Shock response of carbon-aramid composite up to 200 GPa

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Due to the prevalent use of composite materials as shields against hypervelocity orbital impacts, research into their shock-wave properties at corresponding pressures is highly relevant. This study investigates the shock compressibility of a carbon-aramid fiber-reinforced polymer. Experiments at pressures up to 200 GPa analyzed the material's response with fibers oriented both longitudinally and transversely to the direction of shock propagation. Particle velocity profiles were recorded using a multichannel laser interferometer. The shock compressibility and the structure of the shock wave front were determined for each orientation. It is shown that shock Hugoniot of composite does not depend on fiber orientation. A distinct kink observed on Hugoniot in shock velocity–particle velocity variables near 25 GPa is attributed to a phase transition in the composite. Furthermore, the results demonstrate that at pressures below 19 GPa, the anisotropic structure of the composite must be considered to correctly describe its shock response. This anisotropy manifests as a two-wave structure in the longitudinal orientation, whereas a single shock wave is observed in the transverse orientation. At higher pressures, it is crucial to consider the phase transition, which alters the shock compressibility of the carbon-aramid composite.

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