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EOS for WDM

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Physical processes arising under conditions of extreme energy densities, such as hypervelocity impacts, action of powerful energy fluxes on condensed matter and others, are typical domains of Warm Dense Matter. They are of interest for fundamental investigations and for numerous practical applications. The typical features of these phenomena are complicated character of 3D gas dynamic flow and big gradients of flow parameters. The numerical modeling of processes at extreme conditions supports experimental investigations in this area. On the other hand, it is the only tool for investigating phenomena which can not been carried out at laboratory conditions. The dramatic progress in the computer industry in past 20 years resulted to the development of high-performance computers and efficient numerical schemes as well. The equation of state (EOS) governing the system of gas dynamic equations defines significantly accuracy and reliability of results of numerical modeling. In our report, we will discuss EOS problems for WDM and will formulate main mathematical and physical demands to wide-range EOS for physical applications. Nowadays, in spite of a significant progress achieved on construction of EOS in solid, liquid and plasma state with the use of the most sophisticated "first-principle"theoretical approaches (classic and quantum methods of self-consisted field, diagram technique, computer's Monte-Carlo and molecular dynamics methods) the disadvantage of these theories is their regional character. The range of an applicability of each theory is local and, rigorously speaking, no one of them allows to provide for a correct theoretical calculation of thermodynamic properties of matter on the whole phase plane from the cold crystal to liquid and hot plasmas. The principal problem here is the necessity to take into account correctly the strong collective interparticle interaction in disordered media, which meets especial difficulties in the region occupied by dense disordered non-ideal plasmas. In this case experimental data at high pressures, high temperatures are of peculiar significance, because they serve as reference points for theories and semi-empirical models. Data obtained with the use of dynamic methods are of the importance from the practical point of view. Shock-wave methods allow to study a broad range of the phase diagram from compressed hot condensed phase to dense strongly coupled plasma and quasi-gas states. Available experimental data on the shock compression of solid and porous metals as well as isentropic expansion embrace to nine orders with respect to pressure and four to density. Other important information in WDM domain, like measurements of isothermal compressibility in diamond anvil cells, data on sound velocity and density in liquid metals at atmospheric pressure, IEX measurements, possibilities of powerful ion beams, calculations by Debay-Hukkel, Thomas-Fermi models and QMD, evaluations of the critical point are also discussed.

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