

EPOXY NANOCOMPOSITES WITH TUNABLE MATRIX

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Incorporation of inorganic nanoparticles in polymer network materials capable to change reversibly their topology as a result of interchain exchange reactions [1] can improve the materials [2] and impart them new properties.

The present paper is devoted to the synthesis and investigation of properties of epoxy nanocomposites (ENs) containing 10-15-nm SiO₂ spherical nanoparticles (NPs) with phenyl and anhydride surface groups providing, respectively, weak non-covalent and strong covalent binding of NPs with polymer matrix. ENs were prepared by curing of 4-epoxycyclohexylmethyl-3,4-epoxycyclohexane-carboxylate ERL-4221 with 4-methylhexahydrophthalic anhydride in the presence of zinc acetylacetonate (ZA) a catalyst of transesterification reaction and NPs.

It was found that the glass transition temperature T_g of ENs increases with increasing content of anhydride-modified NPs from 0.5 to 5 wt%, which is due to cross-linking of polymer chains by NPs that reduces a segmental mobility. Moreover, incorporation of only 1 wt% of anhydride-modified NPs improves mechanical properties of ENs: strength at break and elasticity modulus show a 2- and 1.5-fold increase, respectively.

The prepared nanocomposites are able for reprocessing, self-healing and welding. Investigation of the welding properties of ENs by the lap-shear test had shown that the rupture of welded connection occurred in the bulk material (out the welded interface) and depended on the character of the interaction between surface functional groups with epoxy chains as well as on NPs and ZA concentrations. The optimum concentration of ZA at which it is possible to achieve the optimum rate of the transesterification reaction for effective reprocessing, self-healing and welding without significant deterioration of mechanical properties and reduction of T_g was determined.

References

1. Montarnal D., Capelot M., Tournilhac F., Leibler L. Science, 2011, 334, 965.
2. Barabanova A.I., Philippova O.E. Patent RU 2638169 C2, 12.12.2017.

Acknowledgment. The work was financially supported by Russian Science Foundation (project № 17-13-01535).