Nanocomposites and nanomaterials

Effect of silane coupling agent on mechanical properties of PU/SiO_2 nanocomposites

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Development of new polymer composites with improved mechanical properties attracts much scientific and industrial interest last years. Among them the most popular are organic-inorganic nanocomposites (OIC) based on alkali silicates and isocyanates. These composites have found their applications as protective coatings, sealants, binders etc. Modification of composite constituents allows to control structure and properties of such materials. In this work effect of 3-(triethoxysilyl)propylamine on mechanical properties of OIC based on polyurethane (PU) and condensed sodium silicate was studied.

PU was synthesized from urethane oligomer based on 2,4-toluenediisocyanate and linear poly(propylene glycol) (trade mark PPG-1052) with molar ratio 2:1. NCO-groups content in urethane oligomer was 5 wt.%. Water-soluble sodium silicate ($nNa_2O{\cdot}mSiO_2{\cdot}wH_2O$, m:n = 3.1, water content – 52 wt.%) was used as inorganic precursor. Organic to inorganic constituents ratio in OIC was 60:40 wt.%. Concentration of silane coupling agent was 5 wt.%.

Mechanical properties of initial and modified PU/SiO_2 nanocomposites were studied. The results obtained show that OIC has increased tensile strength (up to 4.8 MPa) and elongation at break (about 500%) comparing to unmodified composite (3.1 MPa and 350% respectively). This could be explained by composite's structure peculiarities.

The morphology of OIC prepared was studied by scanning electron microscopy. It was revealed that the presence of silane agent leads to the size-decreasing of silicate particles (from 2.3 to 0.7 nm) formed in situ. This effect provides decreasing of heterogeneity and formation of compact structure of OIC. Such phenomena result in improved mechanical properties of silane-containing OIC comparing to unmodified nanocomposite.