The Role of Quenching Pressure on Shock-Induced Phase Transformations in Silica Glass

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Research Question
Does quenching pressure influence the shock-compression behavior of silica glass?

Research Relevance
By investigating the effect quenching pressure may have on the compressibility of silica glass, we could potentially uncover new techniques for increasing the resilience of glass surfaces in space applications.

Methodology
We used LAMMPS, a high performance molecular dynamics simulator, in conjunction with ASU’s HPC Agave cluster to answer our research question.

Molten silica systems were quenched to 300K while under 0.1, 10, 30, and 50 GPa of pressure. Then, each of these quenched systems were shocked at 30, 40, 60, and 70 GPa, producing a total of 16 shocked systems. In order to provide a confidence interval for our results, an additional 3 sets of the 16 shocked systems were produced.

By comparing the Shock Hugoniot plots and structures of these shocked systems, we can deduce whether quenching pressure does or does not influence the shock-compression behavior of silica glass.

Results

Shock Hugoniot Plot

- (Left) Figure of Amorphous Silica
- (Right) LAMMPS Generated Amorphous Silica
- (Left) Figure of Stishovite
- (Right) LAMMPS Generated Shocked Silica at 60 GPa

Conclusions
- Systems quenched at higher pressures exhibit more amorphousness, correlating to flatter RDFs
- For high shock pressures, specific volume of 0.1 GPa quenched systems much larger than 10, 30, and 50 GPa
- Crystallization occurred only for systems quenched at 0.1 GPa and shocked at 60 GPa
- Quenching pressure does influence the shock-compression behavior of silica glass

Works Cited