Structural changes in Mg-silicate glasses up to above 1 Mbar

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The physical properties of silicate melts at temperature and pressure conditions of the Earth's mantle have a fundamental influence on the chemical and thermal evolution of the Earth. However, direct investigations of melt structures at these conditions are experimentally very difficult or even impossible with current capabilities. In order to still be able to obtain an estimate of the structural behavior of melts at high pressures and temperatures, amorphous materials have been widely used as analogue materials.

Here we report experimental investigations of the structural behavior of $MgSiO_3$ glass up to 135 GPa and Mg_2SiO_4 glass up to 172 GPa using x-ray total scattering and pair distribution function analysis. The very high pressure range for these measurements were enabled by the multichannel collimator setup at GSECARS, APS, which significantly reduces the amount of diamond Compton scattering. This facilitates the collection of total x-ray diffraction patterns up to a maximum Q of 14.5 A^{-1} for these low-Z materials even at very high pressure conditions.

The data clearly shows strong changes in the structure factors and pair distribution functions in the first 50 GPa, corresponding to major changes in Mg-O and Si-O coordination numbers. At higher pressures, the glass structure smoothly changes with pressure and does not show any discontinuities up to the highest pressure reached. We were able to separate the Mg-O and Si-O contributions and will report differences in the local environments compared to crystalline materials at the corresponding pressure range.

We will present experimental data, discuss densification mechanisms and differences in comparison to literature data and our previous high pressure investigations on the structural changes of SiO_2 and GeO_2 glass at high pressures.