Synchrotron X-ray experiments for studying structure and properties of liquids and glasses at high-pressure and high-temperature conditions in large volume press

Y. Kono[1]

[1]Geodynamics Research Center, Ehime University, Ehime, Japan **(kono.yoshio.rj@ehime-u.ac.jp)**

Knowledge of pressure-induced structure and physical property changes in liquids and glasses is of great interest in various scientific fields, such as condensed matter physics, geoscience, and materials science. However, due to experimental difficulties, structure and properties of liquids and glasses under high pressure and high temperature conditions have not been well understood in experiments. In the past decades, new developments in high-pressure synchrotron X-ray experiments have advanced the study of liquids and glasses under pressure (cf. reviews in [1]). Here I will introduce experimental studies of structure and properties of liquids and glasses at high pressure and high temperature conditions at the beamline 16-BM-B in the Advanced Photon Source, USA.

The beamline 16-BM-B utilizes white X-ray combined with Paris-Edinburgh large volume press for studying structure and physical properties, such as viscosity and elastic wave velocities, of liquids and glasses at in situ high-pressure and high-temperature conditions [2]. The Paris-Edinburgh press allows the usage of large sample volumes (up to 2 mm in both diameter and height) to high pressures up to 7 GPa and high temperatures to 2000 °C. Structures of liquids and glasses are determined by a multi-angle energy dispersive X-ray diffraction technique. Ultrasonic techniques have been developed to investigate elastic wave velocity of liquids. Falling sphere viscometry, using high-speed X-ray radiography (>1000 frames/s), enables us to investigate a wide range of viscosity, from those of high viscosity silicates melts to low viscosity (<1 mPa s) liquids such as liquid metals or salts. The integration of these multiple techniques has promoted comprehensive studies of structure and physical properties of liquids and glasses at high pressures and high temperatures, making it possible to investigate correlations between structure and physical properties of liquids in situ. In addition, our recent development of double-stage large volume cell opened a new way to investigate structure of oxide glasses under ultrahigh pressure conditions of >100 GPa [3,4].

References

[1] - Y. Kono and C. Sanloup, Magmas Under Pressure: Advances in High-Pressure Experiments on Structure and Properties of Melts (2018).

[2] - Y. Kono, C. Park, C. Kenney-Benson, G. Shen, and Y. Wang, Physics of the Earth and Planetary Interiors **228**, 269-280 (2014).

[3] - Y. Kono, C. Kenney-Benson, D. Ikuta, Y. Shibazaki, Y. Wang, and G. Shen, Proceedings of the National Academy of Sciences **113**, 3436-3441 (2016).

[4] - Y. Kono, Y. Shibazaki, C. Kenney-Benson, Y. Wang, G. Shen, Proceedings of the National Academy of Sciences **115**, 1742-1747 (2018).