7- Multifunctional membranes for electrochemical systems

Hierarchical porous Polybenzimidazole microsieves: An efficient architecture for anhydrous proton transport via Poly-ionic Liquids
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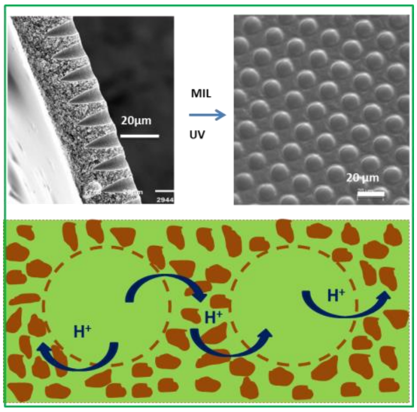
Collaboration: Univ. of Twente- The Netherlands, Univ. of Zaragoza- Spain
Involved MCP researchers: Anne Julbe, Martin Drobek



Liquid induced phase separation micromolding (LIPSµM) has been successfully used for manufacturing hierarchical porous polybenzimidazole (HPBI) microsieves (42-46% porosity, 30-40 µm thick) with specific pore architecture (pattern of macropores ~9 µm in size perforated in a porous matrix with 50-100 nm pore sizes). Using these microsieves, proton exchange membranes were fabricated by infiltration of 1-H-3-vinyl imidazolium bis(trifluoromethanesulfonyl)imide liquid and divinylbenzene (as cross-linker) followed by in-situ UV polymerization. Our approach relies on the separation of the ion conducting function from the structural support function. Thus, the polymeric ionic liquid (PIL) moiety plays the role as a proton conductor, while the HPBI microsieve ensures the mechanical resistance of the system. The influence of the porous support architecture on both proton transport performance and mechanical strength has been specifically investigated by means of comparison with both straight macro-porous (36% porosity) and randomly nano-porous (68% porosity) PBI counterparts. The most outstanding results were obtained with poly[1-(3H-imidazolium)ethylene]bis(trifluoromethanesulfonyl)imide polymeric ionic liquid (PIL) cross-linked with 1 % divinylbenzene supported on HPBI membranes with 21 µm thick skin layer, achieving conductivity values up to 85 mS·cm-1 at 200 °C under anhydrous conditions and in the absence of mineral acids.

Sintering and conductivity of nano-sized yttria-doped ZrO_2 synthesized by a supercritical CO_2-assisted sol-gel process, *The Journal of Supercritical Fluids 115 (2016) 26–32*

Collaborations : LSFC-Saint-Gobain CREE- Cavaillon-France, Univ. Lille- France, CEA Marcoule- France
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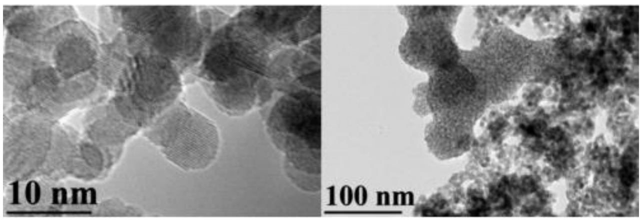

TEM micrographs of nanometric 8Y-ZrO_2 powders

This study reports on the electrical characterization of nano-sized zirconia powders doped with 3 and 8 mol% Yttria, referred to as 3Y-ZrO_2 and 8Y-ZrO_2, respectively. Powders were synthesized using a super-critical CO_2 assisted sol-gel method to control the size and morphology of the powder particles. Spark plasma sintering (SPS) was used to sinter the powders and maintain a fine microstructure with small grain size. The microstructure and chemical composition of the resulting ceramics was evaluated by electron microscopy techniques, showing grain boundaries depleted of amorphous phase. Electric conductivity of the 8Y-ZrO_2 pellets was determined by electrochemical impedance spectroscopy techniques, between 200 and 800°C, and correlated with the microstructure. The bulk electric response at 300°C is comparable to commercially available Y-ZrO_2 compositions. Compared to conventionally prepared samples we obtain lower conductivity in the high temperature range, still values in this study are twice superior to3Y-ZrO_2 samples similarly prepared by SPS.