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Simulation of phase transitions and material decomposition in ultrashort laser–metal interaction MIKHAIL POVARNITSYN, PAVEL LEVASHOV, KONSTANTIN KHISHCHENKO, Institute for High Energy Densities, JIHT RAS — A numerical hydrodynamic study of femtosecond laser irradiation (800 nm, 100 fs, 10^{12}–5×10^{13} W/cm^2) of metal targets (Al, Au, Cu) is presented. A detailed analysis of laser induced phase transitions, melting wave propagation and material decomposition is performed using a thermodynamically complete two-temperature equation of state with separate stable and metastable phase states and phase boundaries. Material evaporation from the target surface and fast melting wave propagation into the bulk are observed. Investigation of the phase trajectories of different target layers shows the presence of the metastable states in rarefaction wave. The lifetime of the metastable liquid state is estimated by means of the theory of homogeneous nucleation. Mechanical fragmentation of the target material at high strain rates is controlled with the help of Grady criterion. As a result, several ablation mechanisms are observed. A major fraction of the ablated material, however, is found to originate from the metastable liquid region, which is decomposed either *thermally* in the vicinity of the critical point into a liquid–gas mixture, or *mechanically* at high strain rate and negative pressure into liquid droplets and chunks. The calculation results explain available experimental findings.

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