Sapphire melting curve at high pressure

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Sapphire is a rigid and transparent dielectric used in dynamic experiments with high pressures and temperatures. The transition of the substance from a crystalline to a liquid state is accompanied by a radical change in its properties. In particular, on both sides of the melting curve there are different densities, as well as specific values of internal energy, entropy and heat capacity. A change of the substance structure can lead to change of the mechanisms of electrical conductivity and heat transfer. The ability of the body to maintain shape disappears during melting, due to a change in the mechanism of resistance to shear stresses. Therefore, knowledge of the boundary between the liquid and solid states of a substance is incredibly important. At the same time, information about the melting curve of sapphire at high pressures is completely insufficient. The calculation of melting curves is made on the basis of the Debye theory of heat capacity (in the case of metals, the contribution of the electronic subsystem to the heat capacity is also taken into account) and the Lindemann melting criterion. The shock adiabats determined in dynamic experiments and the thermophysical characteristics of the substance under normal conditions are used as basic experimental data. Mathematically, the problem is reduced to solving the Cauchy problem for a nonlinear system of ordinary differential equations. The system is solved numerically by the Runge-Kutta method.

The comparison with the available calculated and experimental data, including the melting of sapphire in the shock wave, showed satisfactory agreement of the results.

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