TRANSPORT AND OPTICAL PROPERTIES OF IRON IN THE EXPANDED AND COMPRESSED STATES AT HIGH ENERGY DENSITIES

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The purpose of our work is to develop a calculation method and the studying the transport and optical properties of metals at high energy densities in expanded and compressed states. In this communication, we performed calculations for iron, since it is used as model material for an anode of gas gap controlled by solid-state laser radiation [1,2]. The thermophysical properties of iron at high energy densities are considered in detail in [3]. Also, we proved the importance of studying the physical properties of the expanded state for understanding the physical processes occurring in high-voltage high-pressure gas gaps controlled by laser radiation focused on the anode.

In our model, a local equilibrium neutral metal is a plasma-like medium consisting of ions and electrons. Moreover, ions and neutral atoms do not differ. The charge of iron ions in the average ion (atom) approximation varies from $z_i = 0$ to $z_i = Z = 26$ (see details in [3]). We used the approach proposed in the works of one of us (NBV) [4, 5] for scattering conduction electrons on density fluctuations. According to this approach, the effective potential of of an individual ion takes into account the contribution to scattering, both free and bound (internal) electrons and in the region of intense density fluctuations, where the mean free path l_{ei}, can became less than the interionic (interatomic) distance, $r_s = (3V/4\pi)^{1/3}$ (V is a volume per atom (ion)). The mean free path is regularized as follows: $l_{ei} = r_s$. Taking into account the above, we have obtained formulas for electrical conductivity, electron thermal conductivity, thermoelectric coefficient, and also - real and imaginary parts of the dielectric permittivity, and absorption coefficient for a fixed frequency (wavelength) of laser radiation. With their help, tables of the indicated characteristics of iron were calculated in a wide range of densities and temperatures. The results obtained were analyzed. It is shown that the results obtained demonstrate agreement with the theoretical behavior in the limiting cases of ideal and highly degenerate electron plasma. It was also established that the behavior of electrical conductivity and optical characteristics in the critical and supercritical regions is consistent with the experimental results of the authors [6, 7].

Methodology for calculating the transport and optical characteristics of iron and the results obtained are described in detail by us in [8].

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