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PU/POSS nanocomposites: synthesis, structure, thermal properties

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The nanocomposites based on polyurethanes/polyhedral oligomeric silsesquioxans (PU/POSS) were synthesized via two-step polymerization. Polyether polyol with Mw 5003 and the adduct of trimethylol propane with toluylene-2,4-diisocyanate were used as components of PU matrix of the nanocomposites. 1,2-Propanediolisobutyl-POSS (POSS-diol) was used as inorganic nanofiller with reactive OH-groups.

The effect of POSS content (1 - 10 wt%) on the structural and thermal properties of the nanocomposites were investigated. The structure of created materials were characterized with Fourier transform infrared (FTIR) spectroscopy. FTIR spectra showed chemical bonding of POSS-diol and PU matrix.

Thermal properties of PU/POSS nanocomposites were studied using dynamic scanning calorimetry (DSC) and thermogravimetric analysis (TGA). From the DSC data the glass transition temperature (T_g) of the nanocomposites were found to increase with increasing POSS content from T_g=-61,2ºC (pure PU) to T_g=-58,9ºC (PU/POSS with 10 wt% POSS). According to the TGA data at loadings of 1 wt% of POSS an increase in onset degradation temperature (T_{onset}) from 270ºC for pure PU to 294ºC for the nanocomposite is observed. For PU/POSS nanocomposites with 10 wt% POSS T_{onset}=291,4ºC. Maximum of the thermal decomposition temperatures, defined as the second maximum of the TGA curves, shifts towards higher temperatures with increasing POSS content: from 376ºC for pure PU to 379ºC and 382ºC for the nanocomposites with POSS content 1 and 10 wt.%, respectively.

The morphology of PU/POSS nanocomposites was studied by scanning electron microscopy (SEM). It was found that comparatively homogeneous structure of PU becomes more segregated with increasing POSS content in PU/POSS samples. The POSS particles aggregation in the form of rectangular microdomains at maximum POSS content was observed.

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