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ORIGINAL PAPER

Nano porous structure of resorcinol–formaldehyde xerogels and aerogels: effect of sodium dodecylbenzene sulfonate

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Abstract In the past two decades, resorcinol–formaldehyde (RF) gels have found widespread applications owing to their low density and adjustable pore size. They are usually prepared through sol–gel polymerization of the monomers in an aqueous media followed by evaporative or supercritical drying. In this study, RF gels were synthesized via sol–gel polymerization in the presence of sodium dodecylbenzene sulfonate (NaDBS) followed by ambient and supercritical drying. Dimensional measurements along with N_2 sorption analysis and Scanning electron microscopy (SEM) micrographs revealed that pore structure of the gel is chiefly affected by NaDBS. In all samples (xerogels and aerogels), maximum densities were observed at a critical NaDBS concentration ($\sim$1 w/v%), whereas considerable pore size increments and pore size distribution broadenings were found at higher concentrations of NaDBS ($\geq$5 w/v%). The most increased mesopore volumes were detected in xerogels (133% for acetone-dried and 67% for water-dried samples), while concerning aerogels, the pore sizes enlargement to macropore regime was observed at 5 w/v% of NaDBS. SEM micrographs, in agreement with porosity analysis, depicted that very large pore volumes could be obtained when supercritical drying was employed. However, in the case of xerogels, a more dense structure with smaller pores (micro and mesopores) exists which can only be altered slightly when using large amounts of NaDBS. The results showed that the RF gel pore texture, independent of drying technique, was strongly influenced by the addition of NaDBS, which should be taken into account when using this surfactant in the gel formulation for a wide variety of applications.

Keywords Resorcinol–formaldehyde xerogel · Aerogel · Sodium dodecylbenzene sulfonate · Sol–gel process · Porous structure

Introduction

Organic gels prepared by sol–gel polycondensation in aqueous media were first introduced by Pekala [1]. Due to their scientific and technical importance, these materials are a class of highly nanoporous materials which have been widely investigated during the last two decades [2, 3]. Their three-dimensional open-pore structure is responsible for the gel's fascinating properties such as low density, high surface area and great mesopore volume, as well as, lots of developed applications (e.g., heat insulation, catalysis, energy storage and absorption) [4–6].

The final structure of organic gels depends on precursors, sol–gel polymerization conditions, drying technique and pyrolysis conditions in the case of carbon gels. Initial pH and solid concentration of the sol are two key parameters which control the particle size and pore texture of the gels [7, 8]. On the other hand, drying method drastically affects the surface area, pore size distribution (PSD) and density. Supercritical drying leads to "aerogels" that bring about approximately no collapse. Whereas evaporative drying which produces "xerogels" may cause high-degree of gel shrinkage stemmed from strong capillary forces at the liquid vapor interface. "Cryogels" that were prepared

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