Sound velocity in shock-synthesized stishovite to 72 GPa

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Stishovite (rutile-type SiO_2) is expected to occur in silica-rich domains of the Earth's lower mantle. The presence of 6-fold coordinated Si also makes stishovite an archetype for all lower-mantle silicates. Recent combination of X-ray diffraction with gas-gun experiments have demonstrated that fused silica transforms to stishovite above 34 GPa on its Hugoniot [1]. The occurrence of stishovite as the high-pressure Hugoniot phase of fused silica presents new opportunities to better characterize the thermoelastic behavior of stishovite at the high pressure and temperature conditions of a shock-wave experiment.

Here, we present shock-wave profiles and sound-speed measurements in stishovite synthesized by shock compression of fused silica to 44 – 72 GPa. The plate-impact experiments were conducted using a two-stage light-gas gun combined with laser interferometry in either transmission (Al or Cu impacting fused silica at 5.2 – 7.1 km/s) or front-surface-impact (fused silica impacting LiF at 5.3 – 7.1 km/s) geometry. Shock and particle velocities determined from the transmission-shock wave profiles are consistent with previous measurements in the high-pressure region of the fused-silica Hugoniot. Longitudinal sound velocities were determined by considering the shock velocities from the transmission-shock experiments to constrain the release-wave velocity in the front-surface-impact experiments.

The results greatly reduce the scatter present in earlier experiments. Most significantly, the longitudinal sound speed in the stishovite region of the Hugoniot decreases from 12 km/s at 44 GPa to 10 km/s at 70 GPa, much lower than predicted by theoretical calculations for both stishovite and the higher-pressure $CaCl_2$-type phase. Combined with previous pyrometry data, the measured sound velocities therefore provide strong evidence for the presence of melting on the fused silica Hugoniot.

[1] Tracy et al. (2018) *Physical Review Letters* **120**, 135702.