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Research Article

Synthesis and Physicochemical Behaviour of Polyurethane-Multiwalled Carbon Nanotubes Nanocomposites Based on Renewable Castor Oil Polyols

Alaa Ali,[1,2] Kamal Yusoh,[1] and S. F. Hasany[1]

[1] *Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang, 26300 Kuantan, Malaysia*
[2] *Department of Chemical Engineering, University of Technology, Baghdad, Iraq*

Correspondence should be addressed to Alaa Ali; allavip63@yahoo.com

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Polyurethanes (PUs) are high performance materials, with vast industrial and engineering applications. In this research, effects of Multiwalled Carbon Nanotubes (MWCNTs) on physicochemical properties of Castor Oil based Polyurethanes (COPUs) were studied. MWCNTs were added in different weight percentages (0% to 1% wt) in a castor oil based polyurethane (COPUs-MWCNTs) nanocomposites. The composition, structure, and morphology of polyurethanes were characterized by Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), scanning electron microscopy (SEM), field emission scanning electron microscopy (FESEM), and element detection by energy dispersive spectroscopy (EDX) analysis, respectively. Thermal stability was studied by thermogravimetric analysis (TGA). Barrier properties and surface area studies were investigated by nitrogen permeability machine and BET technique. Mechanical properties were calculated by tensile universal testing machine. Results showed well dispersed MWCNTs in polyurethane matrix at different weight percentages. The best results were obtained with 0.3 wt% of MWCNTs in the composite. Surface area studies revealed presence of very few pores which is in a good agreement with barrier permeability, reduced up to ~68% in 1 wt% and ~70% in 0.5 wt% of MWCNTs in polymer matrix, with respect to pure COPUs samples.

1. Introduction

Polyurethanes are versatile polymeric materials with extensive demand due to exceptional physical properties (e.g., high flexibility, high tensile strength, tear and abrasion resistance, solvent resistance, etc.) and high versatility in chemical structures (discussed by Lu and Macosko [1]; reported by Cao et al. [2]; studied by Oprea [3]; discussed by Akintayo et al. [4]). Footwear, machine industry, coatings and paints, rigid insulations, thermoplastic, foams, and medical devices (discussed by Yusoh et al. [5]; reported by Krushna and Nayak [6]; and discussed by Bhuva Bharat [7]) are some important industrial applications. Polyurethanes are generally synthesized by the polyols derived from the petrochemical industry (reported by Kong et al. [8]; discussed by Lligadas et al. [9]; and studied by [10]). The synthesis involves a poly addition polymerization reaction between organic isocyanate and polyol.

Due to large consumption of PUs, a huge demand of utilization of renewable resources is always a critical job for researchers, to overcome environmental and price controlling issues related with a petroleum industry (discussed by Fan et al. [11]; reported by Spontón et al. [12]). Chang and Lu [13] depicted novel polyols made from modified castor oil (MCO) that was synthesized using a transesterification process with the glycerol competing with the petroleum polyols to overcome the environmental concerns and rising prices of the mineral oil industry. The commercial utilization of biodegradable polymers has become an active research area during past decades due to potential advantages compared with synthetic petroleum polymers owing to their biodegradable properties (discussed by Xu et al. [14]; studied by Baruah [15]). Yuan [16], in his thesis, presented polyol derived from soybean oil; however, this has some major disadvantages that limited its applications. Polyurethane based on polyols derived from different vegetable oils, like castor (discussed by Yeganeh and Hojati-Talemi [17]; studied by Corcuera et al. [18]), soybean (reported by Ismail et al. [19]; discussed by