World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:9, No:12, 2015

Electrospun Nanofibers from Amphiphlic Block Copolymers and Their Graphene Nanocomposites

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Abstract : Electrospinning uses an electrical charge to draw very fine fibers (typically on the micro or nano scale) from a liquid or molten precursor. Over the years, this method has become a widely used and a successful technique to process polymer materials and their composites into nanofibers. The main focus of this work is to study the electrospinning of multi-phase amphiphilic copolymers and their nanocomposites, which contain graphene as the nanofiller material. In such amphiphilic materials, the constituents segments are incompatible and thus the solid state morphology will be determined by the composition of the various constituents as well as the method of preparation. In this study, amphiphilic block copolymers of poly(dimethyl siloxane) and poly(methyl methacrylate) (PDMS-b-PMMA) with well-defined structures were synthesized and the solution electrospinning of these materials and their properties were investigated. Atom transfer radical polymerization (ATRP) was used to obtain the controlled block copolymers with relatively high molar masses and narrow dispersity. First, PDMS macroinitiators with different chain length of 1000, 5000 and 10000 g/mol were synthesized by the reaction of monocarbinol terminated PDMS with α-bromoisobutyryl bromide initiator. The obtained macroinitiators were used for the polymerization of methyl methacrylate monomer to obtain the desired block copolymers using the ATRP process. Graphene oxide (GO) of different loading was then added to the copolymer solution and the resultant nanocomposites were successfully electrospun into nanofibers. The electrospinning was achieved using dimethylformamide/chloroform mixture (60:40 vl%) as electrospinning solution medium. Scanning electron microscopy (SEM) showed the successful formation of the electrospun fibers with dimensions in the nanometer range. X-ray diffraction indicated that the GO nanosheets were of an exfoliated structure, irrespective of the filler loading. Thermogravimetric analysis also showed that the thermal stability of the nanofibers was improved in the presence of GO, which was not a function of the filler loading. Differential scanning calorimetry also showed that the mechanical properties (measured as glass transition temperature) of the nanofibers was improved significantly in the presence of GO, which was a function of the filler loading.

Keywords : elctrospinning, graphene oxide, nanofibers, polymethyl methacrylate (PMMA)
Conference Title : ICCSE 2015 : International Conference on Chemical Science and Engineering
Conference Location : Istanbul, Türkiye
Conference Dates : December 21-22, 2015