【Grant-in-Aid for Scientific Research (S)】

Science and Engineering (Mathematical and Physical Sciences)

Title of Project： Creation of the Best Model of the Earth's Core

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Research Project Number：15H05748　Researcher Number：60136306
Research Area：　Mathematical and Physical Sciences
Keyword：　Earth's core, High-pressure and high-temperature, Inelastic X-ray scattering, Mossbauer, Sound velocity

【Purpose and Background of the Research】

This research project aims to create the model which can explain the seismological observations of the Earth's core based on our new high pressure and temperature experiments on the Earth's core materials. Our research clarifies the partitioning behaviors of light elements between metallic iron alloy solid and liquid at high-pressure and high-temperature, sound velocity measurements of solid and liquid iron-light element alloys based on the inelastic X-ray scattering (IXS) and/or ultrasonic method, and magnetic and electronic states of the alloys based on the synchrotron Mössbauer spectroscopy (SMS), and the equation of state of the alloys using X-ray diffraction (XRD) method. Summarizing the data set on the physical properties of Earth's core materials, we will create the model of the Earth's core which can account for the seismological observations.

【Research Methods】

We determine the partitioning behaviors of the light elements (O, S, Si, C, H) and Ni between metallic iron solid and liquid, and metallic iron and silicates at high pressure and temperature based on the double sided laser heated diamond anvil cell (see Figure 1).

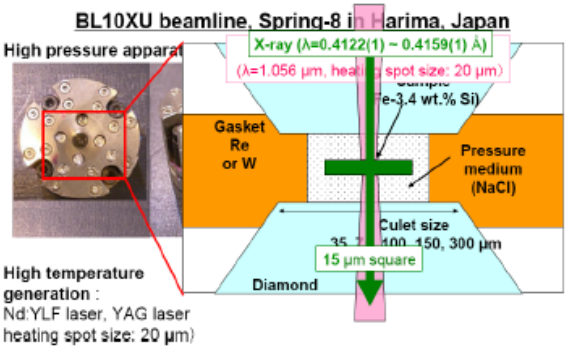

Figure 1. Double sided laser heating Diamond anvil cell used in this study

We also determine the sound velocity, electronic and magnetic states, and equation of state of the earth's core materials such as Fe, Fe-Ni, Fe-Si, Fe3S, Fe_3C, FeO, FeH etc based on their systematic study using IXS and ultrasonic, SMS, and XRD respectively..

【Expected Research Achievements and Scientific Significance】

Figure 2(a) shows an example of the IXS spectra determined at 164 GPa and 3000 K, and Figure 2(b) shows the dispersion curves determined by the IXS spectra obtained at high pressure and temperature. We will make similar measurements for various iron-light element alloys, and create a new model of the Earth's core and the core formation processes. We can clarify unsolved problems on the core, such as seismic velocity anisotropy, inhomogeneity of the inner core, velocity anomalies at the base and top of the outer core.

【Publications Relevant to the Project】

・Sakai T, Takahashi S, Nishitani N, Mashino I, Ohtani E, Hirao N, Equation of state of pure iron and $Fe_{0.9}Ni_{0.1}$ alloy up to 3 Mbar. Phys. Earth Planet. Inter., 228, 114-126, 2014.
・Ohtani E, Shibazaki Y, Sakai T, Mibe K, Fukui H, Kamada S, Sakamaki T, Seto U, Tsutsui S, Baron Q. R. A., Sound velocity of hexagonal close-packed iron up to core pressures. Geophys. Res. Lett., 40, 5089-5094, 2013.
・Ohtani, E, Chemical and Physical Properties and Thermal State of the Core. Physics and Chemistry of the Deep Earth, First Edition. Chapter 8, Edited by Shun-ichiro Karato. John Wiley & Sons, Ltd. Published 2013 by John Wiley & Sons, Ltd., 244-270, 2013.

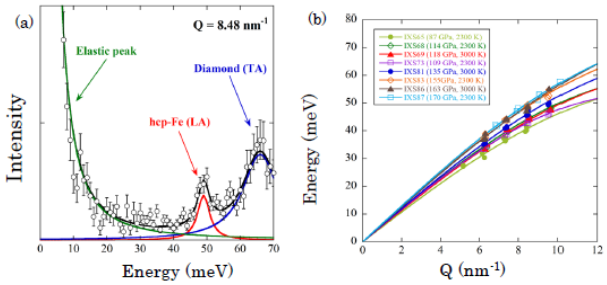

Figure 2. (a) Example of IXS spectrum of hcp-Fe at 164 GPa and 3000 K, (b) Dispersion curves determined by IXS measurements of hcp-Fe at high pressure and temperature

【Term of Project】

FY2015-2019

【Budget Allocation】

149,700 Thousand Yen

【Homepage Address and Other Contact Information】

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