X線ラミノグラフィをダイヤモンドアンビルセルに用いた、高温高圧その場三次元構造解析

In situ 3D textural observations at high pressure and high temperature using X-ray laminography technique in diamond anvil cell

*中島 悠貴[1]、野村 龍一[2]、Xie Longjian[3]、米田 明[3]、上杉 健太郎[4]、廣瀬 敬[1]
*Yuki Nakashima[1], Ryuichi Nomura[2], Longjian Xie[3], Akira Yoneda[3], Kentaro Uesugi[4], Kei Hirose[1]

1. 東京工業大学、2. 愛媛大学、3. 岡山大学、4. 公益財団法人　高輝度光科学研究センター
1. Tokyo Institute of Technology, 2. Ehime University, 3. Okayama University, 4. Japan Synchrotron Radiation Research Institute

High-pressure and -temperature experiments have been widely conducted using diamond anvil cells to understand the structure and evolution of the Earth’s interior. Nowadays, 3D visualization technique has been developed to observe internal structure of the sample recovered from high pressures (Shi et al., 2013; Nomura et al., 2014). In addition, *in situ* high-pressure X-ray computed tomography techniques have been developed by transmitting X-rays through a light metal gasket such as Be (Liu et al., 2008; Wang et al., 2012). Using these techniques, geometric information such as the changes of the volume or shape of the sample with pressure is obtained. However, it is difficult to generate high-pressure and -temperature of the Earth’s lowermost mantle or the core with keeping sufficient sample thickness when light metal is used as a gasket.
To overcome this problem, Nomura and Uesugi (2016) introduced X-ray laminography technique (Gondrom et al., 1999) to diamond anvil cell. In X-ray laminography, the rotational axis of the sample is inclined to the direction of the incident X-ray beam. Therefore, the incident X-ray beam can avoid the metal gasket surrounding the sample; it is no longer necessary to use a light metal as a gasket. However, it is still challenging to combine such measurements with heating technique in the diamond anvil cell.
Here, to carry out *in situ* high pressure and “high temperature” X-ray imaging, we have introduced the internally resistive heating method by using boron-doped diamond as a heater material. Boron-doped diamond has high X-ray transmissivity and can generate high temperatures more than 3000 K with high stability (Yamada et al.,2008; Shatskiy et al., 2009; Yoneda et al., 2014; Xie et al., 2016). We performed X-ray laminography experiments at BL47XU, SPring-8. The sample was Au foil, heater was boron-doped diamond and pressure medium and heat insulator was Al_2O_3. We have obtained the X-ray transmission images of the sample at 20 GPa during heating. Obtained images were sufficiently clear, despite of the Re gasket and boron-doped diamond heater surrounding the sample. We have reconstructed cross-section images of the sample before and after heating. These cross-section images showed that the shape of the sample was largely altered by heating due to melting. The technique developed in this study will provide new method to determine the melting temperature of the sample at high pressure. Our current results demonstrate that the X-ray laminography can be a powerful tool for understanding dynamic process in the deep Earth’s interior, such as melting of the terrestrial materials.

キーワード：ダイヤモンドアンビルセル、X線ラミノグラフィ、その場三次元構造解析
Keywords: Diamond Anvil Cell, X-ray Laminography, In situ 3D textural observations

