European Polymer Journal 47 (2011) 1534–1540

Contents lists available at ScienceDirect

European Polymer Journal

journal homepage: www.elsevier.com/locate/europolj

MACROMOLECULAR NANOTECHNOLOGY

Macromolecular Nanotechnology

Morphology and physical properties of poly(ethylene oxide) loaded graphene nanocomposites prepared by two different techniques

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A R T I C L E I N F O

Article history:
Received 28 December 2010
Received in revised form 26 April 2011
Accepted 7 May 2011
Available online 14 May 2011

Keywords:
Nanocomposites
Graphene
Optical microscopy
Mechanical
Electrical
Casting

A B S T R A C T

Organic–inorganic hybrids are artificially created structures presenting novel properties not exhibited by either of the component materials alone. In this contribution one addresses processing, morphology and properties of polymer nanocomposites reinforced graphene. First, synthesis routes to graphite oxide (GO) and foliated graphene sheets (FGS) are illustrated. Physical characterization of these graphene sheets were conducted using atomic force microscopy and X-ray diffraction techniques. Processing, structure and properties of graphene/poly(ethylene oxide) (PEO) nanocomposites are discussed. FGS was dispersed into PEO via two different composite manufacturing techniques: melt compounding and solvent mixing. Morphology of dispersed graphene and properties from different blending routes are compared. TEM showed that graphene distributed parallel to the composite surface using solvent method, while distributed randomly in melt blended method. Optical measurements indicated that the transparency of PEO/graphene prepared by solvent method is higher than that of melt blended method in the visible region. Electrical conductivity measurements are employed to evaluate threshold concentration for rigidity and connectivity percolation. The percolation concentration of the composites prepared by solvent method is less than those of melt blended method. The mechanical performance of the composites prepared by solvent method is higher than melt blended. Halpin–Tsai model has been used to confirm the distribution of the graphene into PEO by the two different processing techniques.

1. Introduction

Plastics have many outstanding properties: light weight, toughness, good elongation, easy processing and low cost. However, comparing with ceramics and metals, low stiffness, strength, flammability and high permeability to gases and solvents can be their weaknesses. In some applications, higher thermal and electrical conductivity could be advantageous. Reinforcement with nanometer sized fillers can overcome many of these drawbacks if they are well dispersed in the matrix polymer. Most property enhancements can be achieved at significantly smaller loadings than conventional micron sized glass or carbon fibers and resulting "nanocomposites" are much lighter in weight.

Graphene, as an emerging two-dimensional (2D) structure of free-standing carbon atoms packed into a dense honeycomb crystal structure, is being predicted to have numerous potential applications [1,2] because of its unusual electron transport properties and other distinctive characteristics. Various methods have been developed to produce graphene, including mechanical [3], physical [4], and chemical methods [5]. Chemical production of graphene is facile and low-cost and is one of the favored methods for producing graphene. Currently, three major carbon sources are used as starting materials for chemical production of graphene: graphite oxide (GO) [6], expanded graphite (EG) [7], and sieved graphite powder (SGP) [8].

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doi:10.1016/j.eurpolymj.2011.05.011