Development of nano-polycrystalline diamond anvil cells for neutron diffraction experiments under high-pressure

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Neutron diffraction requires significantly larger sample volume than the case of x-ray diffraction because of the relatively small scattering cross section, so that crystallographic studies by neutron diffraction have long been limited to 30 GPa by using the Paris-Edinburgh press (Klotz, 2012), which enables to load larger volume of samples than conventional diamond anvil cells (DACs). Recently, conically shaped single crystal diamond anvils were applied for high-P neutron diffraction for ice VII, and the highest pressure record of 94 GPa was established by Boehler et al. (2013). On the other hand, we have noted that nano-polycrystalline diamond (NPD) rather than single crystal diamond could have a great potential for neutron diffraction (e.g., Okuchi et al., 2010), because of its orientaion-independent hardness owing to the absence of cleavage. Here we report on the development of originally designed anvil cells by using NPD specifically for neutron diffraction studies. Cylinders of NPD with 6 mm diameter and 6 mm height were supplied from GRC, Ehime Univ. and cut and polished to single beveled anvils with 1 mm culet diameter by Syntek co., ltd. Stainless steel (SUS301) drilled with 0.5 mm hole were used as gaskets. Load was applied by the Paris-Edinburgh press (VX2), which was placed on the gonio stage of the beamline PLANET (BL11) in J-PARC. We managed to obtain neutron diffraction from iron oxide up to at least 40 GPa without any damage of anvils, but the diffraction peaks were broadened when deuterated glycerol was used as pressure transmitting medium. We are now developing a gas-loadable cell and it will be tested near future.

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