Development of organic aerogels reinforced with carbonaceous nanomaterials

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Aerogels are currently claimed as one of the most promising materials for different applications such as aerospace, high temperature insulation, cryogenic applications, refrigeration systems, outdoor clothing and building insulation [1]. Aerogel [2,3] is a synthetic porous ultralight material derived from a gel, in which the liquid component of the gel has been replaced with a gas. Basically, an organic polymer aerogel is an aerogel with a framework primarily comprised of organic polymers. They are generally less crumbly and brittle than inorganic aerogels. The most common method to obtain wet gels is sol gel process [4,5]. Nevertheless, the resulting products have some disadvantages such as low porosity, low flexibility and low lightness. However, the freeze-drying method, in which the pore liquid is frozen and then sublimed in vacuum, allows the production of porous aerogels with interesting insulating behavior [6]. This method is simple, low-cost and environmentally friendly. Up to date, few works have been reported about the freeze-drying process to produce organic aerogels [7-9].

Carbonaceous nanomaterials are widely employed as reinforcements to form carbon-reinforced composites which have exhibited enhanced mechanical, electrical and functional properties compared to monolithic materials [10]. Carbon nanofibers or nanotubes (CNF, CNT), carbon nanospheres (CNS), reduced graphene oxide (RG) and, graphene oxide (GO) exhibit outstanding physical and mechanical properties, including high surface to volume area, high Young´s modulus, low coefficient of thermal expansion and an entangled structure. Therefore, the mechanical properties and the thermal and the electrical conductivity of the organic aerogels could be enhanced with the addition of these nanomaterials.

In the present study, the synthesis of carbon nanostructured-reinforced aerogels were studied using freeze-drying method. Furthermore, the physical, morphological and mechanical properties of the final aerogel composite were evaluated using different characterization techniques (X-ray diffraction (XRD), N_2 adsorption/desorption static volumetric apparatus, transmission electron microscopy (TEM), emission scanning electron microscopy (ESEM), thermogravimetric analyzer (TGA), dynamic mechanical analyzer (DMA), IR spectroscopy (FTIR) and Helium pycnometry).

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