POLYURETHANE/GRAPHENE NANOCOMPOSITE FILMS WITH ENHANCED GAS BARRIER AND WEATHER RESISTANCE PROPERTIES

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ABSTRACT

In this study, functionalized graphene has been potentially used for improving gas barrier and weather resistance properties of thermoplastic polyurethane (TPU) film. TPU/graphene nanocomposites were prepared in combination of a solution based master-batch preparation and finally melt-mixing in a twin screw, where the concentration of graphene in polyurethane matrix was varied from 0.5 wt% to 3wt%. SEM and TEM were used to observed graphene dispersion in the polyurethane matrix, showing exfoliated nanocomposite structure. After melt-mixing the extrudate TPU/graphene nanocomposite chips were used to prepare film in a compression molding machine. The nanocomposites films were exposed in accelerated artificial weathering in a weatherometer following ISO 4892 method and controlling the irradiation, temperature, humidity and rain cycle. The exposure was done using a Xenon-arc lamp for 300h and evaluated after each 100h exposure.

The tensile strength of the nanocomposite films increased with increasing graphene concentration up to 1.5 wt%, but no significant change was observed at higher concentration. Percentage breaking extension reduced slightly for nanocomposite films compared to neat TPU film. The helium gas permeability through the nanocomposite films gradually reduced with increasing graphene concentration in the polyurethane matrix, showing about 30% improvement in barrier properties at 3 wt% loading of graphene. Due to the excellent UV absorption capability of graphene, the weather resistance property of nanocomposite films improved significantly compared to neat polyurethane film. As a consequence, the nanocomposite films reinforced with 2-3 wt% graphene showed excellent weather resistance property which resulted in (i) significant increase in UPF values, (ii) reduction in photooxidative index and carbonyl index and (iii) very good retention in tensile and gas barrier properties even after 300h exposure. After exposure in accelerated artificial weathering, the change in surface morphology of the films was analyzed by SEM and the change was very insignificant in case of TPU/graphene nanocomposite films in comparison to neat TPU films, indicating a significant improvement in weather resistance of nanocomposite films.