DEPENDENCE OF THE ELECTRICAL CONDUCTIVITY OF DENSE PLASMAS WITH IONIZATION DEGREE OF THE ORDER OF UNITY ON THE COULOMB-COUPLING PARAMETER

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Calculating the electrical conductivity of dense plasmas with the ionization degree of the order of unity, when the long-range Coulomb interactions dominate in the collisions of the conduction electrons, is a very complex problem. It has long been suggested that there is a universal dependence of the conductivity of such plasmas on the two parameters: the degree of degeneracy of electrons (i.e., the ratio of the Fermi temperature to the temperature) and the classical Coulomb-coupling parameter (the ratio of the average potential energy of the Coulomb interaction between the charges to their average kinetic energy). Sufficiently accurate measurements of the thermodynamic functions and the electrical conductivity of dense lead plasma have recently been carried out for wide ranges of temperature and density [1]. In these experiments, the plasma states with ionization degrees of the order of unity were achieved. As a comparison of the results of these measurements with the results of calculations for several theoretical models has shown, the chemical model of plasma [2] agrees quite satisfactorily with the results of measurements for the entire set of measured quantities. In the present work, this model is used to determine the degree of ionization and temperature of plasma, since these quantities are not currently measured in the experiment. As a result, based on experimental data on the conductivity, density, pressure and specific enthalpy of plasma, the dependence of the dimensionless conductivity of plasma on the Coulomb non-ideality parameter is determined. We find out how accurate is the predicted universal dependence of the conductivity of non-ideal plasma on the Coulomb non-ideality parameter in the case where the plasma is almost classical (the degree of degeneracy is less than one), and the Coulomb non-ideality parameter reaches values of the order of one.

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2. Khomkin A.L., Shumikhin A.S. // High Temperature. 2014. V. 52. P. 328.