High-speed collision of Cu profiled cylinders: Experiments and three-dimensional modeling using smoothed particle hydrodynamics, dislocation plasticity and artificial neural network-based equation of state

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A modification of Taylor anvil-on-rod tests is considered. Cylinders of 8 mm in diameter and 40 mm in length were cut from cold-rolled oxygen-free 99.9% M1 copper rod and machined in the head part to 3 different shapes: the reduced cylinder of 3 or 4 mm in diameter and 10 mm in length and the truncated cone with the top diameter of 2 mm and the length of 20 mm. The samples were launched by a gas gun with velocities from 19 to 78 m/s and collided with rigid anvil. The strains about 0.5 and the strain rates about 5/ms are realized in these experiments. In the case of reduced-diameter cylinders in the head part, the strain is almost equal through the length of the reduced part. The final form of the samples coincides well with the results of three-dimensional numerical simulation using smoothed particle hydrodynamics supplemented by the dislocation plasticity model. An equation of state (EOS) is obtained in the form of artificial neural network (ANN) trained by the results of molecular dynamics simulations. Experimental part of this work is supported by the Russian Science Foundation (project No. 20-79-10229); development of numerical code and ANN-based EOS is supported by the Ministry of Science and Higher Education of the Russian Federation (state assignment No. 075-00250-20-03).