The 409th Geodynamics Seminar

Density measurements of iron alloys at high pressure and high temperature

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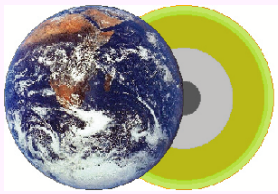

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Abstract

The Earth's inner core and the outer core are believed to be composed mainly of solid and liquid iron-nickel alloys. In 1960s, Birch suggested that the density of the outer core is about 10% lower than the density of iron at the core pressures and temperatures, indicating a presence of light components in the outer core. Since then, a number of elements including hydrogen, carbon, oxygen, sulfur, and silicon have been proposed to be candidates for the light elements in the core. In addition, multiple studies suggested that the inner core is also less dense than pure iron. Since the existence of light elements affect the phase diagrams, melting temperatures, densities, and other physical properties of iron alloys. Thus, knowledge of the composition of the Earth's core is fundamental to interpret the seismic observations and understand the nature of the Earth's core. In order to determine the amount and species of the light elements in the core, a straightforward method is to compare the physical properties of iron alloys at high pressure and temperate conditions with seismic models of the Earth, such as PREM. The high pressure behavior of solid iron alloys, including the density and bulk modulus, have been widely studied both experimentally and theoretically. Although theoretical studies on liquid iron alloys have also been performed by several groups, density measurements of liquid iron alloys at high pressure by experimental studies are limited. Shock wave experiments were performed only along the Hugoniot. For static experiments at higher pressure than several tens GPa, only Morard et al. (2014) has reported the densities of liquid Fe-5wt%Ni-12wt%S and Fe-5wt%Ni-15wt%Si up to 94 GPa determined from x-ray diffraction studies in a laser heated diamond anvil cell. In order to understand the compositional variations of potential iron alloys in the Earth's core and to construct the density model of the Earth's outer core, further studies on various iron alloys at higher pressures are required. In particular, the density of liquid pure iron would be a baseline to understand the origin of the density deficit of the core. In order to determine the density profile of liquid iron alloys at high pressures, we performed in-situ x-ray diffraction measurements of liquid iron alloys, including pure iron, using a laser heated diamond anvil cell. In this study, I will show recent experimental results of liquid alloys and discuss about analyses of density determination.

詳細は当センターホームページ：http://www.grc.ehime-u.ac.jp/をご覧ください
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