SYNCHROTRON DIAGNOSTICS OF SHOCK-WAVE COMPRESSION OF 3D STRUCTURED ALUMINUM

A. M. Asylkaev[1, 2, 3], K. A. Ten[1], E. R. Pruuel[1], A. O. Kashkarov[1], I. A. Rubtsov[1, 3], V. P. Khalemenchuk[1], A. S. Tumanik[1, 3], A. A. Studennikov[1]

[1]Lavrentiev Institute of Hydrodynamics, Novosibirsk, Russia

[2]State University, Novosibirsk, Russia

[3]"Siberian Circular Photon Source" (SKIF) Collective Use Center, Novosibirsk, Russia

Synchrotron radiation (SR) has a significant advantage over traditional X-ray sources due to its ability to generate sequential radiation pulses with fixed time intervals. When passing through the aperture of a channel, the radiation forms periodic bursts, which are recorded as short flashes lasting less than 1 ns. These unique properties of SR are used to create X-ray movies in experiments studying fast processes, such as explosions.

In this work, the shock compression of 3D structured aluminum was studied using synchrotron radiation. The transmitted radiation was recorded by the DIMEX X-ray detector, which is a camera with an ionization gas (xenon). The detector can capture 100 frames (images). The time between frames was determined by the period of bunch rotation in the storage ring of the accelerator and amounted to 610 ns. The experiments were conducted using a compact "explosive" gun, where only 10 grams of explosive were used to generate the shock wave.

Figure 1 shows the results of measurements of the relative change in intensity along the axis of 3D-structured aluminum under shock loading by a copper impactor (X-ray movie). In the experiments with 3D-structured aluminum, measurements of the shock wave velocity in the sample and the mass velocity were also carried out. The shock wave front velocity, as well as the mass velocity, were determined by measuring the distance between adjacent detector frames. Given that the time interval between frames is determined by the operating mode of the VEPP-4 accelerator, this approach made it possible to calculate the average velocity over a 610 ns interval. To obtain additional values of mass velocity and shock wave velocity, similar experiments were conducted with varying impactor velocities. Figure 2 presents the shock Hugoniot for 3D-structured aluminum in comparison with data for powder samples of different densities [1].

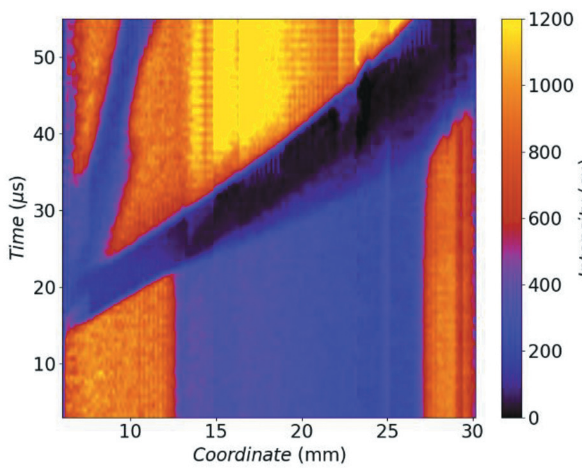

Fig. 1. The intensity distribution of the transmitted radiation

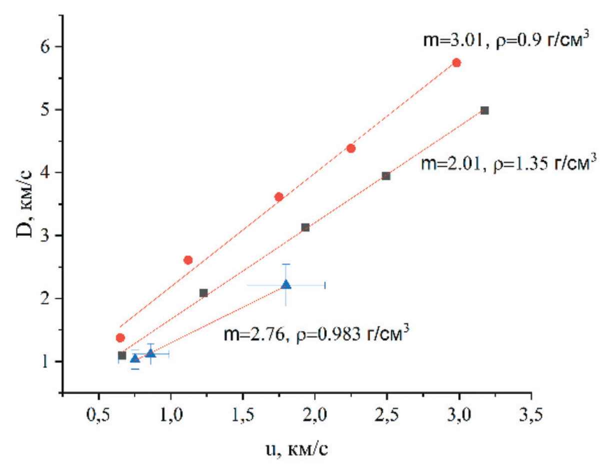

Fig. 2. Shock Hugoniots for 3D-structured aluminum and aluminum powders with different porosity values

References

1. **Bakanova, A. A.** Shock compressibility of porous tungsten, molybdenum, copper and aluminum at low pressures [Udarnaya szhimaemost' poristyh vol'frama, molibdena, medi i alyuminiya v oblasti nizkih davlenij] (in Russian) [Text] / A. A. Bakanova, I. P. Dudoladov, Y. N. Sutulov // Applied mechanics and technical physics [Prikladnaya mekhanika i tekhnicheskaya fizika]. – 1974. – P. 116–117.