

Development of Hybrid Ceramic Membranes for challenging separation applications

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Abstract

The nanomaterial chemistry toolbox offers an infinite perspective to engineer porous membranes with nanoscale features for challenging and demanding applications. Nanochannels showing enhanced selectivity and transport can now be prepared using two-dimensional porous nanomaterials. While the long term stability of these 2D porous nanomaterials-based membranes is often a concern under operation, the stability of such systems can be improved using smart polymer brushes or surface polymerization of organic networks. Combining these nanomaterials and small units of polymer with porous ceramic membranes is highly relevant for niche and challenging applications. Some examples are the removal of small molecules/ dyes removal from the mixture of water and organic solvents or, the separation of H₂ from CO₂ at 200 °C where robust and rigid porous structures are preferred.

However, to achieve complete control of the behaviours and properties of these hybrid/inorganic porous membranes, it is essential to master their features at the nanoscale (between 1 and 100 nm). This is the goal of the next generation of hybrid porous membranes which will push further the combination of two-dimensional nanomaterials (e.g. zeolites, metal-organic frameworks, graphene oxide) and the science of organic surface modification to engineer nanostructured membranes.

In my presentation, I provide an overview of our latest advancements in material development and synthesis protocols for nanostructured porous and hybrid ceramic-based membranes. Additionally, I discuss the current challenges facing these membranes and explore future trends in water and gas separation technologies.

Short bio:

Marie-alix Pizzoccaro-Zilamy received her PhD degree at the University of Montpellier, France. In 2018, she joined the Inorganic Membranes group at the University of Twente, Netherlands as a post-doctoral fellow. In 2022 she became an assistant professor and managed a team that focused on the development and characterization of hybrid inorganic membranes having a controlled pore structure and shape for liquid filtration applications. In December 2022, she received a 1.6 million Euro German grant to set up a new junior research team at the Forschungszentrum Jülich, Germany, in the Membrane division of the Materials Synthesis and Processing (IEK-1) research institute. Her project « hybrid 2D Nanomaterial-based membranes" was funded via the BMBF NanoMatFutur competition. Over the next five years, Marie and her junior research group called Nanostructured Membranes located both at the [University of Twente](https://www.utwente.nl) and at the [Forschungszentrum Jülich](https://www.fz-juelich.de) will work on the development and characterization of nanostructured robust defect-free hybrid 2D-nanomaterial-based membranes for challenging gas separation and liquid filtration applications.

