Thermodynamic properties of dense bismuth plasma in shock-compression and isentropic-expansion processes

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Knowledge of the thermodynamic characteristics of matter at high pressures and temperatures is important for solving applied energy problems due to the need for hydrodynamic modeling of physical processes under such conditions. For this reason, the development of models describing the thermodynamic properties of materials in a wide region of the phase diagram is currently relevant. One of the substances of interest to nuclear energy is bismuth, which is used as a component of liquid metal coolants.
In this work, an equation of state for bismuth is proposed within the framework of a simple semiempirical model. It is represented by the functional dependence of specific Helmholtz free energy on specific volume and absolute temperature. The Helmholtz free energy is given as the sum of the cold curve energy (on zero-kelvin isotherm) and the thermal contribution of atoms and electrons. The model considered in this work contains parameters (constants) that are determined from the condition of the best description of the data from shock-wave experiments. Using the proposed equation of state, the kinematic and thermodynamic characteristics of dense bismuth plasma in the processes of shock loading and isentropic unloading were calculated. The calculation results are in good agreement with the available experimental data.
The developed equation of state for bismuth can be applied in hydrodynamic modeling of physical processes at high energy densities.
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