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Programme and Abstracts

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STRUCTURE AND PROPERTIES OF EPOXY-SILICA AND EPOXY-TITANIA COMPOSITES OF CATIONIC POLYMERIZATION

Natalya Leonova, Svetlana Zhiltsova

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Epoxy polymers possess high mechanical, electrical, and adhesion properties. But one of the negative features of highly-crosslinked systems is their brittleness. The introduction of fillers obtained by the sol-gel method affords a decrease in the brittleness and increase in the operational characteristics.

Epoxy-silica composites of cationic polymerization based on epoxy resin Eponex 1510 (dicyclohexylolpropane diglycidyl ether) and tetraethoxysilane were synthesized. The catalyst for cationic polymerization was the complex of boron trifluoride with benzylamine (UP 605/3r). The epoxy-silica composites were obtained according to the procedure described in [1]. Highly dispersed TiO_2 nanoparticles were synthesized by hydrolytic polycondensation of titanium tetrabuthoxide (TBT) in the presence of epoxy resin, solvent and water at ambient temperature. Glacial acetic acid was added to TBT before mixing with other components to reduce the hydrolysis rate. Curing process of composites was 100 °C 1 h; 120 °C 2 h; 140 °C 2 h; 160 °C 2 h. All the received materials demonstrated high optical transparency.

The influence of the nano-sized filler on the structure and dynamic mechanical properties of the epoxy-silica systems of cationic polymerization were investigated. It was found that the effect of small additions in the composites takes place: at the concentrations of SiO_2 0.5–1.5 wt.% the high elasticity modulus and the concentration of internodal chains increase and the glass transition temperature reduces. Increase of concentration of silica particles' in the composites to 2.0–3.0 wt.% leads to imperfection of topological structure of epoxy resin and increasing of molecular weight of internodal chains of polymer network. Investigation of thermophysical characteristics of the epoxy-silica systems showed that filler introduction leads to decrease in crosslink density and glass-transition point owing to the changes in the topological structure of composites. The resulting polymers have heterogeneous structure that contains regions with increased molecular mobility showing their own values of the glass-transition point. Similar dependence was observed for the synthesized epoxy-titania nanocomposites. The higher the filler content the lower the glass transition point and sol-fraction yield. Despite decrease of network density of the composites compared to unmodified epoxy polymer, the received epoxy-silica and epoxy-titania materials demonstrate increased stability to thermal oxidation.

The obtained epoxy-inorganic composites can be used as adhesives and protecting coatings. It was established that the received epoxy-silica composites of cationic polymerization provide for the high adhesion of coatings to aluminum substrate already at low filler concentration in the system. The lattice-cut method was used to estimate the adhesion of the unmodified polymer and hybrid materials to D16 aluminum alloy surface. It was shown that an increase in the adhesion from three points to one is observed already at the introduction of 1 wt.% of SiO_2. The impact adhesion strength of the epoxy-silica films on D16 aluminum alloy was estimated. All the tested coatings possess the maximum impact strength (50 kgf cm). After tests with the D16 alloy plates coated with the composite, no mechanical damages, cracks, layering, and crumpling were observed. It was determined using potentiodynamic method that effectiveness of corrosion protection of surfaces of aluminum alloy D16 by epoxy-titania composite coatings is 96.2–99.6 % and for epoxy-silica composite coatings is 98.4–99,9 %.

[1] N. G. Leonova, V. M. Mikhal'chuk, L. A. Savenkova, and V. A. Beloshenko, Vopr. Khim. Khim. Tekhnol., No. 1, 48–53 (2009).

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