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Molecular dynamics simulation of shock wave and spallation phenomena in metal foils irradiated by femtosecond laser pulse VASILY ZHAKHOVSKY, BRIAN DEMASKE, University of South Florida, NAIL INOGAMOV, Landau Institute for Theoretical Physics, Russia, IVAN OLEYNIK, University of South Florida — Femtosecond laser irradiation of metals is an effective technique to create a high-pressure frontal layer of 100-200 nm thickness. The associated ablation and spallation phenomena can be studied in the laser pump-probe experiments. We present results of a large-scale MD simulation of ablation and spallation dynamics developing in $1, 2, 3\mu m$ thick Al and Au foils irradiated by a femtosecond laser pulse. Atomic-scale mechanisms of laser energy deposition, transition from pressure wave to shock, reflection of the shock from the rear-side of the foil, and the nucleation of cracks in the reflected tensile wave, having a very high strain rate, were all studied. To achieve a realistic description of the complex phenomena induced by strong compression and rarefaction waves, we developed new embedded atom potentials for Al and Au based on cold pressure curves. MD simulations revealed the complex interplay between spallation and ablation processes: dynamics of spallation depends on the pressure profile formed in the ablated zone at the early stage of laser energy absorption. It is shown that the essential information such as material properties at high strain rate and spall strength can be extracted from the simulated rear-side surface velocity as a function of time.

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