Development of cellulose-TiO_2 nanocomposite aerogels processed by ionic liquids and supercritical CO_2

I. Drygiannaki, C. Tsioptsias, C. Panayiotou*

Department of Chemical Engineering, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece
* email: cpanayio@auth.gr

ABSTRACT

Aerogels are a class of advanced materials and nanomaterials. They exhibit unique and unusual properties such as extremely low density, high surface area, small pore size distribution (typically <50nm), along with good mechanical and thermal properties. Their applications include gas separation, packaging materials, ultra insulation, catalysis, aerospace applications, etc. Cellulose is a natural polymer with certain advantages such as abundance, low cost, thermal and chemical stability. TiO_2 is widely used in photocatalytic applications and. for wastewater treatment. Room temperature ionic liquids and supercritical fluids are two of the most important solvent categories of green chemistry. In this study, cellulose-TiO_2 nanocomposite aerogels were developed, by dissolving cellulose in a room temperature ionic liquid. In this medium, the dispersion of TiO_2 nanoparticles was also performed. The regeneration of cellulose with methanol resulted in highly swollen cellulose (and cellulose-TiO_2) methanogels. These methanogels were dried under supercritical conditions (250bar and 50^oC) using the critical point drying method. A series of cellulose-TiO_2 composite aerogels were prepared at various proportions (50.4%, 33.4%, 25.2%, 12.8%, 9.5% and 0% w/w of TiO_2). The characterization of the cellulose-TiO_2 aerogels was perfomed by various means such as electron microscopy (SEM), surface area and pore size estimation by nitrogen adsorption measurements (BET), thermogravimetry (TGA), density measurements and shrinkage behavior in liquid medium. Representative values of the composite aerogels were 300 m^2/g for the specific area, 0.0477 g/cm^3 for the density, and pore size in the meso scale (2-50nm) and microscale (<2nm). It was found that the thermal stability of the composite aerogels was not proportional to the TiO_2 content, as one could expect due to a number of intervening competitive phenomena.