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Compatibilizing effect of mesoporous fillers on the mechanical properties and morphology of polypropylene and polystyrene blend

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ABSTRACT

Polypropylene(PP)/Polystyrene(PS) (PP/PS = 80/20) blend with different types of fillers were prepared by using melt method. Four different types of fillers, namely mesoporous MCM-41 (without template), nano-SiO_2, Polymethylmethacrylate (PMMA)/MCM-41 and PMMA/SiO_2 were considered. For PMMA/MCM-41 filler, the synthesis of the filler consisting of entrapped strand of PMMA within the pores of mesoporous MCM-41 (without template) was described. The mechanical properties of the blend determined as the nano-fillers contents and the different types of blend were found to vary with the different interface between fillers and the matrix. SEM revealed a good interaction between the matrix phases and PMMA/MCM-41 or MCM-41 (without template). The decreased T_g of PS implied that the good adhesion between PP and PS blend was obtained by adding PMMA/MCM-41 nano-filler.

1. Introduction

Polymer blending is a convenient route for the development of new polymeric materials, which combines the excellent properties of more than one polymer. Additionally, many applications request the use of the reinforced materials, and the development of nano-composites has been widely used with this purpose. So far most of the reinforcing nano-fillers such as clay silicates, calcium carbonates and other inorganic solid fillers have stimulated great interest in the field of polymer blends materials [1,2]. As demonstrated by Albano et al. [3] who analyzed the effect of $CaCO_3$ on blends of PP/HDPE found that the addition of this blend at 30 wt.% did not improve the mechanical properties of the blends. To increase its compatibility with the polymer, these nano-fillers are usually treated with various coupling agents or surfactant-like materials exchanging reaction between the modified fillers and the organic group of polymer [4]. However, several publications reported the compatibilizing effect of organoclay on immiscible polymer blends. For example, Gelfer et al. [5] as well as Wang et al. [6] observed a drastic enhancement of the degree of dispersion in blends of PS/PMMA and PS/PP modified with organoclay. Yurekli et al. [7,8] reported that the kinetics and morphological development of phase separated PS/PVME blends were significantly influenced by the presence of organically modified layered silicates.

In contrast to those treated nano-fillers, mesoporous MCM-41 (without template) with nano-particle and nano-channel as reinforcing filler to polymers was used in our previous study. Some examples as MCM-41 (without template) in PP-based, PE-based and epoxy resin nano-composites have been reported [9–12]. The mechanical performance of these nano-composites depends on the adhesion between the dispersed filler and the continuous phases. MCM-41 (with template) nano-filler can also be used as compatibilizer in PP/PS blend which was also reported in our previous paper [13]. The SEM indicated that incorporation of MCM-41 (with template) into PP/PS blend resulted in a decreased particle size of dispersion phase together with morphological evidence of interfacial adhesion.

In this paper, we select MCM-41 (without template), SiO_2, PMMA modified MCM-41 (without template) and PMMA modified SiO_2 as compatibilizer to improve the adhesion between the immiscible PP and PS blend. Different from MCM-41 (without template) and those treated nano-fillers, the methylmethacrylate(MMA) monomer is introduced into the pore channel of MCM-41 (without template) firstly and then is polymerized in the pore to get the modified MCM-41 (without template), namely PMMA/MCM-41. The PMMA chain inside the pore channel extending to the opens can give physical entanglement with matrix polymeric molecules. The main objective of the research here is to analyze the effect of the four different nano-fillers on the tensile performance, fractured surfaces and the dynamic mechanical properties in PP/PS immiscible blend.

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