Modeling shock-wave processes in face-centered cubic metals using the artificial neural network

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In the present paper, the artificial feedforward neural network was developed to approximate the equation of state for face-centered cubic metals. The data for learning the network was obtained from molecular dynamics modeling of the triaxial compression and tension Al, Cu and Al–Cu crystals. The obtained values of the weights and displacements of the neural network are needed to calculate the thermodynamic characteristics of a deformable material, such as pressure and internal energy, from the current values of density, temperature, and concentration of copper in an aluminum crystal. Plastic deformations emerging at the collision of metal plates were calculated using the modified Maxwell relaxation model. Dynamic loads can lead not only to deformation of the material, but also to cracking and destruction. Therefore, a fracture model was included in the simulation. This made it possible to describe the nucleation, growth, and collapse of pores in the sample under tension. The dynamics of the shock wave was investigated in a one-dimensional formulation in samples with various concentrations of copper. The results of measuring the velocity of the target free surface in pure metals were compared with the experimental data. The work is supported by the Ministry of Science and Higher Education of the Russian Federation (state assignment No. 075-00250-20-03) in the part of the equation of state and by the Russian Science Foundation (project No. 20-79-10229) in the part of the description of destruction.