PRESSURE IONIZATION OF MULTIPLE SHOCK COMPRESSED PLASMAS AT MEGABARS

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Physical properties of hot dense plasmas at megabar pressures are of important for astrophysics, planetary physics, geology, ICF target design and for understanding of physical processes of intense laser and particle beam-target interactions. Moreover, the intense laser and particle beams are the unique tools for generation of shock waves with ultramegabar pressure amplitudes, which open the new possibilities for experimental investigation of physical properties of matter at high pressure. The physical properties of hot dense matter at high pressures and energy densities are analyzed in a broad region of parameters. The theoretical and experimental methods of non-ideal plasma investigations are discussed. Main attention is paid to the dynamical methods. Intense shock, rarefaction, and radiative waves in solid and porous samples, electrical explosion and bulk electron and ion heating were used for generation of high density matter at extremely high pressure. The highly time-resolved diagnostics permit us to measure thermodynamical, radiative and mechanical properties of high pressure condensed matter in the phase diagram broad region – from the compressed condensed solid state up to the low density gas range, including high pressure evaporation curves with near-critical states of metals, strongly coupled plasma and metal-insulator transition regions.

The theoretical interpretation of the opacity measurements demonstrates a strong deformation of discrete spectrum in non-ideal plasmas. The pressure ionization phenomena in hydrogen, helium, noble gases, iodine, silica, sulfur, H_2O, fullerenes and some metals are analyzed on the base of multiple shock wave electrical and explosion experiments. The data obtained were described by the non-ideal plasma model taking into account increase of charge carrier number as a result of "pressure" ionization. In contrast to these experiments the multiple shock compression of solid Li, Ca and Na shows dielectrization of these elements at megabars. The estimations of the dielectrization pressure range for some elements at ultramegabars are presented.

The experimental data obtained allow us to construct four-phase wide-range equations of states and transport properties models, which describe the physical properties of matter within a broad phase diagram region with taking into account high pressure melting, evaporation, ionization, and metal-insulator transition. The computer simulations of high-pressure fast phenomena in condensed matter were carried out using these semi-empirical models