THE INFLUENCE OF TiO_2 NANOPARTICLES ON THERMAL DECOMPOSITION OF POLYURETHANE HARD SEGMENTS

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Abstract

Polyurethanes are one of the most versatile materials, used in countless commercial applications, mainly because of their outstanding performances. Due to the constant market need to push the boundaries of quality, even with proven good materials, the incorporation of various nanoparticles has become an established method for properties enhancement of polymer-based materials. Therefore, the goal of this work was to investigate the influence of TiO_2 nanoparticles on thermal degradation and thermal degradation kinetics of the hard segments of polyurethane network based on polycaprolactone and aliphatic hyperbranched polyester. For that purpose, two composites were prepared by embedding 1.0 wt.% of unmodified or surface modified TiO_2 nanoparticles into polyurethane matrix. Modified TiO_2 nanoparticles were prepared by their surface modification with lauryl gallate. In order to explore the influence of TiO_2 nanoparticles on thermal degradation kinetics of polyurethane network, thermogravimetric analysis at different heating rates in nitrogen atmosphere was conducted and obtained results were compared with results gathered for pure polyurethane. Model-free iso-conversional Ozawa-Flyyn-Wall method was applied to evaluate kinetic energy of thermal degradation at various degrees of conversion. Furthermore, Coats-Redfern model-fitting method and forty kinetic models were checked to find the one that can adequately describe the degradation mechanism of the hard segments in prepared samples. Obtained results revealed that the presence of unmodified or modified TiO_2 nanoparticles led to the small decrease of the temperature of maximum thermal degradation rate of weak urethane bonds in hard segments. Also, due to the lower crosslinking density, maximum thermal decomposition rate of examined composites was visibly diminished in comparison to the pure polymer. After application of different kinetic model functions through Coats-Redfern equation, it was established that in the case of pure polyurethane network and composite prepared with unmodified TiO_2 nanoparticles, thermal degradation of urethane linkages can be described by power law model, while two-dimensional diffusion is the best fitting kinetic model for describing thermal degradation mechanism of urethane linkages in composite prepared with modified TiO_2 nanoparticles.

Keywords: *polyurethane, TiO_2 nanoparticles, composites, thermal degradation, kinetics.*

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