Nonideal Plasma - Density and Charge Coupling

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The physical properties of nonideal plasmas at extremely high energy densities are analyzed in a broad region of the phase diagram. The theoretical and experimental methods of hot dense plasma investigations are discussed. Main attention is paid to shock wave methods. Intense shock, rarefaction and radiative waves in gaseous, solid and porous samples, explosion and bulk electron and ion heating were used for generation of extremely high temperatures and pressures in plasma. The highly time-resolved diagnostics allow us to measure the thermodynamic and radiative properties of high temperature plasma in the broad region of the phase diagram from compressed condensed solid states up to the low density gas range, including high temperature evaporation curves with near-critical states of metals, strongly coupled plasma, and metal-insulator transition regions.

Thermodynamic parameters of metal critical points are analyzed and compared with the theoretical predictions. The computer simulations of high energy density phenomena in strongly coupled plasma generated by hypervelocity impact and intense particle beams are presented.

The shock-wave-induced non-equilibrium phenomena at fast melting and adiabatic condensation are analyzed in the framework of the interspinodal decomposition model. The theoretical interpretation of the opacity measurements demonstrates strong deformation of discrete spectrum in coupled materials. “Pressure ionization” phenomena in hydrogen, iodine, silica, sulfur, fullerenes, and some metals are analyzed on the base of multiple shock compression experiments. Analytical models based on the ionization shift stimulated by plasma compression and Quantum Monte Carlo calculations were used for theoretical interpretation of the “pressure ionization” of plasma. The effect of “dielectrization” for some metals (Li, Na) is discussed on the base of the multiple shock compression experiment. The theoretical models and experiments on plasma phase transition in nonideal plasma are discussed. Strongly coupled multicomponent plasma thermodynamic models were applied for theoretical description.