calculations of electronic transport coefficients and pressure in nickel plasma

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The investigations of the equation of state, transport coefficients and the other thermophysical properties are necessary both for the theories and the applications. Thus corresponding calculations and measurements have been carried out for more than a century. This fact concerns the metals as well, where we have reliable experimental data for the crystal and liquid phases. But when the temperature is rising and when there is the transition to the plasma region or warm dense matter, the performance of the measurements becomes difficult or even impossible. Corresponding area starts at the temperatures greater than 5- 19 kK and the densities lower that the normal one (for nickel it is ρ0 = 8.9 g/cm3). Nevertheless during two last decades there are new measurements of the electrical conductivity, pressure, internal energy for some number of substances namely in the plasma region [1-4]. As a rule these experiments are based on the process of the wire or foil explosion. The temperature can not be measured directly in these measurements. So some hybrid approaches (experiment + calculation) should be used to find the temperature. But this new data should be accounted for the construction and correction of the theoretical models.

Such a model has been worked out earlier by us for the plasma of noble metals, inert gases and semiconductors [5-7]. Within its frames there are calculations of the chemical (ionic) composition, pressure, internal energy and the electronic transport coefficients (the electrical and thermal conductivities and the thermal power). The composition calculations originate from the law of mass action (see for instance [8]). The electronic transport coefficients are determined within the relaxation time approximation. The exact electron – atom momentum cross –sections are of especial importance for this approximation, as far as this type of scattering dominates. In present work we have applied our model to calculate the pressure and the electronic transport coefficient in nickel plasma. The experiments where these properties have been measured are presented in [1] at T ≥ 10 kK along the isochore ρ=0.1 g/cm3 (i. e. the metal expands in ρ0/ρ = 89 times!). These conditions correspond to the low-temperature, partially ionized plasma. The isotherms only for electrical conductivity of nickel plasma (T = 10 kK, 20 kK, 30 kK) when the density changes from 0.01toо ~1 g/cm3 have been measured in [2, 3]. Our calculations have been fulfilled under the sane conditions. The good agreement is obtained between our results and the measurements as well as the calculations of other researchers,.

References

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