

Controlled formation of multi-scale porosity in ionosilica templated by ionic liquid

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Abstract

A new synthesis pathway of hydrolytic ionosilica films with mesopores formed by ionic liquid (IL) templating is proposed and compared to the traditional non-hydrolytic strategy. For both pathways, the multi-scale formation of pores has been studied as a function of IL content, combining results of thermogravimetric analysis (TGA), nitrogen sorption, and small-angle X-ray scattering (SAXS). The combination of TGA and nitrogen sorption provides access to ionosilica and pore volume fractions, with contributions of meso- and macropores. We then elaborate an original and quantitative geometrical model to analyze the SAXS data based on small spheres ($R_s = 1 - 2$ nm) and cylinders ($L_{cyl} = 10 - 20$ nm) with radial polydispersity provided by the nitrogen sorption isotherms. As a main result, we found that for a given incorporation of templating IL, both synthesis pathways produce very similar pore geometries, but the better incorporation efficacy of the new hydrolytic films provides a higher mesoporosity. Our combined study provides a coherent view of mesopore geometry, and thereby an optimization pathway of porous ionic membranes in terms of accessible mesoporosity contributing to the specific surface. Possible applications include electrolyte membranes of improved ionic properties, e.g., in fuel cells and batteries, as well as molecular storage.