Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SMP044-04 Room:301B Time:May 25 11:00-11:15

Development of density measurement method using X-ray micro tomography under pressure

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Density of melt is an important property for discussing melts related geodynamics processes in the deep Earth. Density measurement of melt at high-pressure is challenging because of its technical difficulties. Several methods, such as sink-float and the shock experiments have been developed to measure the densities of melts, but they are not enough. We have developed the novel X-ray absorption technique to measure the densities of melts at the desired P-T conditions using the multi-anvil press and synchrotron radiation. However, it has an intrinsic uncertainty because the length of sample is not measured directly. X-ray tomography is a breakthrough technique, which can yields the sample length as well as the sample absorption for X-ray. Thus, we are developing the new density measurement technique for melts using the high-pressure X-ray micro-tomography. Here we report the results of the reconnaissance experiments using the polycrystalline KBr up to 3 GPa.

X-ray tomography experiments were carried out using the tomography press TPH at BL20B2, SPring-8. The TPH is the 80 tons uniaxial press with two wide windows for observation and equips the toroidal type opposed-anvils. The TPH was set on the X-Y-Z-rotating stage and X-ray shadowgraphs of sample were acquired each 0.2 degree during rotation of the TPH. X-ray absorption of sample (I/I_0) was calculated from the shadowgraph image, and the sample length t was evaluated using the tomography slice image. Then, the densities of KBr at high pressures were calculated based on the Lambert-Beer law. The mass absorption coefficient of KBr was evaluated from the data acquired at 0.1 MPa, where the density is well defined.