Electrical property and compressional behavior of Fe-Si alloys under high pressure

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The density of the core is smaller than that of pure iron under the core conditions. Therefore, the core has been considered to contain light elements, such as H, S, Si, C, and O. In particular, Si is one of the most important light elements in the core because Si is a major element in the Earth and depleted in the mantle compared to CI chondrite. Although the phase relations and compression behaviours in the Fe-Si alloys have been studied at high pressure and temperature in order to investigate properties of the inner core, electrical properties of Fe-Si alloys have not been investigated well. Recently, electronic topological transitions of Fe and Fe-Ni alloys under high pressure were reported by Glazyrin et al. (2013) and they suggested Fe and Fe-Ni alloy changed their elastic properties before and after the transition. In order to clarify the electrical properties of the Fe-Si alloys, we made simultaneous measurements of XRD and synchrotron Mössbauer spectroscopy on the Fe-Si alloys up 60 GPa at RT.

The Mössbauer spectra and XRD patterns of $Fe_{0.95}Si_{0.05}$ and $Fe_{0.88}Si_{0.12}$ enriched with ^{57}Fe were obtained at the beamlines, BL10XU and BL11XU of SPring-8. The isomer shift and c/a ratio changed discontinuously at 37 GPa for $Fe_{0.95}Si_{0.05}$ and 52 GPa for $Fe_{0.88}Si_{0.12}$ respectively. The present results implied that the hcp phase of Fe-Si alloy underwent the electronic topological transition. The similar change in c/a of Fe was also reported by Ono et al. (2010) at RT and Ono (2015) at HT. These results suggested the changes occurred higher pressure at higher temperture, suggesting the change may occur under the core conditions.

Glazyrin et al. (2013) Physical Review Letters, 110, 117206.
Ono et al. (2010) American Mineralogist, 95, 880-883.
Ono (2015) Solid State Communications, 203, 1-4.