S- and P-polarized reflectivities of strongly correlated plasma

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The experimental data from investigations of optical properties of a strongly correlated plasma is an important cornerstone to construct theoretical models for the description of warm dense matter. The analysis of the response of a dense plasma to electromagnetic waves of moderate intensity can be used as a tool to investigate the validity of the physical models describing the behavior of matter under extreme conditions, high temperatures and pressures.

The plasma created has transitive surfaces with a density profile. The research of the transitive layer of a explosively driven dense plasma can be carried out using the technique of inclined probing by polarized electromagnetic waves. Angular dependence of S- and P-polarized reflectivities at several wavelengths can be used in the integration of Maxwell equations to construct the spatial profile of the density of charge carriers. In this paper, we report new results of S- and P-polarized reflectivity measurements of a non-ideal plasma at $\nu_{las} = 2.83 \cdot 10^{14}$ s^{-1} (λ_{las} = 1064 nm), $\nu_{las} = 4.33 \cdot 10^{14}$ s^{-1} (λ_{las} = 694 nm) and $\nu_{las} = 5.66 \cdot 10^{14}$ s^{-1} (λ_{las} = 532 nm).

To generate the non-ideal plasma, we used explosively driven shock waves which lead to compression and irreversible heating of xenon and to measure the dense xenon plasma polarized reflectivity index, a pulsed RUBY and YAG+KTP system with a four-channel pulse high-speed device for determination of the Stokes vector components was used [1]. The device allowes to measure the intensity of the reflected laser beam for four azimuthal angles and was equipped with filters for selection of probing frequency.

In order to determine the thermodynamic parameters and composition of plasma suitable calculations have been carried out. Working with a grand canonical ensemble, virial corrections have been taken into account due to charge-charge interactions (Debye approximation). Short-range repulsion of heavy particles was considered within the framework of a soft sphere model [2-3].

In Figure 1, the experimental data and results of solving of Maxwell equations using the generalized Drude formula and the dynamical collision frequency in Born approximation [4] are shown. Results of calculations with layer temperature profile and ea-collisions as factor are shown in Figure 1 too.

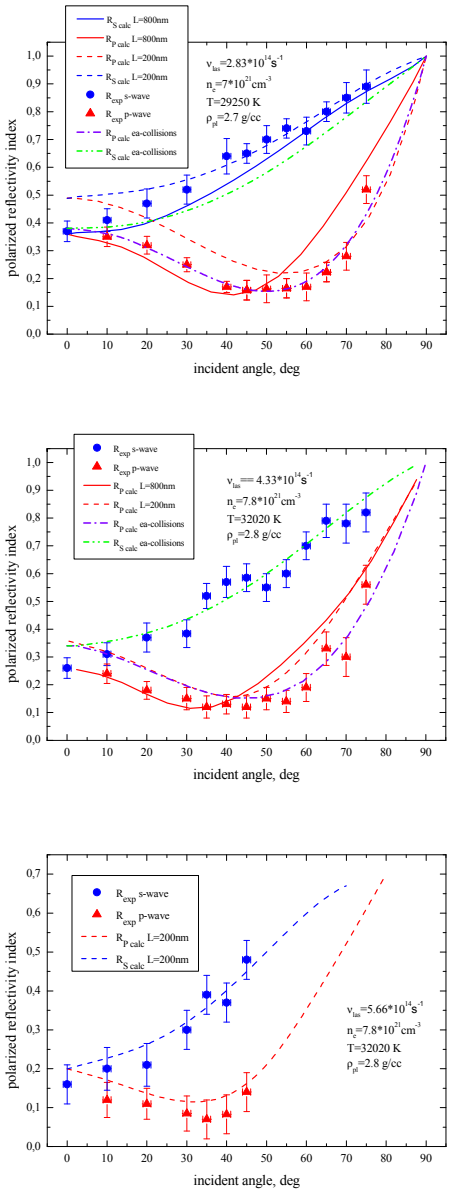

Figure 1: S- and P-polarized reflectivities calculated in comparison to the experimental data.

References

[1] Zaporoghets Yu.B., Mintsev V.B., Gryaznov V.K., Fortov V.E., Reinholz H., and Röpke G. // J. Phys. A: Math. Theor. 2009. V. 42. P. 214063.

[2] Ebeling W., F¨orster A., Fortov V., Gryaznov V. and Polishchuk A. Thermophysical Properties of Hot Dense Plasmas. Stuttgart: Teubner, 1991.

[3] Fortov V.E., Gryaznov V.K., Mintsev V.B., Ternovoi V.Ya., Iosilevski I. L., Zhernokletov M.V. and Mochalov M.A. // Contrib.Plasma Phys. 2001. V. 41. P. 215.

[4] Reinholz H., Röpke G., Wierling A., Mintsev V.B. and Gryaznov V.K. // CPP. 2003. V. 43. P. 3.