Direct Probing of Structural Transitions in Amorphous Oxide under Extreme Compression and Friction

Sung Keun Lee*[1]

[1]Seoul National University – School of Earth and Environmental Sciences, South Korea

Abstract

Electronic bonding transitions in amorphous oxides with low-z elements under extreme compression and friction is critical in clarifying the chemical and physical evolution of the Earth. Recent advances in element-specific experimental probes, such as nuclear magnetic resonance spectroscopy and inelastic x-ray Raman scattering (XRS) allowed us to reveal the detailed structural transitions around the low-z elements under extreme compression and friction. Here, we provide an overview of the recent progress that we have made into the bonding transitions in amorphous oxide at high pressure and rapid frictional slip [1,2,3]. Although anomalous melt properties have been attributed to the presence of triply coordinated oxygen ([3]O), the presence of [3]O in covalent amorphous oxides has not been revealed experimentally. We report the 17O NMR spectrum for amorphous Al2O3 and reveal the presence of [3]O. The detailed NMR characteristics of the oxygen tricluster are distinct from those estimated for the crystalline analogs, thus indicating its unique structure [1]. We also report the detailed structural transitions of oxides under extreme friction, which reveals the atomistic origins of the melting temperature depression of materials during frictional heating [2]. Finally, we showed the structural transition in amorphous oxides under extreme compression above megabar pressures using both experimental and theoretical XRS at high pressure up to _˜120 GPa [3]. [1] Lee, S. K. and Ryu, S. B., Journal of Physical Chemistry Letters 9, 150-156 (2018); [2] Lee, S. K., Han, R., Kim, E. J., Jeong, G.Y., Khim H., and Hirose, T., Nature Geoscience, 10, 436 (2017); [3] Yi, Y. S. and Lee, S. K., Physical Review B, 94, 094110 (2016)

Keywords: anomalous melt properties, triply coordinated oxygen, NMR, XRS, glasses under extreme compression and friction

*Speaker