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Surface nano-structuring produced by spallation of metal irradiated by ultrashort laser pulse NAIL INOGAMOV, Landau Institute for Theoretical Physics of RAS, VASILY ZHAKHOVSKY, YUSUF EMIROV, IVAN OLEYNIK, University of South Florida, SERGEY ASHITKOV, MIKHAIL AGRANAT, ANATOLY FAENOV, Joint Institute for High Temperatures of RAS, TATIANA PIKUZ, MASAHIKO ISHINO, NOBORY HASEGAWA, MASAHARU NISHIKINO, TETSUYA KAWACHI, Quantum Beam Science Directorate, JAEA — Response of metal to heating by ultrashort laser pulse was studied using both two-temperature hydrodynamics modeling and molecular dynamics simulation. Our simulations of Al, Ni and Ta showed that deposition of laser energy in range of $\sim$ 50-200 mJ/cm^2 in a thin surface layer leads to high electron temperature, which propagates supersonically into the bulk of metal. As a result, the thicker heated layer of $\sim$ 100 nm deep with molten metal in electron-ion thermal equilibrium is formed after several picoseconds. Because expansion of the layer into vacuum, the tensile wave propagates into metal and may produces significant negative pressure. Above some critical energy deposition where the tensile stress exceeding the strength of liquid metal, many voids start to nucleate beneath the surface forming a foam-like material, which may lead to spallation of a liquid shell if its kinetic energy is enough to overcome the tensile strength of foam. We found that the fluence threshold for cavitation is about a few tens percent less than the spallation threshold. Simulated evolution of surface liquid foam, including its breakings and freezing with formation of 3-D nanostructures on surface, was compared with our experimental observations.

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