CALORIMETRIC SCREENING OF INTERFACIAL INTERACTIONS IN GLASS POLYMER COMPOSITES

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Polymer nanocomposites consist of two phases: a polymeric matrix phase and an inorganic filler phase. The creation of multicomponent filled polymer composites is aimed at forming new materials with the combined properties of a polymer matrix and a disperse filler.

Recent decades have seen a considerable growth of interest in filled composites owing to the development of nanotechnologies and the use of nanodispersed fillers. With an increase in the degree of dispersion of the filler, the fraction of the polymer at the interface tends to increase and the interfacial effects become more pronounced. A considerable number of studies have indicated that the energetics of interfacial interactions plays the decisive role in the description of properties of composite polymer materials and phenomena occurring at the interface. Thus, structuring of the polymer at the interfacial layer, formation of adsorption layers, densification or loosening of the polymer matrix, and the effect of polymer reinforcement in the presence of fillers are usually attributed to the manifestation of interfacial interactions.

The experimental investigation of interfacial phenomena in the condensed multiphase superfine system is a complicated problem. One of the approaches to solving this problem includes measurement of increments for basic thermodynamic functions of the system during introduction of the filler into it and formation of corresponding structures linked to the interfacial layer.

The enthalpy of mixing of composites based on a glassy polymer matrix filled with particles was estimated by calorimetric method. The alternating sign pattern of the enthalpy of mixing was established. This parameter assumed negative values in the case of composites with a high content of the polymer and positive values at a high content of the filler. It was suggested that the alternating sign pattern of the concentration dependence of the enthalpy of mixing is related to superposition of the effects of adhesion interfacial interaction on the filler surface and the effect of additional vitrification of the polymeric matrix in the filled composite. To account for these two processes, the equation for the dependence of the enthalpy of mixing of the polymer with the filler on the composite composition was proposed. Application of this equation to a range of glassy polymers in combination with nanodispersed fillers demonstrated that the model good corresponds to experiment.

Calorimetric screening using the proposed model allows us to solve the following problems in the of glass polymer composites: the influence of the polymer nature, the efficiency of filler surface modification, particle aggregation, and the influence of particle shape and size on interfacial interaction.