Nanocomposites and nanomaterials

Epoxy-titania nanocomposites of cationic polymerization received via the sol-gel method

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Sol-gel method is widely used for the synthesis of homogeneous composites with in situ formed nanoparticles. This technology utilization results in optically transparent high performance materials with enhanced properties compared to unmodified polymer or polymer filled with particles by mechanical mixing. In particular, epoxy resin – titania composites with adjustable structure, optical, dielectric and mechanical properties may be obtained. The goal of this work was sol-gel synthesis of optically transparent epoxy-titania nanocomposites by cationic polymerization and investigation of their properties.

Diglycidyl ether of dicyclohexylolpropane (EPONEX 1510) was used for polymeric matrix formation. Polymerization process was catalyzed by complex of BF_3 with diethyleneglycole. 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 hydrolysis rate. Solvents used in the sol-gel process were ethanol (EtOH), methylethylketone (MEK) and tetrahydrofuran (THF). Nanofiller amount was varied from 0.5 to 2 mass.%. Curing process of composites was 100 °C 1 h; 120 °C 2 h; 140 °C 2 h; 160 °C 2 h. The received materials demonstrated high optical transparency.

It was shown that solvent used results in different network density of the composites: glass transition temperature decreases and sol-fraction yield increases in the range MEK – THF – EtOH. Such effect may be caused by kinetic chain termination in the presence of EtOH and by cleavage of THF cycle and its reaction with epoxy ring during polymerization process. Despite reduction of network density of composites compared to unmodified epoxy polymer, received materials demonstrate increased stability to thermal oxidation: oxygen uptake by 0.2 μm composite film is three times slower than that of the neat polymer. It was also shown that synthesized nanocomposites might be used as anticorrosive coatings for aluminium alloy D16. Corrosion current density decreases by three orders of magnitude for sample with 1.5 mass.% of TiO_2 compared to bare aluminium alloy.