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Nanocomposites of Polypropylene/Nano Titanium Dioxide: Effect of Loading Rates of Nano Titanium Dioxide

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TiO_2 filled Polypropylene (PP) nanocomposites were prepared with a single screw extruder and then by injection molding of the blends. Water absorption, density, mechanical properties, morphological characterization, FTIR analysis, and the thermal stabilities of the nanocomposites were investigated. The results showed that water absorption decreased and density increased as the amount of nano-TiO_2 added increased. The mechanical properties improved for all formulations with the addition of nano-TiO_2, except for the tensile modulus of elasticity and the izod impact strength. Thermogravimetric analysis (TGA) indicated that the thermal stability of the nanocomposites improved as the amount of nano-TiO_2 increased. The melting and decomposition peaks of DTA increased as nano-TiO_2 was added. The differential scanning calorimetry (DSC) results showed that the melting temperature (*Tm*) increased with the addition of nano-TiO_2. Scanning electron microscopy (SEM) images of the nanocomposites showed uniform dispersion for 0.5, 1, and 2 % TiO_2, but some agglomerations were found on the surfaces and in the fractured sides of the nanocomposites with 4 % TiO_2. The agglomerates were determined by SEM mapping. The changes in the chemical structure of the nanocomposites were determined with Fourier transform infrared (FTIR) spectroscopic analysis. The FTIR results showed that the chemical structures of the composites were similar and that there were no major differences between the composites.

Keywords: polypropylene, TiO_2, nanocomposites, mechanical properties, thermal stability.

1. INTRODUCTION

Polymers are used in many areas, such as automotive, electronics, and different construction equipment. Generally, they are used after being reinforced with various nano fillers to provide unique properties, such as aspect ratio, low weight, and easy formability [1]. These kinds of composites that are reinforced with nano-scale fillers are called 'nanocomposites.' In recent years, nanocomposites have attracted the attention of many researchers because of the significant enhancements in many properties at low loadings [2, 3]. Many researchers have investigated different polymers with various fillers. Polypropylene (PP) is one of the most extensively used polymers due to its ease of processing and low cost. It is used in many applications, such as packaging, textiles, plastics, reusable boxes, laboratory equipment, automotive components, and others. Many types of particles have been used to improve PP's properties, such as its UV resistance, its mechanical properties, and its stability. Titanium dioxide particles have been used for this purpose because they enhance UV stabilization, strength, and antibacterial activity [4, 5]. Titanium dioxide (TiO_2) is an inexpensive and non-toxic semiconductor, and it enhances the properties of polymers, allowing the development of new nanocomposites with enhanced behaviours [6].

Altan and Yildirim [4] investigated the properties of PP/TiO_2 nanocomposites, and their results indicated that composites with TiO_2 had better mechanical properties than pure PP. The mechanical properties of the composites varied according to the dispersion, and low loadings with uniform dispersion were found to produce better mechanical properties. Yang et al. [7] also studied the mechanical properties of PP/TiO_2 nanocomposites, and their results indicated that the mechanical properties improved with nano-TiO_2 particles in the polymer. Zohrevand et al. [8] worked on the thermal stability and mechanical properties of PP/TiO_2 nanocomposites. The results showed that the thermal properties of the nanocomposites were affected significantly by the dispersed particles. The TiO_2 particles decreased the elastic modulus and yield strength of the nanocomposites. Micromechanical analyses showed that there was enhanced interaction between the organic and inorganic phases of the nanocomposites. In other studies of polypropylene/TiO_2 blends, the mechanical properties of the blends were found to be improved by the addition of nano-TiO_2. Incorporation of nanoparticles improves the thermal stability of PP. DSC analysis also showed that an improvement in crystallinity was observed when the nano-TiO_2 particles were added [9]. In this study, it was investigated the effects of different loadings of hydrophilic, nano-sized titanium dioxide particles (nano-TiO_2) on the thermal stability, mechanical properties, and morphological characteristics of polypropylene (PP) composites.

2. MATERIALS AND METHODS

2.1. Materials

Polypropylene (EH241) was supplied by PETKIM, Inc., Turkey. The properties of the PP are listed in Table 1.

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