Equations of state of the Mie–Grüneisen type as applied to problems of laser hardening of materials

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Strengthening of materials by means of exposure to laser radiation is one of the promising technologies in the field of interaction of laser radiation with matter. If ultrashort femtosecond laser pulses are used to strengthen metals, an almost isochorically heated region of increased pressure is created in the near-surface layer of the metal. A shock wave propagating from it deep into the metal changes the physical properties of the metal during its passage. Therefore, when calculating the dynamics of the target matter under the action of femtosecond laser pulses, especially in two-dimensional and three-dimensional cases, it is important to use the compact equation of state of matter, which describes well both the Hugoniot adiabat of the compressed substance and the Poisson adiabat of the expanding matter. As such an equation of state of matter, using the example of aluminum, we considered various versions of the Mie–Grüneisen equation of state with both constant and density-dependent Grüneisen coefficients using cold pressure and internal energy curves obtained as a result of calculations using density functional theory methods.