Three-state mesoscopic model of a heterophase fluid in application to the dielectric-semiconductor transformations in expanded mercury

O. Bakai

National Science Center "Kharkiv Institute of Physics & Technology", 61108 Kharkiv, Akademichna 1, Ukraine E–mail: bakai@kipt.kharkov.ua

The fluid states of mercury are described in the framework of a mesoscopic theory of a 3-phase random mixture of mutually transforming fluctuons. Fluctuons represent the mesoscopic liquid-like-metallic, liquid-like-nonmetallic, and gas-like species. Formulated free energy of the system of interacting fluctuons produces a thermodynamic equation of state. It is found that for an appropriate set of parameters both the vapor-liquid transformation and the metal-nonmetal transformation in the liquid phase of mercury are accurately described. This communication is mainly devoted to the dielectric-semiconductor transformation in mercury. It is shown that the observed dielectric anomaly in mercury is induced by an excitonic transition at the percolation threshold of the nonmetallic liquid fraction. The partial conductivities and dielectric permittivities of gas phase, as well as those of the semiconducting liquid phase are determined. Applicability criterion of the Landau-Zeldovich scenario of the gas-nonmetallic liquid transformation is formulated.