Institute for Functional Materials and Catalysis
Institut für Funktionelle Materialien und Katalyse

Nanoporous Materials and Their Applications

Mini-Symposium

Date & Time: Donnerstag, 05.06.2025, 14:00 - 17:00 Uhr
Place: Hörsaal 4 Chemie / HP, Währinger Straße 42, 2H23
Host: Univ.-Prof. Dr. Freddy Kleitz

1. **Dr. Marie-Alix Pizzoccaro-Zilamy (NL/DE)** (Inorganic Membranes group, Univ. Twente, NL; Materials Synthesis and Processing (IMD-2), Forschungszentrum Jülich, Germany)**: Nanostructured hybrid ceramic membranes for advanced industrial wastewater treatment**

Nanostructured hybrid ceramic membranes represent an innovative and effective solution for the selective separation of solutes such as ions, dyes, and organic micropollutants from industrial wastewater streams. This lecture will begin with an overview of membrane technologies, emphasizing the unique advantages of ceramic membranes in terms of chemical, thermal, and mechanical stability. The focus will then shift to the engineering of nanostructured hybrid/ceramic membranes with a presentation of the main strategies to create the desired nanoscale features: Organic surface modification (e.g. grafting, polymer coating), incorporation of two-dimensional nanomaterials such as graphene oxide, zeolites, and metal-organic frameworks (MOFs). The lecture will showcase organofunctionalized ceramic membranes that enable precise tuning of surface characteristics, leading to improved separation performance for challenging industrial wastewater treatment. The presentation will also address current challenges in the field, such as the scalability of production and nanomaterial leaching, which can impact both performance and environmental safety. Finally, a glance at our current development will be presented, with a focus on the role of two-dimensional materials and advanced organic functionalization in the development of nanostructured membranes.

Biography: Marie-Alix Pizzoccaro-Zilamy is an Assistant Professor at the University of Twente (Netherlands) and team leader at the Forschungszentrum Jülich (Germany). She earned her PhD degree from the University of Montpellier, France. In 2018, she joined the Inorganic Membranes group at the University of Twente as a post-doctoral fellow, and in 2022, she was promoted to Assistant Professor. The same year, she received a prestigious €1.6 million grant from Germany's BMBF NanoMatFutur competition to establish her research group at Forschungszentrum Jülich. Since 2023, she has led the

Nanostructured Membranes research group, which operates across both of her research locations. At the Forschungszentrum Jülich, her team is focused on developing novel two-dimensional zeolites and metal-organic frameworks (MOFs) membranes. By combining innovative synthesis approaches with surface polymerization methods, they aim to produce defect-free, robust membranes with controlled morphology for gas separation applications. At the University of Twente, her research team specializes in engineering organofunctionalized and/or reactive porous ceramic membranes with controlled surface properties for liquid filtration applications (organic solvent recovery, wastewater treatment). The core of the nanostructured membranes is composed of porous ceramic supports, which provide essential mechanical and chemical resistance to meet the demands of complex separations. The team's shared vision is to develop sustainable and green synthesis routes that are not only effective but also easily scalable for real-world applications.

2. **Prof. Sabine van Rijt (NL)** (Instructive Biomaterials Engineering (IBE) Department, MERLN Institute, Maastricht University):
   Mesoporous Silica Nanoparticles and Nanocomposites for In Situ Bone Regeneration

Mesoporous silica nanoparticles (MSNs) provide a versatile platform for designing advanced biomaterials that support in situ bone tissue regeneration. Following a brief introduction to materials-driven tissue regeneration, this lecture will focus on how MSNs can be engineered as responsive and instructive elements within nanocomposites that promote bone repair. We will highlight strategies for functionalizing MSNs to deliver bioactive signals that drive stem cell differentiation and extracellular matrix production. Additionally, we will examine how incorporating MSNs into composite materials enables control over mechanical properties, degradation rates, and self-healing behavior. The lecture will also explore how the nanoscale surface properties of MSNs influence stem cell–material interactions, enhancing cell adhesion and osteogenic differentiation. This lecture aims to provide a multidisciplinary perspective on the design and function of bioactive nanomaterials at the interface of nanotechnology, stem cell biology, and materials science.

Biography: Sabine van Rijt performed her PhD research in the lab of Prof. Peter Sadler, developing

labile organometallic compounds for cancer therapy. Following a short postdoc, she obtained the Alexander von Humboldt fellowship to develop therapies based on multifunctional nanoparticles carrying small molecule therapeutics to treat lung cancer at the Helmholtz Institute in Munich, Germany. Sabine started her own research group at the MERLN institute of technology inspired regenerative medicine at Maastricht University in 2016. In her current position as associate professor, she aims to develop

new types of responsive nanocomposite materials that can induce (bone) tissue regeneration, and nanoparticles that can be used in various theranostic applications. She is active in several consortia where she seeks to (clinically) apply her nanomaterials to relevant biological systems. Specifically, as member of the NWO gravitation consortium "materials driven regeneration" (www.mdr.nl) she is interested to develop mechanically enforced, yet responsive nanobiomaterials. As co-applicant in two EU grants PREMSTEM and JOINTPROMISE (both granted in 2019) she uses nanoparticles to study stem cell distribution and mechanism of action in 3D cell cultures and in several *in vivo* models. In 2023 she obtained the prestigious ERC consolidator grant, in which she will focus on responsive biomaterials for hard tissue regeneration and osteosarcoma treatment. Since 2024 she is department chair of the instructive biomaterials engineering (IBE) department at MERLN institute, at Maastricht University.

3. **Prof. Sebastien Royer** (FRA) (Université du Littoral Côte d'Opale):
   Supported transition metal catalyst preparation; Uses in energy-related reactions

The talk proposed today introduces the preparation of supported catalysts, a major class of heterogeneous catalysts commonly encountered in the industry. Supported catalysts are composed of a porous support (several hundreds of square meter per gram of material), on which active elements are stabilized at its surface in the form of fine particles. Reaction thereafter occurs at the surface of these particles. Then, the dispersion of the active phase (that is the particle size of the active phase), and its accessibility to the reactants, conditions the activity of the catalyst and then the conversion/selectivities achieved. During the presentation, we will introduce some classical preparation procedures (wet impregnation, incipient wetness impregnation) and define the key properties of supported catalysts such obtained. Thereafter, alternative procedures of preparation (deposition precipitation, melt infiltration) will be presented and the properties obtained discussed. Finally, catalytic results obtained with supported transition metal for ammonia synthesis, CO_2 methanation, CO_2 reforming, biomass HDO will be presented, and the role of dispersion during reaction highlighted.

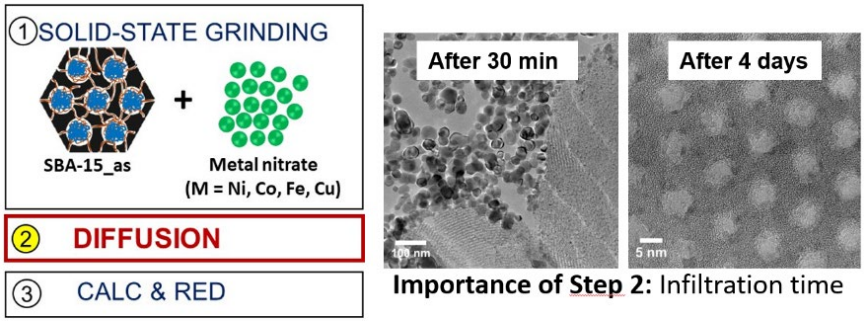

Illustration of melt infiltration preparation procedure

Ciotonea et al. Catal. Sci. Technol. 7 (2017) 5448; Chen et al. Catalysis Today 334 (2019) 48

Biography: Sebastien Royer (https://orcid.org/0000-0002-5635-0144) is professor at the Université du Littoral Côte d'Opale, France, since 2024, after being professor at Université de Lille in the UCCS Laboratory (2015-2024). He leads a research group working on the synthesis of heterogeneous catalysts, and develops researches in the fields of porous materials (mesostructured solids, zeolites, MOFs, carbons), oxides and mixed oxides, supported nanoparticles syntheses, with applications in green chemistry, energy and environment. The group also study small catalyst scale-up and shaping in view of industrial application.