Monolithic homogeneous silica-graphene oxide aerogels synthesised via pH-controlled rapid gelation

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Silica aerogels have been considered for a variety of applications, such as thermal insulation, gas sensors, or biomaterials, thanks to the versatility of the synthesis procedure. Very recently, graphene is being embedded into silica aerogels broadening the possible functionalities of these materials [1-3]. This work introduces a rapid controlled gelation synthesis procedure for obtaining monolithic graphene oxide (GO) – silica aerogel composites, and describes their structural and mechanical properties.

Samples from 0.0 to 4.0 wt.% of GO were obtained by a pH-controlled rapid gelation route that enables the GO to be "frozen" homogeneously dispersed into the highly porous silica matrix, almost instantaneously. Sol is created by mixing a GO suspension in absolute ethanol, acidic water and TEOS upon sonication. Next, basic water is added while pH is controlled. After that, gelation takes place in less than 45 s, and finally, aerogels were obtained via supercritical drying in ethanol. Obtained aerogels after supercritical drying can be seen in Figure 1.

Densities of the sample series were almost constant, ca. 80 mg/cm^3 in all cases. N_2-physisorption show that the S_{BET} is almost doubled, from 490 m^2/g (pure silica sample) to 900 m^2/g (4.00 wt.% GO). SEM imaging revealed that the morphology of SiO_2 matrix based on the aggregation of spherical particles (~50 nm size) is maintained, even with the incorporation of high content of GO. Raman analyses confirmed that the difference between the characteristic peaks of SiO_2, (2896 and 2936 cm^{-1}) decreased with GO content thus, confirming hybridization of SiO_2 with GO.

Uniaxial compression tests reveal that compressive strength and maximum deformation decrease by the inclusion of 1.00 wt.% GO. Nevertheless, higher GO contents lead to an increasing trend and 4.00 wt.% composite presents similar properties than the pure silica sample (140 ± 40 kPa and 38 ± 4%). Higher mechanical values can be expected for higher GO contents. Besides, Young's modulus exhibits a reduction from 330 ± 30 kPa for pure silica sample to 295 ± 7 kPa, for the 4.0 wt.%.

The rapid controlled gelation is confirmed as a promising procedure that will enable further research lines for new technological applications for silica-graphene hybrid composites.

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Figure

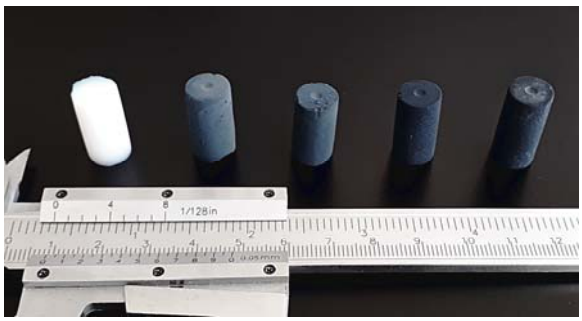

Figure 1: From left to right, monolithic hybrid aerogels with GO contents ranging 0-4 %wt.