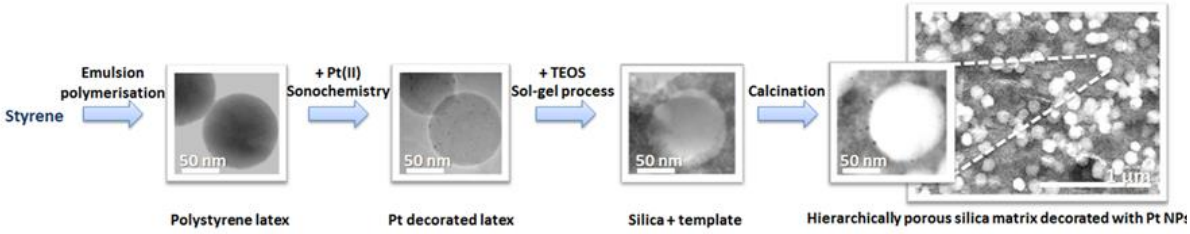
6- Multifunctional membranes for catalytic et photocatalytic reactors

Engineering of silica-supported platinum catalysts with hierarchical porosity combining latex synthesis, sonochemistry and sol-gel process - I. Material preparation
Microporous and Mesoporous Materials 234 (2016) 207-214.

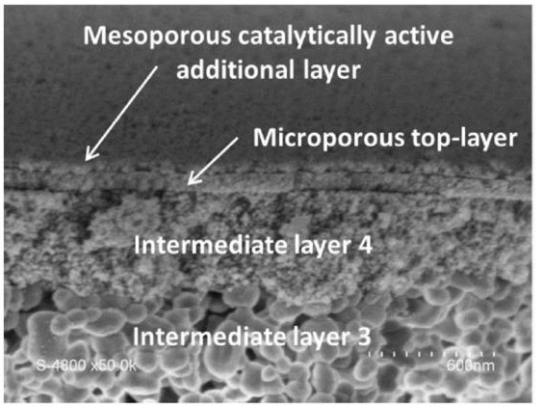
Collaboration: ICGM-Montpelier- France, ICSM-Marcoule- France, Univ. of Cape Town, Delft Univ. of Technology- The Netherlands ; University of Messina- Italia
Involved MCP researchers: André Ayral



Mass transport limitations in catalytic processes may be alleviated by the preparation of materials with hierarchical porosity. In this work, a novel catalyst preparation procedure is proposed in order to enhance the noble metal distribution at low loadings, while controlling the hierarchical porosity of the support material. Thus, a silica-supported platinum catalyst with hierarchical porosity was prepared using a combination of three processes performed in aqueous medium: emulsion polymerisation, sonochemistry and sol-gel synthesis. First, a polystyrene latex template of ca. 130 nm was synthesised by emulsion polymerisation and subsequently decorated with Pt nanoparticles of ca. 2.1 nm by sonochemical reduction of sodium tetrachloroplatinate. Then, the mesoporous silica support was prepared by a two-step acid-base catalysed sol-gel synthesis around the Pt-loaded latex spheres. Materials with specific surface areas and total pore volumes as high as 615 $m^2.g^{-1}$ and 0.74 $cm^3.g^{-1}$, respectively, were obtained.

Functionalized ceramic nanofilter for wastewater treatment by coupling membrane separation and catalytic ozonation
Journal of Environmental Chemical Engineering 8 (4) (2020) 104043.

Collaboration: GPM/IEM
Involved MCP researchers: André Ayral

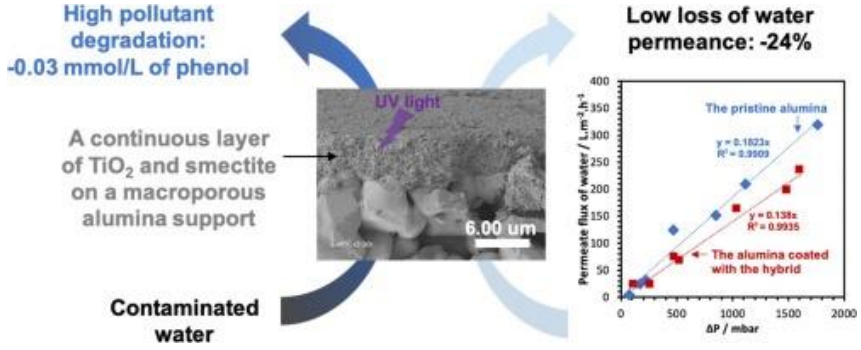


Micropollutants elimination in water becomes a global concern and represents an important issue for a possible reuse or a release to the environment. Hybrid processes combining membrane filtration and catalytic ozonation offer promising opportunities for micropollutant removal. A ceramic commercial nanofilter with a very low molecular weight cut-off of 200 Da was functionalized by sol-gel deposition of a mesoporous maghemite (γ-Fe_2O_3) thin layer. Preliminary experiments enabled to determine the maximum temperature usable for the thermal strengthening of the catalytic layer without significant permeance change. The catalytic activity of the iron oxide equivalent powder was tested in batch reactor with ozone and para-chlorobenzoic acid (pCBA) which quickly reacts with hydroxyl radicals formed with ozone at the catalyst surface, and only very slowly with ozone itself. The operational performance of the functionalized ceramic

membrane was evaluated in a dedicated pilot. The obtained results unequivocally show the catalytic activity of this functionalized membrane.

Simple and efficient method for functionalizing photocatalytic ceramic membranes and assessment of its applicability for wastewater treatment in up-scalable membrane reactors
Separation and Purification Technology 262 (2021) 118307.

Collaboration: Vidyasirimedhi Institute of Science and Technology (VISTEC), Thailand
Involved MCP researchers: André Ayral



A photocatalytically active layer composed of TiO_2 (Evonik P25) was successfully deposited on the macroporous (3 µm pore size) permeate side of an asymmetric porous alumina membrane with the aid of a smectite (a synthetic hectorite, Sumecton SWF) by dipping the membranes into an aqueous suspension containing P25 and the smectite. After the heat treatment at 400 °C, the coated hybrid was adhered on the macroporous support enough to be applied for the photocatalytic decomposition of organics (methylene blue and phenol as model molecules) in water. The water permeance of the membranes after the coating with the P25-smectite hybrid was reduced by only 24% compared with that of the pristine membrane, showing that the advantages of the present method for the preparation of the photocatalyst layer on the surface of the macroporous alumina without significant infiltration of the suspension into the support pores. The amount of MB and phenol degraded using the P25-SWF hybrid was equal to 0.007 and 0.023 mmol.L^{-1}, respectively, when the reaction was carried out using the four single-channel tubular membrane reactor at transmembrane pressures of 250 mbar. The implemented photocatalytic membrane reactor can easily be up-scaled by increase the size of the membrane module, with more tubes and longer tubes (lengths up to 1 m are commercially available), paving the way to potential technological applications for the continuous treatment of polluted waters.