ABSTRACT

Rheokinetics of epoxyphosphazene curing

Relevance of the research and the degree of its development

Epoxy resins are one of the most widespread classes of resins, taking the second place in the world after polyester resins. Epoxy resins are outstanding in the adhesion to many substrates, high physical and mechanical characteristics, chemical resistance, electrical and corrosion resistance, and low cost. The disadvantages of the matrices used include low heat resistance, high flammability, and low impact resistance. Today resins based on epoxy oligomers are used in aircraft, automotive, shipbuilding as interior and structural polymer composite materials (PCM), etc.

In the context of modern trends of an import substitution, energy efficiency and environmental ecology, the study of new modifiers that could be produced in Russia.

The epoxyphosphazene oligomer proposed as a modifier for epoxy-amine matrix, patented at Mendeleev University of Chemical Technology of Russia, has a simple scalable technology of production. Synthesis and study of epoxyphosphazenes at the Department of Chemical Technologies of Plastics under the leadership of V.V. Kireev. have been practicing for over 30 years. Recently, the study of D.V. Onuchin on the properties of epoxyphosphazene polymers has been appeared, in which it was shown their promise of use in the field of matrices for PCM.

The purpose of work was to establish of rheokinetic patterns of curing of epoxyphosphazene resins and development of formulations with improved thermal and physical-mechanical properties.

To achieve the purpose it was necessary to solve the following tasks:

• to establish rheokinetic patterns of the curing process of epoxyphosphazene compositions;

• to establish the regularities of the effect of epoxyphosphazene on the spatial network of the cured polymer;

• to establish relationships between polymer network and thermal characteristics.

Scientific novelty

The effect of epoxyphosphazene on the kinetics and rheokinetics of epoxy-amine matrix curing by model and isoconversion approaches has been studied. Kinetic models of isothermal and non-isothermal curing have been constructed. It was determined that:

• the introduction of epoxyphosphazene accelerates the process of increasing viscosity at all stages of the structuring process;

• the isothermal curing of the compositions can be satisfactory fitted by the second-order kinetic equation and by 1-order equation with self-braking, and non-isothermal curing has a model of two-stage kinetics with the Prout-Tompkins equations;

• the introduction of epoxyphosphazene leads to a greater contribution of the diffusion control over curing.

It was shown that the introduction of epoxyphosphazene increased the rigidity of the network and, as a consequence, the glass transition temperature and the temperature of the β-transition was increased.

Theoretical and practical significance of the work

The results made it possible to expand the understanding of the rheokinetics of curing of epoxophazene compounds.

As a result of the studies carried out, the optimal epoxyphosphazene fraction in compositions with DGEBA and DDS in an amount of 10 wt% was determined, allowing to achieve improved physical and mechanical characteristics and an increase in the heat resistance of the polymer matrix. The possibility of production PCM by the winding method was shown.

The following are submitted for defense:

• Rheokinetics and features of the curing process of epoxyphosphazene compositions;

• Regularities of the effect of epoxyphosphazene on the spatial network of the cured polymer;

• The relationship between the properties of the networks and the thermal and mechanical characteristics of the cured test binders.