THERMODYNAMIC PROPERTIES OF THE MATERIAL OF INTERFACIAL FORMATIONS

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Melting point is a key parameter characterizing the thermal stability of nanomaterials. The thermodynamic properties of nanomaterials differ significantly from their bulk counterparts due to the high proportion and number of surface atoms within the particle, as well as size effects. Nanostructures are known to be characterized by increased internal energy, lower melting point, anomalous heat capacity, and reduced thermal conductivity.

The aim of this study is to evaluate the influence of the nature of the solvent and acid on the melting point of the interfacial material, which spontaneously forms in the interface of a heterogeneous liquid system consisting of an aqueous solution of a metal salt and an acid solution in a non-aqueous solvent immiscible with water.

The material interfacial formation (MIF) was obtained as follows. A cylindrical cell with an interfacial area of 14 cm^2 was charged with 8 ml of a solution with the higher density (0.1 M aqueous metal salt solution or 0.1 M acid solution in chloroform). Then, 2 ml of a solution with the lower density (0.1 M acid solution in toluene (heptane) or 0.1 M aqueous metal salt solution) was carefully poured along the cell wall. After 2 hours, the interfacial material was collected from the interface with a spatula. It was washed with water and the organic solvent (heptane, toluene, or carbon tetrachloride) used in the synthesis and dried for 24 hours in air. To determine the melting point, a sample of crushed dry MIF was added to a clean, dry, thin-walled capillary made of heat-resistant glass, 1 mm in diameter and 20 mm long, sealed at one end. The filled capillary was placed in an SMP50 melting point apparatus. To determine particle size, dry samples were dispersed in an appropriate solvent under ultrasonication for 1 hour. Particle size distribution curves for the dispersed MIF were then recorded using a Nanoflex II apparatus.

The data obtained indicate that the melting point MIF of the based on di-(2-ethylhexyl)phosphates of cerium rare earth elements (160 ± 10^0) is lower than that of yttrium rare earth elements (110 ± 10^0), due to a lower crystallinity and higher water content in the material. The effect of particle size on melting point can be explained by the surface pressure acting on the material. Since it is inversely proportional to particle size, the Gibbs free energy increases, and consequently, the melting point decreases. In heptane-based systems, the accumulation of both di-(2-ethylhexyl) phosphates and metal stearates in the interfacial layer is higher than in toluene- and chloroform-based systems. The MIF based on metal stearates is characterized by a lower melting point, which is due to a lower crystallinity and higher water content in the material.

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