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Coupling of strong elastic shock with supersonic melting front produced by ultrashort laser pulse NAIL INOGAMOV, Landau Institute for Theoretical Physics of RAS, VASILY ZHAKHOVSKY, BRIAN DEMASKE, University of South Florida, VIKTOR KHOKHLOV, Landau Institute for Theoretical Physics of RAS, IVAN OLEYNIK, University of South Florida — Generation of ultrashort shock elastic and plastic waves by femtosecond laser pulses in Al and Ni films is investigated by two-temperature hydrodynamics (2T-HD) and molecular dynamics (MD) methods. Ultrafast laser heating of metals is approximately isochoric during first several picoseconds. It leads to significant overheating of surface layer above the equilibrium melting line $T_{\mathrm{m}}(P)$, causing the melting front to propagate with supersonic speed as deep as a local degree of overheating drops to $\sim$1.2. After that the melting front decelerates quickly and a compression wave leaves the heated surface layer. Because the melting transition occurs at isochoric compression, the pressure and temperature at a solid-liquid interface in a moment when the melting front stops are independent on laser energy absorbed in metals. If absorbed energy exceeds some threshold, the compression wave splits into elastic and plastic shock waves. Evolution of those waves, including their coupling with the melting front at early stage and emission of rarefaction and compression elastic pulses by a plastic front, was studied by both 2T-HD and MD simulation. It was shown that the elastic precursor has a fluence-independent amplitude; whereas the plastic front undergoes significant attenuation during propagation and may fully decay within a metal film.

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