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SYNTHESIS AND CHARACTERIZATION OF POLYURETHANE/MICROCRYSTALLINE CELLULOSE BIONANOCOMPOSITES

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Abstract: Polyurethane/microcrystalline cellulose bionanocomposite were prepared by adding microcrystalline cellulose (MCC) in a polyurethane matrix. The naostructure of this polyurethane was characterized by Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), transmission electron microscopy (TEM) and thermogravimetric analysis (TGA). The resulting nanocomposites show improved the mechanical properties due to good interaction, by both covalent and hydrogen bonds, between the polyurethane and the microcrystalline cellulose.

Keywords: Polyurethane, Bionanocomposite, Microcrystalline cellulose

1. INTRODUCTION

Polymer nanocomposites have attracted great interest during recent years. One reason is the potential for significant improvements in mechanical properties already at very small volume fractions of the reinforcing phase [1]. Examples of reinforcements include clay minerals and carbon nanotubes. In the context of biopolymer-based reinforcement, cellulose is of major interest because the experimentally measured axial Young ′ s modulus of the cellulose crystal is 134 GPa [2]. cellulose has a major load-bearing function in many plants and is present in the form of microfibrils, consisting of aligned threadlike bundles of poly-β(1, 4)-D-glucose molecules in extended-chain conformation. In the microcrystalline, the molecules are stabilized laterally by hydrogen bonds between hydroxyl group and oxygens of adjacent molecules [3]. The small size of the typical lateral dimension (20-40 nm) combined with potential lengths of several μm provides very high aspect ratio at small scale [4]. MCC is obtained by acid hydrolysis of cellulosic fibers, and typical dimensions of dispersed MCC nanofibrils are 20 nm in diameter and around 200 nm length [5, 6]. In the present article, we report the synthesis and characterization of polyurethane/microcrystalline cellulose (PU/MCC) bionanocomposites. The resulting nanocomposites were investigated using Fourier transform infrared (FT-IR) spectroscopy, thermogravimetric analysis (TGA), X-ray diffraction (XRD), andtransmission electron microscopy (TEM). In addition, mechanicalproperties of nanocomposites are also investigated.

2. EXPERIMENTAL

2.1. Materials

All chemicals were purchased from Fluka Chemical Co. (Buchs, Switzerland), Aldrich Chemical Co. (Milwaukee, WI), Riedel-deHaen AG (Seelze, Germany) and Merck Chemical Co. N,N-Dimethylacetamide (DMAc, Merck) was purified by distillation under reduced pressure over barium oxide. Microcrystalline cellulose was purchased from Sigma–Aldrich. N,N-Dimethylformamide (DMF, Merck), toluene-2,4-diisocyanate (TDI, Aldrich), phenolphthalein (PHP, Merck), lithium chloride (99%, Sigma), and1,4-butanediol (1,4-BG, Fluka) were used as received.