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コア圧力下における Fe-FeS 系の融解実験
Melting experiments in the system Fe-FeS at core pressures

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Most of the Earth's core is iron and nickel alloy. However, the density of the core acquired from Preliminary reference Earth model (PREM) is smaller than that of pure iron. The amount of deficit is 6-10 wt % at the outer core and 1-3 wt % at the inner core. To explain this deficit, the core might contain one or more light elements (H, C, N, O, Si, S).
S is depleted in the crust and mantle compared to other volatile elements (Poirier ,1994). Moreover, iron meteorites contain S (Chabot, 2004), thus we focus on S. In order to discuss the composition of the core, the phase diagram is important. The bulk core composition must be Fe-rich side at inner core boundary (ICB) because the outer core incorporates larger amounts of light element than the inner core. Fe-FeS phase diagram is determined by X-ray diffraction (XRD) pattern (e.g. Morard et al. 2008) or chemical analysis of recovered sample (e.g. Kamada et al. 2012). However, no accurate determination of the eutectic composition has been obtained by XRD. On the other hand, constraining by chemical analysis has not been done using sample recovered from core pressure. Thus, we examine Fe-S phase diagram at higher pressure.

High pressure and temperature (P-T) conditions were generated in a laser-heated diamond-anvil cell. We used Fe-7.5, 13.5 wt.% S foil as a starting material. Angle-dispersive in situ X-ray diffraction (XRD) measurements at high P-T were conducted at BL10XU, SPring-8. The textural and chemical characterizations of recovered samples were made with a field-emission-type scanning electron-microprobe (FE-SEM) equipped with energy dispersive x-ray spectrometry (EDS) and with a field-emission-type electron probe microanalyzer (FE-EPMA). Cross sections of samples were carefully examined by combining a focused Ga ion beam (FIB) with FE-SEM.

From quantitative analysis, we observed the trend that the amount of S in melt decreases and that the amount of S in the solid Fe increases with increasing pressure.
Obseving the sample using Fe-7.5 wt % S by SEM, we can see the 3 textures; melt, solid Fe, subsolidus phase. Melt includes more S than solid Fe. The content of S in liquid is between 12.5 and 10.4 wt. % in the range of 38-138 GPa. The eutectic composition is expected to have S than molten iron. Moreover, according to the experiment using S rich starting material, the texture of recovered sample contain melt ,Fe3S, subsolidus phase. The S content in melt is larger than that in eutectic composition.Using both of S-rich and S-poor starting material, we can constrain the eutectic composition.

Assuming that the negative pressure dependence of S content in melt is retained up to ICB pressure, the content of S in liquid Fe at ICB pressure is lower than 10 wt %. The S amount required to explain core density deficit (CDD) is 11.9-13.9 wt.% at outer core and 6-6.6 wt. % at inner core (Sata et al. 2010) . In this condition, the S content of eutectic composition is more than 11.9 wt.%. However, this value is great comparing to the eutectic composition expected from this study. Therefore, S is not the only light element inthe Earth's core.

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