Experimental examination of self-diffusion coefficient of iron under high pressure and its implication to the viscosity of the Earth's inner core: a preliminary result

*Yohan Park[1], Kenji Ohta[1], Shoichi Itoh[2], Kei Hirose[3]

1. Tokyo institute of technology, 2. Kyoto University, 3. University of Tokyo

Complex seismic anisotropy of the Earth's inner core suggests various possible mechanisms for its dynamics. However, viscosity of the inner core, the key parameter to investigate its dynamical processes, is one of the most vaguely known physical properties. Knowing self-diffusion coefficient of iron, the main component of the Earth's core, under high pressure is crucial to understand viscous flow in the inner core since pressure effects on viscous behavior of metals are generally related to pressure dependence of its self-diffusion coefficient. While Fe-Ni inter-diffusion experiments under high pressure have been conducted as a proxy of iron self-diffusion, to our knowledge, pressure effects on self-diffusion coefficient of iron have never been experimentally studied. Here, we performed diffusion experiments on iron under high pressure by using internally resistive heated diamond anvil cell (IHDAC) to evaluate pressure effects on self-diffusion coefficient of iron. Diffusion couple composed of ^{56}Fe-rich and ^{57}Fe-rich layers was loaded into IHDAC and heated by joule heating from its own electrical resistivity. Temperature of ~1840 K was maintained under pressure condition of ~30 GPa during diffusion experiment. Planck radiation from the heated hot spot was collected and used for temperature estimation. After heating, the sample was recovered and subsequently polished to make a cross section across the diffusion boundary. Secondary Ion Mass Spectrometry (SIMS) analysis on the cross section of the heated diffusion couple was conducted to obtain iron isotopes distributions, hence diffusion profiles. Quantitative reliability of our diffusion profiles is currently under estimation. The diffusion coefficients of iron will be extrapolated to the actual inner core pressure-temperature conditions and applied further to the known flow law of metals for estimating viscosity of the inner core.

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