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Research paper

High density polyethylene/graphite nano-composites for total hip joint replacements: Processing and in vitro characterization

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ABSTRACT

The main objective of the present study is to investigate how the thermal, rheological, mechanical and cytotoxicity behavior of High Density Polyethylene (HDPE) can be changed by the addition of graphite nano particles (GNPs) at different contents. The HDPE/GNPs composites were prepared using melt blending in a co-rotating intermeshing twin screw extruder. The in vitro tests results showed that the original material (HDPE) and all HDPE/GNPs composites do not exhibit any cytotoxicity to the WISH cell line. The microscopic examination of the nano-composite tensile-fractured surface found a good distribution of GNPs in the HDPE matrix. The Differential Scanning Calorimetry (DSC) results indicated that the crystallization percentage increased by adding GNPs to HDPE up to 4%. The XRD patterns of the HDPE/GNPs composites showed an increase in peak intensity compared to neat HDPE. This increase echoed the crystallinity results obtained from DSC. The rheological tests showed that the complex viscosity of the HDPE increased as the percentage of GNPs increased due to the restriction of the molecular mobility. The tensile test results showed that with increasing the GNPs content, Young's modulus and the yield strength of the HDPE/GNPs composite increased while the strain at fracture decreased. Finally, the preliminary results of the abrasion test indicated that the abrasion rate decreased by increasing the GNPs ratio up to 4% content. The prepared HDPE/GNPs composites appear to have fairly good comprehensive properties that make them a good candidate as a bearing material for the total joint replacement.

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1. Introduction

Polyethylene (PE) is one of the engineering thermoplastics that has excellent biocompatibility and mechanical properties. Its products such as high density polyethylene, HDPE

(Zhil'tsova et al., 2009) and ultra high molecular weight polyethylene, UHMWPE, (Xiong et al., 2009; Saikko and Shen, 2010; Xue et al., 2006) have been used as bearing components in total joint replacements due to their excellent properties.

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