Nanocomposites and nanomaterials

Nanocomposites based on polyurethaneuerea, modified montmorillonite and sodium silicate

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Progress in science and engineering is closely associated with involving of new materials with improved mechanical and physical properties. An important place among them belongs to the polymer nanomaterials consisting of organic and inorganic constituents – so called organic-inorganic nanocomposites (OIN). Industrial and engineering demands for the new nanocomposites with complex of useful properties, availability of the source of raw materials make the development of nanomaterials one of the topical and high-priority problems in material science. Some kinds of nanocomposites are called *«smart materials»* thanks to their extraordinary unique and specific parameters. These *«smart materials»* are able to respond on environmental changes and their properties are varied depending on application conditions. The aim of the present work was the development of OIN based on polyurethaneurea, montmorillonite nanofiller and sodium silicate.

Polymer matrix was synthesized from urethane oligomer based on 2,4-toluenediisocyanate and linear polypropyleneglycol (trade mark PPG-1052) with molar ratio 2:1. NCO-groups content in urethane oligomer was 5 wt.%. Water-soluble sodium silicate (SS) having general composition $nNa_2O \cdot mSiO_2 \cdot wH_2O$ was used as inorganic precursor. Silicate modulus (m to n ratio in sodium silicate composition) was 3.1, water content – 52 wt.%. Montmorillonite (MMT) modified with octadecylamine was used as natural filler. MMT was used as a 20 wt.% suspension in sodium silicate solution. MMT Concentrations of organic and inorganic constituents in OINs were 70:30 and 60:40 wt.% respectively.

Any visible inclusions and no foaming in obtained films-like samples of OIN were not detected. Mechanical characteristics of composites have been studied in tensile mode. It was revealed that introduction of the natural nanofiller improves slightly tensile strength (from 2.0 MPa to 2.4 MPa) and elongation at break (from 325% to 425%) comparing to the unfilled samples. These results could be explained by the formation of the developed three-dimensional structure of composites in the presence of the nanofiller. It is well known [1] that layered silicates including montmorillonite undergo delamination (exfoliation) under appropriate conditions such as external shearing force application or separating force during the swelling in hydrophilic medium. The procedure of OINs samples preparation mentioned above allow us to expect an enormous swelling of MMTs particles in SS solution followed by increasing of interlayer spacing up to the total exfoliation forming developed surface. Organically modified MMT has increased compatibility to the polymer matrix providing additional reinforcement comparing to the unfilled OINs.

Water-sorption characteristics of the OINs have been studied as well. It was revealed that introduction of the nanofiller increased sorption capacity of OINs. On the first stage a rapid mass increase owing to the saturation was observed. Reaching a maximum sorption capacity turned to decreasing up to the equilibrium. All OINs studied reached their maximum of sorption capacity (up to 400%) during 3 days independently of the MMT content. Such behavior could be explained by the presence of the natural nanofiller that adsorbs water and holds it back in the structure. The peculiarities of the OINs structure as well as effect of small additives on the structure formation process define the character of OINs sorption dependences.

Thus films-like nanocomposites based on polyurethaneurea, modified montmorillonite and water-soluble sodium silicate were developed. Improved mechanical and sorption properties of the synthesized compositions provide their application as short-term packing materials.

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1 Polymer-clay nanocomposites / eds. T.J. Pinnavaia, G.W. Beall – Chichester: John Wiley & Sons Ltd., 2000. – 349 p.