Measurement of shock compressibility of silicon and softening of its Hugoniot curve at 200–500 GPa

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Previously, Hugoniot data on silicon in multi-megabar region was limited by Pavlovsky data (from 80 to 196 GPa), although well studied for pressures up to 60 GPa. However, theoretical calculations by Lomonosov (1996, semiempirical model) and Militzer (2016, quantum molecular dynamics) demonstrated significantly softer shock Hugoniot of Si, than Pavlovsky's experiment. In this work, experiments on shock compression of Si up to 510 GPa were performed to understand its Hugoniot. Mach-type explosive cumulative generators were used. Shock compressibility was determined by impedance matching with quartz reference. Two techniques were used to register the wave velocities in reference and sample. First is a fast optical detectors, registering the shock propagation in transparent reference and the exit of shock from opaque sample, a row of few detectors was necessary. Second is an infrared detector, possible to register the propagation of shock in both reference and sample due to transparency of silicon in infrared band. Experimental data, obtained at pressure 280–510 GPa, confirms the softening of Si Hugoniot, proposed by Lomonosov (1996) and Militzer (2016).