The 521th Geodynamics Seminar

Rheology of hcp-iron studied using D111-type apparatus

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Seismic observations have revealed presence of axi-symmetric anisotropy with respect to polar direction in the Earth's inner core which consists of solid metal, where a P-wave propagating along the polar direction is ~3% faster than that along the equatorial direction. Although many hypotheses have been proposed for origin of seismic anisotropy in the inner core, there is no general consensus for its origin. Dominant mechanism of the inner core dynamics depends on the inner core age and viscosity. Since the inner core is considered to consist of hexagonal close-packed iron(hcp-iron), information of viscosity of hcp-iron is a key for the understanding of the inner core dynamics. We have studied rheology of hcp-iron based on high-pressure and high-temperature deformation experiments. Uniaxial deformation experiments were carried out using a D111-type apparatus installed on a beamline NE7A at PF-AR, KEK and a deformation-DIA apparatus installed on a beamline BL04B1 at SPring-8. Deformation experiments were carried out at pressure of 15.1-22.6 GPa, temperature of 423-873 K. The results suggest that power-law dislocation creep with stress exponent of ~5 is dominant at >~800 K whereas a low-temperature mechanism with power-law breakdown is predominant at lower temperatures. Extrapolation of the data based on homologous temperature scaling suggests that viscosity of hcp-iron at the inner core conditions is ~10^{21} Pa s or higher when the power-law dislocation creep is assumed to be the dominant mechanism.

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