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Internally-heated diamond anvil cell experiments on Earth's core materials

Tetsuya Komabayashi[1*]

[1]Dept. Earth Planet. Sci., Tokyo Tech.

I will review the recent technical development of the so-called internally heated diamond anvil cell (DAC) experiments on Earth's core materials. As iron is the primary phase of the Earth's core, its phase relations have been extensively investigated for the last 50 years, mostly by means of high-pressure experiments. For high-temperature DAC, high temperature can mostly be achieved by either a laser-heating or an external-heating system. Laser-heating produces very high temperatures ($>$ 3000K), but the heating stability may be affected by many factors during the heating and the temperature uncertainty is large (+- 200 K). The external-heating system can stably heat the sample and the temperature uncertainty is small (+- 10 K) but it is limited to lower temperatures ($<$ 1300 K). We have developed a resistive internal-heating technique, in which thin iron (alloy) foil served as a heater and a sample simultaneously. By resistance heating, it produces much more stable heating than the laser-heating technique and much higher temperature than the external-heating system. Together with an angle-dispersive high-resolution X-ray diffraction method, we have carried out high-P-T in-situ measurements of the gamma-epsilon transition in Fe and Fe-Ni alloy. Accurate determination of the gamma-epsilon transition boundary is essential for assessing the phase diagram of iron at high pressure and temperature. In addition, it is quite useful for testing and deriving a thermodynamic model of the pure iron because many of the thermodynamic parameters for the gamma and epsilon phases cannot be directly measured. In addition, I will also present new data of Fe-Si alloy from the internally-heated DAC.

Keywords: high-pressure experiment, diamond anvil cell, resistive-heating, internal-heating, Earth's core