Iran Polym J (2012) 21:109–120
DOI 10.1007/s13726-011-0008-8

ORIGINAL PAPER

Polylactide/graphite nanosheets/MWCNTs nanocomposites with enhanced mechanical, thermal and electrical properties

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Received: 30 July 2011 / Accepted: 14 November 2011 / Published online: 3 January 2012

Abstract In this study, we have prepared a series of novel biodegradable polymer [polylactide (PLA)]-based nanocomposites using graphite nanosheets (GNs) and multiwalled carbon nanotubes (MWCNTs) by solution-blending technique and investigated their morphologies, structures, thermal stabilities, mechanical and dielectric properties, and electrical and thermal conductivities. Before preparation of the PLA/GNs/MWCNTs nanocomposites, the raw GNs used were endured a rapid expansion by thermal treatment. Temperature of this treatment had some obvious impacts on morphological changes of graphite nanosheets which were verified by means of scanning electron microscope (SEM) and X-ray diffraction (XRD) techniques. Resultant nanocomposites were characterized and evaluated by means of SEM, XRD, thermal conductivity measurements, tensile and impact tests, thermogravimetric analysis and dielectric measurements. Results obtained in this study indicated that thermal-expanded GNs in the presence of MWCNTs facilitate the formation of an appropriate conductive network in PLA matrix which resulted in a relatively low percolation threshold for thermal and electrical conductions of PLA/GNs/MWCNTs nanocomposites. Significant improvements in thermal and electrical conductivities, thermal stability and mechanical properties of PLA/GNs/MWCNTs nanocomposites obtained through the presence of both nanoparticles in PLA matrix were associated with their good co-dispersion and co-reinforcement effects. The macroscopic properties of nanocomposites were found to be strongly dependent on their components, concentrations, dispersion, and the resulted morphological structures.

Keywords Polylactide · Graphite nanosheets · MWCNTs · Nanocomposites

Introduction

Polylactide or poly (lactic acid) (PLA) is a biodegradable aliphatic polyester of lactic acid, a monomeric precursor that can be obtained by natural fermentation from renewable resources, mainly containing starch or sugar. This material has one of the most important situations in the biodegradable polymers market due to its various fields of application. They include a wide variety of biomedical products, packaging materials, fiber production, and more recently, as composites for technical applications. With a tremendous increase in production capacity over the past years, PLA is potentially interesting for engineering applications (electronic and electrical devices, mechanical and automotive parts, etc.) [1–3]. PLA is of increasing interest in industry and academia, because it owns attractive properties comparable with petroleum-based polyolefins [4–6].

Although PLA has balanced properties of mechanical strength, thermal plasticity, and compatibility for short-term commodity applications, the improvement in thermal and mechanical properties of PLA is needed to pursue for

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