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ORIGINAL PAPER

Degradation of linear low-density polyethylene/poly(vinyl alcohol)/kenaf composites

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Abstract The interest of this study was to examine various kenaf (KNF) loadings and burial time, and their effects on degradability behavior of linear low-density polyethylene/poly(vinyl alcohol)/kenaf (LLDPE/PVOH/KNF) composites in soil. The LLDPE/PVOH/KNF composites with various KNF loadings were melt-mixed in a Thermo Haake internal mixer. The composites were buried in soil and their extent of degradability was assessed by tensile properties, morphological study, and weight loss and crystallinity measurements of the degraded composites. Fourier transform infrared spectroscopy was utilized to monitor the changes in chemical structure of the composites before and after degradation in soil. The results showed that with increase in KNF loading, the tensile modulus increased; meanwhile, the tensile strength and elongation-at-break of the degraded composites were dropped. Tensile properties of the degraded composites were decreased with prolonging soil burial time. The formation of cracks and pores was observed in field emission scanning electron microscope micrographs. By measuring the weight loss in LLDPE/PVOH/KNF composite samples before and after the soil burial testing and differential scanning calorimetry measurements, it was found that the weight loss and crystallinity of the composites increased with soil burial time. The degradation of the composites was confirmed by the formation of a strong absorption band assigned to carbonyl groups.

Keywords Linear low-density polyethylene/poly(vinyl alcohol) · Kenaf · Composites · Soil burial · Degradability

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Introduction

Polyethylene (PE) and polypropylene (PP) are among the popular thermoplastics that have attracted applications in various packaging industry, owing to low cost and their relatively good mechanical characteristics [1–3]. However, these polymer materials have aggravated significant environmental problems because of their stability, and that it may take hundreds of years to degrade when they are buried in typical solid waste sites [4–6]. Therefore, all over the world, the development of environmentally friendly polymer products is highly encouraged. Several attempts have been made to reduce the environment impact using degradable synthetic polymer and/or renewable natural polymer resources as the raw materials [7–9]. Renewable natural resources can be used in the form of natural fibers including cellulose, starch, and chitosan [10]. The introduction of renewable natural resources into the non-degradable polymers is the cheapest alternative to produce the partially degradable polymer composites [2]. Kenaf fiber, as a renewable natural resource, is widely utilized as filler/reinforcement in natural fiber polymer composites due to its low cost, biodegradability characteristics, high specific mechanical properties, and abundant availability [11–13].