Iron diffusion in ε-iron

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Seismic observations in the inner core suggest the variation in the seismic attenuation between the western side and eastern side of the inner core (Monnereau et al., 2010, Iritani et al., 2014, Pejic et al., 2017). Western side shows 2-3 times higher quality factor and smaller attenuation than western side. For the constraint on dynamics of the inner core, it is important to understand the reason why such variation is formed. The inner core is mainly composed of hcp Fe-Ni alloy with some amount of light element(s). Rheological properties of hcp iron (ε -iron) are therefore keys for understanding such seismological features because there is strong relationship between quality factor and viscosity. Taking account into the secular growth of the inner core in the light elements enriched outer core, the investigation of the effect of light element(s) on viscosity of ε -iron is necessary for understanding rheology of ε -iron of the inner core. In this study, we determine self-diffusion of iron in ε -iron at high pressure and temperature and investigate the effect of silicon, as one of candidate of light element, on the diffusivity by means of isotope diffusion method with high pressure experiments. We conducted high pressure experiments at pressures of 40-55 GPa and temperatures of 1300-1400 K in the Kawai-type multianvil apparatus installed at Okayama University. In the experiments, the natural isotopic iron and ^{54}Fe enriched iron was used as diffusion couple together with 3 wt.% silicon bearing iron. Diffusion profiles were obtained by using isotope imaging technique using SIMS1270 at Hokkaido University. Obtained diffusion profiles indicate that self-diffusion coefficient of iron in pure ε -iron is slightly higher than that in silicon bearing iron. This suggest that the observed large variation in quality factor is difficult to be explain by simple alloying by silicon.

