High pressure generation up to 24 gigapascals using a D-DIA apparatus combined with jacketed anvils

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Rheological properties of high-pressure polymorphs of olivine are important to understand the cause of seismic anisotropy, viscosity structure, deep-focus earthquakes in the deeper part of the Earth’s mantle. Three types of deformation apparatus, namely, the D-DIA type (Wang et al., 2003), the rotational Drickamer apparatus (RDA: Yamazaki and Karato, 2001), and the Kawai-type apparatus for triaxial deformation (KATD: Nishihara, 2008) have been developed to deform high-pressure polymorphs of olivine. Although recent studies by Girard et al. (2015) and Tsujino et al. (2016) succeeded to deform bridgmanite at lower mantle pressures and temperatures using a RDA and a KATD respectively, in-situ D-DIA experiments are still limited to the conditions of lower part of the mantle transition zone (Kawazoe et al., 2016). The main cause disturbing further pressure generation using an in-situ D-DIA apparatus is relatively low toughness of the x-ray transparent anvils made from sintered diamond or cubic BN. In the geometry of cubic-type multianvil apparatus, the available press load needs to be low (usually < 0.6 MN) to avoid the breakage of the x-ray transparent anvils. The advantages of D-DIA apparatus are as follows: i) compatible with acoustic emission monitoring (i.e., many transducers are available) and ii) temperature can be monitored by using a thermocouple. To explore the quantitative deformation experiments at lower mantle conditions, we adopted the ‘jacketed’ 6-6 type anvils (Yamada et al., 2016) and optimized the cell assembly using preformed gaskets (e.g., Kawazoe et al., 2010). Combining these techniques, I succeeded to generate 24 GPa at room temperatures using a D-DIA apparatus (in the case of truncation edge length = 3 mm). Pressures higher than 20 GPa are also available using the ‘jacketed’ x-ray transparent anvils. Optimization of the design of ‘jacketed’ x-ray transparent anvil and cell assembly would lead to quantitative deformation experiments at lower mantle conditions in near future.

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