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Approaching the Ultimate Shear and Tensile Strength of Aluminum in Experiments with Femtosecond Laser Pulses SERGEY ASHITKOV, MIKHAIL AGRANAT, GENNADY KANEL, VLADIMIR FORTOV, Joint Institute for High Temperatures of Russian Academy of Sciences — We studied the shock-wave phenomena generated by femtosecond laser pulses in aluminum films with thicknesses from 0.5 to 1.2 microns. The free surface displacement as a function of time has been measured with ultrafast time-resolved interferometric microscopy and converted into the free-surface velocity history. The relation between the shock front velocity and the particle velocity indicates the shock compression remains elastic at least up to 13 GPa under these conditions. Shear stresses reached 3.4 GPa, which is close to estimated ultimate value for aluminum. The observed elastic shock wave results in the small ($\leq$1 ps) rise time of the shock fronts. The data are in excellent agreement with dependence of apparent Hugoniot elastic limit on the wave propagation distance in the plate impact experiments. The spall strength of aluminum at strain rates of about 10^9 s^{-1} is comparable with its ultimate tensile strength of perfect Al crystal and is in good agreement with molecular dynamics calculations.

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