Polyurethane foam/graphene nanocomposites

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INTRODUCTION

Graphene is a 2D material comprised of carbon atoms forming hexagonal lattices. Its characteristic structure confers graphene excellent electrical, thermal, mechanical and optical properties, becoming an interesting nanomaterial for its application in polymer nanocomposites. Graphene was obtained by liquid exfoliation from graphite and size selected by centrifugation[1]. The obtained graphene was used to confer electrical conductivity to polyurethane foams incorporating graphene by impregnation technique.

METHODS

Graphene was obtained by liquid exfoliation of graphite powder by sonication with N-methyl-2-pyrrolidone (NMP). The resulting dispersion was centrifuged at different rates to obtain fractions of different sizes of graphene. Solid graphene was isolated by filtration obtaining also recoverable NMP. Morphology of graphene was analyzed by Raman spectroscopy, atomic force microscopy (AFM) and transmission electron microscopy (TEM) and electrical properties were assessed by electrostatic force microscopy (EFM) technique.

For the preparation of polyurethane foam nanocomposites, a dispersion of graphene in cyclohexane at 1 mg mL^{-1} was prepared. Foams were immersed in the graphene suspension and were sonicated for different times. Microstructure and properties of nanocomposites were analyzed by thermogravimetric analysis (TGA), scanning electron microscopy (SEM) and the assessment of electrical properties.

RESULTS

Raman spectra of graphite and graphene fractions showed typical bands associated with carbon materials. Differences on flake size of graphene are evidenced by the ratio of I_D/I_G Raman bands intensity since it is related with edge defects[2]. According to AFM analysis, flake sizes change in 5-0.4 µm range and flake thicknesses in 8-1.5 nm range when final centrifugation rate is changed from 500 to 4000 rpm, respectively. The low layer content of graphene fraction centrifuged at the highest rate was verified by TEM analysis and their conductive properties were confirmed by EFM analysis.

By using the ultrasound assisted impregnation method graphene flakes were adhered to polyurethane foam matrix. The presence of graphene flakes was confirmed by SEM analysis. The adhered graphene content on the surface was calculated from TGA results and varied with the sonication time. Graphene provides foam matrix with electrical conductivity. Graphene content has high influence of electrical resistance values. Apart from this, it was seen that the electrical resistance of the nanocomposites was sensitive to compressive mechanical deformation, diminishing with the elastic bending of cell struts and the contact posterior to cell collapse3.

References

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