Influence of carboxyl graphene on the physical, chemical and biological performances of polysulfone porous films

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Abstract

The present study highlights the preparation and extensive characterization of new carboxyl acid functionalized graphene / polysulfone (PSF/G-COOH) composite films. PSF porous films loaded with 0.25, 0.5, 1 and 2 wt% G-COOH were obtained by coupling G-COOH dispersion *via* ultrasound technique with polymer precipitation by wet phase inversion. Structural features were evaluated by Raman spectrometry, X-ray diffraction and transmission electron microscopy (TEM), results indicating optimal dispersion of G-COOH layers within the polymer matrix. Moreover, TEM revealed evenly distribution and bended G-COOH nanosheets. Further on, morphological features were thoroughly investigated by scanning electron microscopy (SEM) for both surfaces of the films, as well as their cross-section. Results suggested a slight increase of superficial pores under the influence of G-COOH addition for both film sides. Subsequently, sharp formations were identified onto G-COOH containing composites and attributed to the presence of graphenous sheets jutting out along films surfaces. Fracture morphologies revealed asymmetric configurations for all composites, with more homogenous porosity in the case of 1 wt% containing composite film. Surface profiles assessed by optical profilometry highlighted the smoothing effect of G-COOH on both film sides, with a half reduction of surface roughness values. Water contact angle measurements revealed differences between the hydrophilic-hydrophobic character of the two surfaces, however without important differences under the influence of G-COOH addition. Further on, materials rheological and mechanical performances were determined by dynamic mechanical analysis and tensile tests. The energy dissipation potential against temperature was found to progressively increase with G-COOH concentrations. This observation indicates a better damping response, which was further assigned to the ability of graphene based materials to facilitate load receipt and transfer [1]. A ~69% improvement was recorded for 0.25 wt% G-COOH containing composites. Tensile tests highlighted the importance of determining the optimum G-COOH concentration so as to ensure the maximum reinforcing efficiency. Accordingly, a better improvement of both tensile strength and Young's modulus is rather recorded at low G-COOH concentrations (0.25 – 1 wt%) compared to higher ones, a trend which fits similar reports on different graphene based materials [2]. Eventually, PSF/G-COOH porous films were subjected to biological assessments in order to determine cells viability, cytotoxicity and cytoskeleton development of murine mesenchymal stem cells (MSCs). Results indicated PSF/G-COOH to provide a favorable environment for MSCs development and proliferation. The highest amount of G-COOH (2 wt%) was found as the most advantageous for cells simultaneous proliferation and cytoskeleton formation.

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References

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