Shock-wave dynamics in pressed aluminum V-ALEX nanopowder

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Studies of the impact response of nanostructured systems are of great interest due to their advantageous characteristics provided by the ultrasmall scale of constituent elements. Numerous works investigated high-strain rate processes in various nanomaterials and nanosized bodies to gain a comprehensive understanding of their dynamic properties. In this work the dynamic behavior of the pressed aluminum nanopowder of 30% porosity was studied in plate impact experiments at shock pressures and strain rates up to 2.4 GPa and $4{\cdot}10^7$ s^{-1}, respectively. Samples were made of the commercially available V-ALEX nanopowder. The purpose was to explore the effect of the extremely small size of powder grains (100-200 nm on average) on the shock response of this nanomaterial. Plate impact experiments were carried out using the common gun technique. The two-step structure of propagating shock compaction waves was captured using a laser velocimetry technique. It was shown that the properties of the precursor wave traveling in the material ahead of the main shock compaction wave are controlled by the grain scale. The parameters characterizing the structure of the main wave, maximum strain rate and rise time, are also affected by the grain scale, but the shocked state behind this wave is only governed by the initial porosity, at least in the studied pressure range. Additionally, the influence of pore morphology and initial porosity of aluminum on the longitudinal sound velocity, precursor velocity and Hugoniot elastic limit was described. This work was supported by Russian Science Foundation, grant No. 24-19-00746.