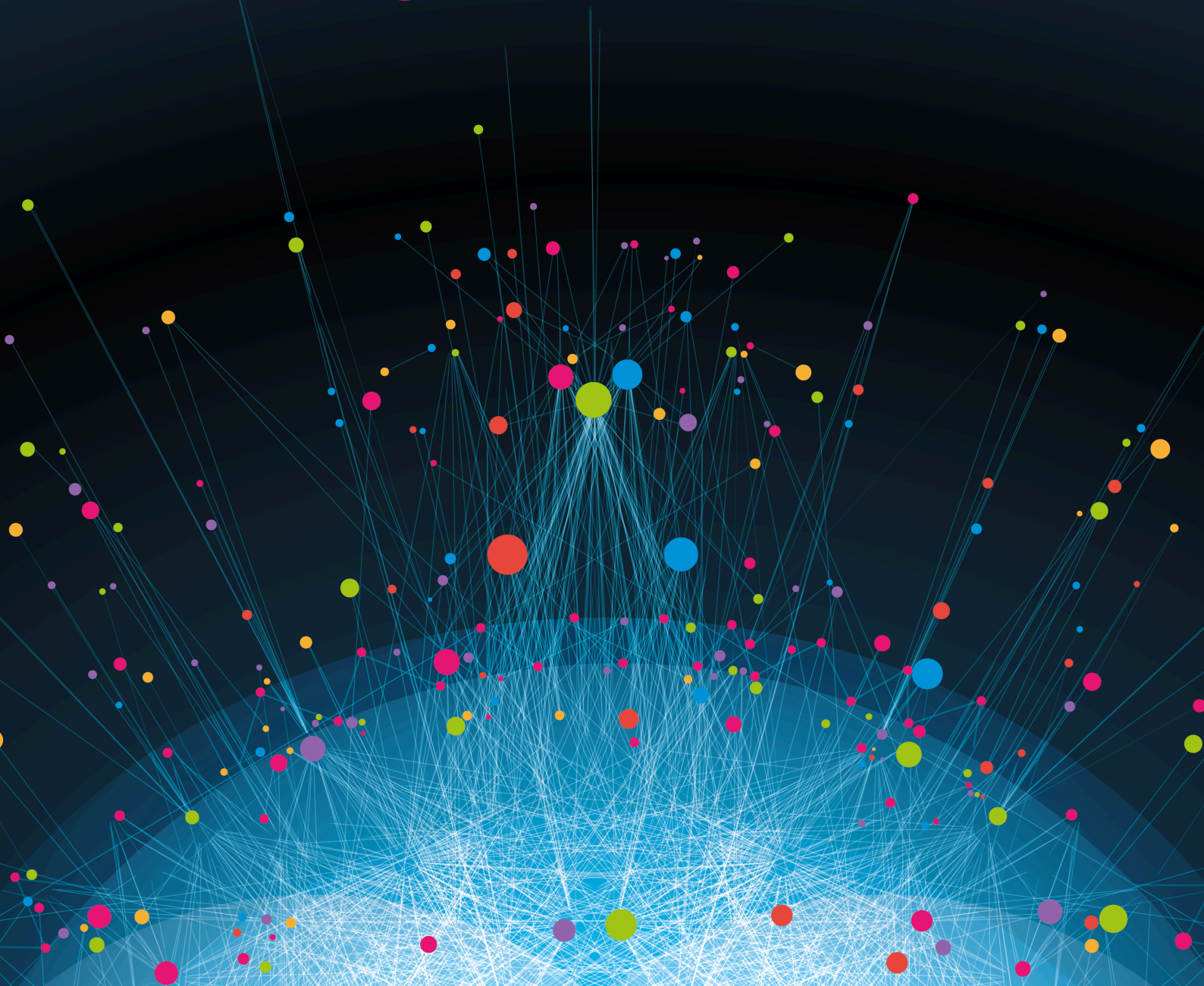
BOOK OF ABSTRACTS

Sustainability and eco design of nanomaterials



Wednesday March 19th

10:30 A.M. - 12:30 A.M.

ROOM CD

Program of the session :

Chair: Emmanuel FLAHAUT

HOUR	NAME	TITLE
10:30	**Simon CLAVAGUERA** **LITEN - CEA**	**Operationalization of Safe- and Sustainable-by-Design Approaches for Advanced Materials: A Journey from Nanomaterials to Plastics**
11:00	Jamie SILK LMGP - Grenoble INP	Life Cycle Assessment of Metal Oxide Nanowires for Applications in Passive Atmospheric Water Collection
11:15	Gustavo Vinicios MUNHOZ GARCIA GET - CNRS	Glyphosate-based nanosystems: from design using natural polymers to toxicity in target and nontarget organisms
11:30	Chiddharth MUTHURAJ LCMCP - Soronne Univ.	Solvent free sol-gel strategy: The road to sustainability for the synthesis of oxides and mixed oxides based heterogeneous catalysts
11:45	Lucas NOLANN LERMaB - Univ. Lorrainne	Nanolignins for innovative materials
12:00	Gaëlle CHARRON MSC - Univ. Paris Cité	Surface enhanced Raman Scattering: the winding road from a fundamental phenomenon to action research
12:15	-	-

Simon CLAVAGUERA (CEA - LITEN, Grenoble), télécharger le résumé

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Short biography

Dr Simon Clavaguera graduated in 2004 in chemistry and chemical engineering (ENS Chimie Montpellier). He then received his Ph.D. in chemistry at the University of Montpellier in 2007 on the development of chemical sensors for explosives detection. After working as a postdoctoral fellow with Professor Yves Rubin at the University of California Los Angeles on the chemistry of fullerenes, he joined the Atomic Energy Commission in Grenoble, France in 2009. After working a decade on developing methods and devices for exposure assessment to harmful substances and airborne particles, he contributed to the implementation of Safe- and Sustainable-by-Design approaches towards the development of advanced materials for energy. He also gained expertise on the transformation of materials that can lead to the release of substances of concern during their life cycle, by measuring pollutants in different environments (air, water, soil) and proposing technological solutions to protect people and the environment. He coordinates the European project SURPASS on Safe- and Sustainable-by-Design Plastics and leads the Measurement, Safety and Sustainability Laboratory of CEA Liten.

Operationalization of Safe- and Sustainable-by-Design Approaches for Advanced Materials: A Journey from Nanomaterials to Plastics

The transition to Safe- and Sustainable-by-Design (SSbD) approaches is crucial to innovate on advanced materials assuring they are both safer and more environmentally sustainable. This keynote explores the operationalization of the SSbD framework developed by the European Commission's Joint Research Centre, highlighting its role in minimizing environmental impacts and supporting a zero-pollution, climate-neutral economy. Examples from nanomaterials to plastics will illustrate how SSbD principles can be integrated through eco-innovation and life cycle thinking. The Labex Serenade project demonstrated a Safer-by-Design (SbD) approach in mitigating exposure risks by assessing release scenarios on a TiO_2-based photocatalytic mineral paint. Findings showed that SbD coatings reduce nanoparticle release and toxicity during accelerated aging. Building on this, the Horizon Europe-funded SURPASS project applies SSbD principles to plastics, developing materials for the building, transport, and packaging sectors. These innovations aim to significantly reduce plastic waste while improving sustainability in key industries. A structured assessment process identified release hotspots along the polymer life cycle, followed by experimental verification of substance release. Hazard assessments, combining the exploitation of existing toxicological data, QSAR modeling, and in vitro assays, addressed data gaps related to cytotoxicity, inflammation, oxidative stress, genotoxicity, epigenetics, endocrine disruption and acute aquatic toxicity. Environmental impacts were evaluated using Life Cycle Assessment, while Life Cycle Costing provided economic insights. A unified scoring system integrating hazard, exposure, environmental, and cost assessments was developed to guide decision-making in polymer design. These efforts contribute to the creation of a digital tool that will help SMEs and industry stakeholders in implementing sustainability-driven strategies fostering innovation in Safe- and Sustainable-by-Design Plastics.

Keywords

SSbD framework, Eco-innovation, Sustainability, Life cycle thinking, Tools

Acknowledgement

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References

Caldeira, C., et al., “Safe and sustainable by design chemicals and materials - Framework for the definition of criteria and evaluation procedure for chemicals and materials,” JRC Technical Report, 2022, doi: 10.2760/487955
Caldeira, C., et al. « Safe and Sustainable by Design chemicals and materials: Application of the SSbD framework to case studies », JRC Technical Report, 2023, doi: 10.2760/329423.
Abbate, E., et al. « Safe and Sustainable by Design chemicals and materials - Methodological Guidance », JRC Technical Report, 2024, doi: 10.2760/28450.

Abstract

Thematic Session: Sustainability and Eco-design of Nanomaterials
Disciplinary fields involved: Chemistry, Materials Science, Eco-design
Keywords (max. 4-5)**:** life cycle assessment, atmospheric water harvesting, nanowires, biphilic surfaces

Life Cycle Assessment of Metal Oxide Nanowires for Applications in Passive Atmospheric Water Collection

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1. *LMGP, Université Grenoble Alpes, CNRS, Grenoble INP, Grenoble, France*
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Water is essential for human life, yet roughly two billion people worldwide still lack access to safely managed drinking water, with this number expected to increase through 2050 as a result of the climate crisis affecting global water supply [1]. Passive atmospheric water collection is a novel approach that aims to collect the large quantity of clean water stored in the Earth's atmosphere without ongoing electricity input, addressing climate change-induced water scarcity without further contributing to the climate crisis [2]. The goal of this study is to develop a device inspired by nature that combines a biphilic metal oxide nanowire film with a radiative cooling coating to passively harvest atmospheric water. To develop the biphilic nanowire film, both zinc oxide and cuprous oxide nanowires are considered due to their low cost, ease of fabrication, and safety for the human body. With the goal to develop the most environmentally sustainable device possible, a life cycle assessment (LCA) methodology is employed to quantitatively compare the environmental impacts of each of these nanomaterials and their synthesis methods in a variety of impact categories including global warming, water consumption, and ozone depletion. Further, LCA methodology is used to understand the largest contributing factors to these impact categories, which encourages further innovation in the design process to reduce negative impacts. The results of this LCA will be used to guide decision-making to design the most efficient passive atmospheric water harvester with the fewest negative impacts on the environment.

References:
[1] "The Sustainable Development Goals Report 2022," United Nations, New York, USA, Jul. 2022. Accessed: Apr. 17, 2024. [Online]. Available: https://unstats.un.org/sdgs/report/2022/
[2] H. Jarimi, R. Powell, and S. Riffat, "Review of sustainable methods for atmospheric water harvesting," International Journal of Low-Carbon Technologies, vol. 15, no. 2, pp. 253–276, May 2020, doi: 10.1093/ijlct/ctz072.

Abstract

Thematic Session: Sustainability and eco design of nanomaterials.
Disciplinary fields involved: Chemistry, Agriculture, Biology.
Keywords: nanoparticle, sustainability, weed control, green chemistry.

Glyphosate-based nanosystems: from design using natural polymers to toxicity in target and nontarget organisms

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2. *Institute of Science and Technology, Sao Paulo State University, Sorocaba, SP, Brazil.*
3. *Géosciences Environnement Toulouse, Centre National de la Recherche Cientifique, Observatoire Midi-Pyrénées, Toulouse, France.*

Abstract

Natural polymers have become a viable tool for smart-delivery of drugs and pesticides using nanotechnology. Glyphosate is the most used herbicide worldwide for weed control (0.7 Mt per year), being necessary in several crop systems. It is also a contaminant in the environment, due this high use, being necessary to optimize and reduce the amount used in agriculture. This work aimed to elaborated strategies to enhance glyphosate efficacy using polymeric nanosystems (zein, chitosan and lignin) to reduce the amount applied to the environment, as well as to control the toxicity to non-target organisms. System responses were assessed through toxicity to weed species, soil respiration (^{14}C-glucose mineralization), and soil enzyme activity (β-glucosidase and arylsulfatase). Zein + pluronic (ZN-PL) nanosystems in *A. hybridus* showed higher weed control efficacy (90-96%) at half the recommended dose, compared to the commercial glyphosate showing a moderate efficacy (40%) at full dose. A reduced control was proportioned by ZN-PL to *E. indica* (51%) and *I. grandifolia* (18%). No toxicity of glyphosate (both formulation) was observed in glyphosate-resistant crops, soil respiration, or soil enzymes. This work suggests that the ZN-PL system could be an alternative for glyphosate delivery with improved efficiency to *A. hybridus*, but the environmental impact is similar to the commercial glyphosate. It could yet be an interesting approach to reduce the doses applied on fields, while managing *A. hybridus* in agriculture using glyphosate, highlighting the potential of nanotechnology in contributing to a more efficient and rational agriculture.

Acknowledgement:

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Abstract

Thematic Session: Sustainability and eco design of nanomaterials
Disciplinary fields involved: Chemistry
Keywords: Sol-gel, sustainability, solvent-free, zirconia

"Solvent free sol-gel strategy" – The road to sustainability for the synthesis of oxides and mixed oxides based heterogeneous catalysts

Chiddharth Muthuraj[1], Ryma Haddad[1], Cedric Boissiere[1], Corinne Chaneac[1]

1. *Laboratoire de Chimie de la Matière Condensée de Paris (LCMCP), Sorbonne Université, Paris, France*

Catalysts play an essential role, significantly affecting processes across various industries and aspects of daily life. Though catalysts pave the way to provide sustainable chemical processes, the environmental burden caused in preparing a catalyst must also be taken into account. There are several strategies for synthesizing heterogeneous catalysts. All of them are environmentally detrimental.

We developed a new strategy called "solvent free sol-gel" which allows the synthesis of catalysts in a single step, without using any solvents, producing no waste, in a continuous process. Haddad et al., for the first time, used this approach to synthesize Ru doped γ-Al_2O_3 materials and used them for the CO_2 methanation reaction. They were able to synthesize high surface area materials (700m^2/g) with good dispersion of Ru over the alumina support[1]. An assessment was carried out to demonstrate the energy efficiency of the process compared with the conventional industrial process, and a huge atom economy was achieved.

By taking this as a proof of concept, we wanted to extend this approach to other metal oxides in order to demonstrate its versatility and potential for rethinking an industry that is more respectful of the environment and in tune with energy issues. To do that, we work on zirconium oxides and doped zirconium oxide catalysts. It is a more challenging system than the former because the alkoxides of zirconium are highly reactive. We try to decrease the reactivity of the precursors using a chelating ligand. This approach has also been used to synthesize doped or mixed oxides which includes Ni/γ-Al_2O_3 and CeO_2 doped ZrO_2. The challenge in using multi-metallic system lies in choosing the right precursors. Yet the approach of solvent free sol-gel strategy can be applied to many chemical systems that can be used for a plethora of applications.

Reference

[1] Haddad R, Zhao Y, et al., Chemistry of Materials (2023) 8248-8260, 35(19).

Abstract

Thematic Session: Sustainability and eco design of nanomaterials
Disciplinary fields involved: Chemistry
Keywords): Nano-lignin, nanoparticles, Organosolv, Pickering emulsion, Biomass

Nanolignins for innovative materials

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Abstract :
In light of fossil resource depletion and the need for sustainable solutions, the interest for lignocellulosic biomass-derived products is always bigger. Among them, lignin, the most abundant renewable aromatic biopolymer, remains underutilized, often limited to energetic valorization[1], despite its antioxidant, UV protection, and antimicrobial properties, which could address various technical and industrial needs[2]. Waste produced by the wood industry or agriculture offers significant potential for extraction of macro-lignin.
In this work macro-lignin are firstly extracted using the eco-friendly organosolv process[3]. Then the nano-lignins are produced through an anti-solvent process[3-4]. Nano-lignins, with their small size (100-150 nm)[4], has a larger specific surface area, and a better homogeneity making their incorporation promising in various applications. One example of this valorization is the stabilization of Pickering emulsions. Pickering emulsions are widely used in the cosmetic[5] and pharmaceutical industries, particularly for encapsulating active ingredients. The majority of nanoparticles currently used are manufactured using environmentally detrimental processes, and thus, the study of the stability of Pickering emulsions stabilized with nano-lignins addresses this issue. To optimize this process, a parametric study is conducted, optimizing key factors such as the concentration of nano-lignins in suspension, the energy supplied for agitation, the oil/water ratio, and the lignin sources (Beech, Spruce, Wheat Straw). This study highlights the strong ability of nano-lignin to stabilize emulsions, notably through the achievement of emulsions stable for 60 days with a suspension concentration of only 5 mg/g.

References :
[1]Bajwa, D., et al. (2019). Industrial Crops And Products, 139, 111526. [2]Zhang, Z., et al. (2021). Nanomaterials, 11(5), 1336. [3]Girard, V., et al. (2024). ACS Sustainable Chemistry & Engineering, 12(18), 7055-7068. [4]Girard, V., et al. (2024). Nanomaterials, 14(22), 1786. https://doi.org/10.3390/nano14221786[5]Espinoza-Acosta, J. L., et al. (2021). (2016). BioResources, 11(2), 5452-5481.

Acknowledgement:
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Abstract

Thematic Session: Sustainability
Disciplinary fields involved: physical chemistry, chemical analysis, scientific integrity
Keywords (max. 4-5)**: SERS, sensors, environmental analysis**

Surface enhanced Raman Scattering: the winding road from a fundamental phenomenon to action research

Gaëlle Charron[1]

1. *Gaëlle Charron, sustainability vice-dean of the faculty of Sciences, Université Paris Cité, 10 rue Alice Domon et Léonie Duquet, 75013 PARIS*

Abstract (**no longer than 250 words** or 18 lines max. incl. figure), Calibri 11, single line spacing, black)

Surface Enhanced Raman Scattering – SERS -, is a spectroscopic phenomenon that has been deemed groundbreaking for quantitative analysis of environmental contaminants since its first discovery 50 years ago.

Yet, about 1,500 research papers related to environmental applications of SERS later, only about 60 actually deal with the practical use of SERS as an analytical tool for monitoring contaminants. And only a handful claim quantitative measurements by non-expert users.

There is patent disconnection between the meaning of "applications" in the scientific community and the actual, routine use and impact of SERS outside of research labs. I experienced this disconnection through ten years of working on the development of frugal SERS-based sensors of aquatic contaminants that would be practical to use by non-expert communities. The considerations of cost, robustness and practicality were largely neglected in favour of the pursuit of exceptional sensitivity, more often than not without relevance to actual pollution issues.

Based on an original scientometric analysis, I will discuss were the research efforts of SERS for environmental monitoring have gone so far, and were they should go from now on in the context of increasing ethic pressure on conducting research with a positive impact on sustainability.

Poster Session

NANOCHEMISTRY & NANOPARTICLES/NANOBIOSCIENCES & NANOMEDECINE /NANOMATERIALS FOR ENERGY/ SUSTAINABILITY AND ECO DESIGN OF NANOMATERIALS

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32	Green synthesis of curcumin based nanoparticle	BASU	Surita
33	Synthesis of Polyvinylpyrrolidone nanocomposite with palygorskite for application in water-based drilling fluids	DALMONEKI	Anna Clara
34	Carbon supported metal oxides nanoparticles and their applications in biomass valorization	DJELLALI	Ali
35	Synthesis of Polyacrylamide/Palygorskite Nanocomposites for Application in Water-Based Drilling Fluids	GOMES	Ana Beatriz
36	Re(CO)-based silica-nanoparticles as multimodal probes for bio-imaging	KAUFFELD	Willem
37	Chiral CdSe/CdS Nanonails	KUZNETSOVA	Vera
38	Towards large-scale production of Cobalt nanorods	LISOIR	Emma
39	Synthesis and Evaluation of PAMAM G0.5 Dendrimer as a Swelling Inhibitor Additive for Clays in Water-Based Drilling Fluids	LOPES/SPINELLI	Grazielle/Luciana
40	Plasmonic nanoclusters synthesized by a multi-step colloidal approach	ROMANUS	Martin
41	Influence of CuInS2 crystalline structure on the synthesis of CuIn1-xFexS2 quantum dot by cation exchange	ROUX-BYL	Céline
42	Chirality in Zinc Oxide nanoparticle synthesis	SARTOR	Valerie
43	Application and evaluation of core-shell nanocomposite using silica nanoparticles and AM/AMPS/DMDAAC/AAC tetrapolymer	SPINELLI	Luciana
44	Design of efficient nanocatalysts for H2 release from boranes and silanes	THIBAULT	Maxime
45	Influence of crystalline structure on the acoustic vibrations of elongated nano-objects	VERNIER	Charles
46	Chemistry and biological effects of germanium oxide nanoparticles	VIKRAMAN	Haribaskar
47	From laser-synthesized nanoparticles to innovative medical devices	AL KATTAN	Ahmed
48	Ultra-small Superparamagnetic Iron Oxide Coated Phosphonate-based Ligand for MRI Application	CHE DJI	Lyns Verel
49	Magnetic hyperthermia tumor ablation and tumor microenvironment modulation monitored by optical imaging	COSTE	Henri
50	Synthesis of iron oxide nanoparticles and magnetic properties tuning by temperature cycling: towards fine control of crystal phase and size distribution	HUEZ	Cecile
51	Hybrid plasmon-semiconductor nanoparticles for charge or resonant energy transfer based dynamic phototherapy	JEFFRIES	Beatrice
52	Re(CO)-based silica-nanoparticles as multimodal probes for bio-imaging	KAUFELD	Willem
53	Force nanosensor development for measuring mechanical stress exerted by living cells	LACROIX	Noemie
54	Combination therapy using nanoheaters and CAR-T immunotherapy on 3D tumor models	LEINEBO	Charlotte Amalie
55	Red-blood-cell-membrane-coated polymer micelles/vesicles as biomimetic nanoassemblies for potential photocatalytic cancer therapy under hypoxia	MA	Yandong
56	Vivoptic, a preclinical optical imaging platform for the evaluation of diagnostic and therapeutic strategies	MORNET	Stéphane
57	On the Roles of Polymer Chemistry, Kinetics, and Mixing in the Assembly of Loaded Polymer Nanoparticles	REISCH	Andreas
58	Digital colorimetric biosensing on gold-DNA origami nanostructures	ZHANG	Zixiao
59	Cu Isotopic Fractionation Following Foliar uptake	CALAS	Aude
60	New process "Multi-Dip Coating" applied for biological statistical analysis of Antimicrobial Surfaces	CHARLIAC	Jérôme
61	One step synthesis using laser pyrolysis of nanostructured carbides molybdenum catalysts for hydrogen production	RIO	Simon
62	Study of the reactivity of Fe(0) nanoparticles towards ammonia	ZAMBLE	Christian Irie
63	Chemical Passivation of GaN Nanowires for the Development of Innovative Photocatalysts	ZORAI	Amel

Abstract

Thematic Session: Sustainability and eco design of nanomaterials
Disciplinary fields involved: Biology, Geochemistry
Keywords: Copper, Isotopic fractionation, Nanomaterial, Foliar uptake

Cu Isotopic Fractionation Following Foliar uptake

CALAS Aude[1], SALLEM Fadoua[1], ANNABI Eloise[1], LARUE Camille[2], SCHRECK Eva[1], WAGNER Mickaël[1], VIERS Jérôme[1] and AVELLAN Astrid[1]

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2. *Centre de recherche sur la biodiversité et l'environnement (CRBE), CNRS, Université de Toulouse, Toulouse INP, IRD, Toulouse, France.*

Abstract:

Copper (Cu) is an essential nutrient for plants. However, it can become toxic in excess. Cu-based inputs have been widely used on crops since the late 19th century, and several forms of Cu are used for foliar application for both nutrition and plant protection purposes, and nanoformulations are being developed to decrease the associated Cu leaching and soil contamination. Although it has been shown that a fraction of foliarly deposited Cu nanomaterial can enter leaves and be mobile, the mechanisms of Cu uptake at the leaf level, along with Cu fate *in planta* remain unknown.
Isotopic process tracing tool have been used to further understand the biogeochemical processes of Cu uptake by roots, but Cu isotope fractionation after foliar application and uptake remain unraveled. Is fractionation different from root uptake? Does it depend on the initial Cu speciation? On the initial Cu concentration? To answer these questions, we assessed Cu isotopic fractionation on different tissues of tomato plants exposed to different doses and forms of Cu, including CuO NP and Cu salt in comparison with root application.
Developing this knowledge will improve our understanding of Cu use in agriculture and further enhance our ability to develop safer Cu-based agrochemicals, while unravelling plant strategies to deal with foliarly delivered Cu.

Acknowledgement:

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Abstract

Thematic Session: Nanomaterials
Disciplinary fields involved: Chemistry, Process
Keywords: Dip Coating, multiple parallel growth, sol-gel, antimicrobial, eco, responsible

New process "Multi-Dip Coating" applied for biological *statistical analysis* of Antimicrobial Surfaces

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Abstract

Statistical analysis in biological research is often considered only after a series of experiments has been completed [1]. The need to generate a sufficiently large number of samples to ensure statistical significance is often overlooked or only partially considered in materials science. Scaling up shaping processes to produce multiple samples simultaneously is not always feasible with scientific laboratory equipment. However, it is desirable to develop synthesis processes to address this production challenge.

Recently, formulations of functional films deposited on substrates were investigated as part of a study aiming at avoiding biofilm formation on functional surfaces. These films were synthesized in two stages from two solutions. The first solution was obtained through radical polymerization at mild temperatures and contained methacrylate monomers. The second solution was produced via the Sol-Gel process at room temperature, in the presence of inorganic precursors. Both solutions were then mixed and dip-coated onto various glass substrates. Heat treatment finalized the consolidation process of the functional films.

To generate statistically significant biofilm formation data in our tests, we modified our dip-coating apparatus to accommodate the coating of 24 glass slides (size: 75 × 24 × 1 mm) or 12 slides (size: 120 × 60 × 7 mm) at a time. This poster outlines the various steps involved in realizing the improved process (CAD design, additive manufacturing, assembly, and implementation) for two PhD projects and actual biofilm testing [2].

References:

1. *Nature Collection 09 May 2017,* Statistics for Biologists

Abstract

2. *Laurence Gbaguidi, JED_Book_2023, jed397*, Ecoresponsible Functional Antimicrobial Surfaces – SAFE

Acknowledgement: Laurence Gbaguidi, Lionel Nicole, Cédric Boissière.