Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SIT003-11 Room:101 Time:May 26 11:35-11:55

The crystal structure of iron at the inner core

Shigehiko Tateno[1*], Kei Hirose[1], Yasuo Ohishi[2], Yoshiyuki Tatsumi[3]

[1]Tokyo Institute of Technology, [2]JASRI, [3]JAMSTEC

The Earth's solid inner core is mainly composed of iron. Thus the crystal structure of iron is of prime importance for understanding the nature of solid inner core. Despite many efforts to investigate phase relations of iron have by dynamic and static compression, and theoretical calculation, consensus on the stable phase at the inner core condition has never been achieved. While hcp-Fe can persist to core pressures at 300 K, a phase transition at elevated temperature is a possibility. Both theory and experiments proposed different forms of iron at simultaneously high P-T conditions, which include bcc, face-centered-cubic (fcc), and hcp structures. The structure of iron has never been examined experimentally at the inner core P-T conditions (>330 GPa and >5000 K), because such extreme conditions could only be achieved by shock-wave compression experiments.

Based on static compression experiments in a laser-heated diamond-anvil cell (DAC), we determined the structure of iron up to 377 GPa and 5700 K. Iron powder and thermal insulation layers of SiO2 glass were loaded into a hole of a pre-indented rhenium gasket placed in the For experiments beyond 300 GPa, the double-beveled diamond anvils with 40-microns culets were used, and accordingly the sample size was limited to about 20 microns. Heating was performed from both sides of the sample by employing two single mode, Yb fiber lasers with output power up to 100 W each with flat-top beam shaping optics to minimize temperature gradient across the sample. Angle-dispersive x-ray diffraction measurements were conducted at BL10XU of SPring-8.

Six separate sets of experiments were conducted in a wide P-T range from 135 GPa and 2690 K to 377 GPa and 5700 K. We observed crystal growth and hence the stability of hcp-Fe at these P-T conditions with no evidence for a phase transition to bcc nor fcc iron phases. The c/a axial ratio of hcp-Fe at high temperature was also studied, which has significant effect on the nature of the elastic anisotropy. We found that c/a ratio at 330 GPa is substantially lower than the ideal value of 1.6299 for hcp structure with small temperature dependence, which is contrary to the theoretical studies. These observations suggest the should be elastically anisotropic even at the high temperature conditions of the inner core.

Keywords: core, iron, DAC