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Application of the EXEFS to the structure of the high-pressure aluminosilicate glasses

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Silicate melts play an important role in the chemical evolution of the planetary mantle during the early magma ocean stage as well as the subsequent long history. Movement of silicate melt in the mantle is controlled by its viscosity and density that are related to the melt structure. Therefore, the structural study of silicate melts under pressure is fundamental to understand the magma-related phenomena within the planets. Pressure-induced structure change in silicate melts have been studied with the quenched glass by using spectroscopic methods such as the NMR and the XAFS. Here we report the first results of application of the extended x-ray emission fine structure (EXEFS) to the structure analysis of the quenched silicate glass. The EXEFS arises from the radiative Auger effect and has the same structure as the XANES. The EXEFS can be measured using a wavelength-dispersive electron microprobe.

We measured the EXEFS spectra of the $Ca_3Al_2Si_6O_{18}$ (CAS) composition glasses quenched at 0.1MPa and 8 GPa. High-pressure glass was prepared by using a KAWAI type multi-anvil apparatus. The Si EXEFS spectra show that the silicon in the CAS glasses takes four fold coordination up to 8 GPa. On the other hand, the coordination change of aluminum from four to five is detected by the EXEFS, which is consistent with the results of the Al NMR study on the same composition quenched glasses (Allward et al. 2005).