

Internally resistive heated diamond anvil cell experiments with metal encapsulated minerals

*YAMAMOTO TOMONARI¹, Kenji Ohta¹, Sho Suehiro¹, Hayato Inoue¹

1. Tokyo Institute of Technology

Heating technique is crucial for *in-situ* high pressure-temperature (P - T) studies into the physical and chemical properties of minerals in the diamond anvil cell (DAC) under deep Earth's conditions. External resistive heating methods that use resistive heaters such as AlChrom-O wire and graphite surrounding the DAC or just the diamonds (Dubrovinskaia and Dubrovinsky, 2003; Du et al., 2013). This approach creates a homogeneous temperature field in the sample chamber but limits the maximum temperature of about 1200°C due to graphitization of diamond anvils. Double-sided laser heating with a DAC generates the P - T conditions corresponding to the center of the Earth's (Tateno et al., 2010). However, tightly focused laser beams, instabilities in output laser power and misalignment of the focused beams on the sample surface result in significant temperature variation within the sample in the DAC. Internally resistive heated DAC is an effective heating method to overcome the temperature limitation of external heated DAC and the significant temperature gradients experienced in conventional laser-heated DAC (e.g., Zha and Bassett, 2003). However, the internally resistive heated DAC is mostly applied to metal sample to study the properties of the planetary metallic core despite this technique could be applicable to an insulating mineral.

In this study, we modified the internally resistive heated DAC technique for nonmetallic material. We developed a microfabrication technique for total metal encapsulation of the nonmetallic sample. The sample encapsulated by platinum was loaded in DAC with thermal insulator and connected with two electrical leads to make electrical circuit for resistive heating. We confirmed very stable and homogeneous heating for insulating sample at 30 GPa to 2450 K in the modified internally resistive heated DAC. The highest temperature which this method can generate depends on the metal heater encapsulating the sample. This method offers a larger heating volume with more stable and uniform temperature than laser heating and at temperatures much greater than those that can be generated by external resistive heating methods.

References

- Dubrovinskaia, N., & Dubrovinsky, L. (2003). Whole-cell heater for the diamond anvil cell. *Review of Scientific Instruments*, 74(7), 3433-3437.
- Du, Z., Miyagi, L., Amulele, G., & Lee, K. K. (2013). Efficient graphite ring heater suitable for diamond-anvil cells to 1300 K. *Review of Scientific Instruments*, 84(2), 024502.
- Tateno, S., Hirose, K., Ohishi, Y., & Tatsumi, Y. (2010). The structure of iron in Earth's inner core. *Science*, 330(6002), 359-361.
- Zha, C. S., & Bassett, W. A. (2003). Internal resistive heating in diamond anvil cell for in situ X-ray diffraction and Raman scattering. *Review of scientific instruments*, 74(3), 1255-1262.

Keywords: Internally resistive heated diamond anvil cell, high pressure-temperature experiments