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A multi-faceted experimental study on the dynamic behavior of $MgSiO_3$ glass in the Earth's deep interior

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Abstract

Pressure-induced structural modifications in silicate melts play a crucial role in controlling dynamic processes in the deep interiors of the Earth and other planets. The correlation between structural and macroscopic properties of silicate liquids (densification, viscosity, chemical differentiation, etc.), however, remains poorly understood. Here we report the evolution of structural modifications and elastic properties of $MgSiO_3$ glass to pressures up to ~70 GPa using a combination of experimental techniques, including micro-confocal Raman spectroscopy, angle-dispersive X-ray scattering, and Brillouin spectroscopy in the diamond-anvil cell. Our combined data set provides consistent and complementary evidence of a series of pressure-induced structural modifications in $MgSiO_3$ glass at ~2, ~8, ~20, and ~40 GPa. Based on these results, a structural evolution model for $MgSiO_3$ glass is proposed. We also discuss the role of Mg-O component in $MgSiO_3$ and Mg_2SiO_4 glasses in controlling pressure-induced structural modifications and mechanical responses in these supercooled liquids.

Keywords: $MgSiO_3$ glass, high pressure, structural modification, Raman spectroscopy, Brillouin spectroscopy, X-ray scattering