Grain growth of ε-iron

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Seismology revealed the hemispherical asymmetry of the Earth's inner core (e.g., [1]). Based on the multiple scattering method, the estimated grain size at eastern side is larger than that in western side [2]. It is proposed, therefore, that the inner core is translating from west to east to explain such heterogeneity, which is supported by the geodynamical consideration of the ellipsoidal convection model [3]. In this model, the grain size variation in the observation is derived from the grain growth during translation. If this is the case, grain growth rate provides the time scale for the translation and hence constraint of the inner core age. In the present study, we experimentally determined the grain growth rate of ε-iron, which is considered to be dominat phase in the inner core [4], at high pressure and temperature.

We carried out in situ obervation experiments at ~55 GPa and 1200-1500 K by using a Kawai-type multianvil apparatus equipped with sintered diamond anvil at the synchncroton facility. Polycrystalline iron was prepared for starting material. In the experiments, the monochromatic X-ray beam with wavelength of ~51 keV was used as incident beam and the diffracted beam is received by two dimensional detector, imaging plate or CCD. We estumated the grain size using the relationship that the number of diffraction spots on two dimensional detector that fulfill the Bragg's condition is proportional to the number of grain in the radiated volume.

By fitting the data to the grain growth law, the grain growth rate of ε-iron at 55 GPa was determined and it is ~6 orders of magnitude lower than that of α-iron [5]. We extrapolate the grain growth rate at 55 GPa to the inner core conditions and we calculated the grain size in the inner core for the given initial grain sizes and time span. Based on the seismological observation that the grain sizes in the east side and west side of the inner core are 5-10 km and 300-700 m, respectively, the present result indicates that the time span for grain growth requires more than for 2.9 Gy.

[1] Tanaka et al. (1997) *J. Geophys. Res.* **102**, 2925-2938. [2] Monnereau et al. (2010) *Scicence*, 328, 1011-1017. [3] Alboussiere et al. (2010) *Nature*, 466, 744-747 [4] Tateno et al. (2012) *Geophy. Res. Lett.*, 39, L12305. [5] Hu (1974) *Can. Metall. Quart.*, 13, 275-286.