Article ID: 1003-7837(2005)02,03-0272-01

Phase transitions in confined nanoparticles

Baryshnikov S. V.[1], Charnaya E. V.[2], Andriyanova N. P.[1], Stukova E. V.[1]

(1. The Blagoveshchensk State Pedagogical University, Blagoveshchensk, Russia; 2. Institute of Physics, St. Petersburg State University, Petrodvorets, Russia)

Recently a great deal of attention in solid state physics was paid to studies of size effects on properties of materials. In particular, numerous theoretical and experimental researches carried out for small particles have revealed pronounced changes of their physical properties upon size reduction. Size effects also influence strongly phase transitions of various nature.

One of the ways to produce small particles consists in embedding the substance under study into a porous matrix, which characteristic pore size is in the nanometer range.

In the paper results of studies of the superionic transition in AgI, embedded into mesoporous matrices, of the ferroelectric phase transition in confined $NaNO_2$ and the melting-freezing phase transition in $NaNO_2$ within nanopores are presented.

The silicate materials SBA-15 and MCM-41 were used as matrices. These materials have a hexagonal structure like cells with the thickness of the walls 0.6-0.8 nanometers and the calibrated size of channels-pores: SBA-15-52 A, MCM-41(C-16)-37 A, MCM-41(C-12)-20 A. After embedding the substances in the powder mesoporous sieves, the samples were pressed as tablets with the 10 mm diameter under the pressure of 5000-6000 kg/cm^2. The measurements of the electric properties were carried out at a frequency of 1 MHz using the RLC gauge-E7-12. The In-Ga paste was applied as electrodes. The measurements were carried out in the temperature interval covering the phase transition area.

The results obtained showed a shift of the superionic phase transition for AgI to higher temperatures (ΔT_c=14K) and a decrease by a factor of five of the conductivity jump with reducing the pore size from 52 A to 20 A. For the ferroelectric phase transition in $NaNO_2$ the reduction of the pore size from 5 A to 2 A resulted in the T_c increase from 163℃ up to 175℃. The nonmonotonic dependence was observed for the melting-crystallization transition: for big pores (porous glasses) T_c decreases to 250℃ and then upon reducing the pore size (mesoporous matrices) the temperatures of the phase transitions increase again, approaching 270℃ for the pore size 20 A.

Received date: 2005-08-29