SIT02-P04 会場:コンベンションホール 時間:5 月 22 日 17:15-18:30

遷移層までの圧力におけるマントル鉱物の熱的性質の測定
Thermal property measurements of mantle minerals under pressures to the transition zone

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Determination of thermal diffusivity or thermal conductivity under high pressure and at high temperature is a vital issue for the study of the mantle dynamics, and knowledge of heat capacity under pressure has a significance for assessment of the equations of state of the Earth's interior. So far thermal diffusivity and thermal conductivity of upper mantle minerals were measured using the pulse-heating method of one-dimensional heat flow. This simultaneous measurement also yields heat capacity data. It was found that the thermal conductivity or thermal diffusivity of olivine and garnet, increased 3-4 % per 1 GPa, and that olivine likely maintained anisotropy in thermal diffusivity or thermal conductivity under the conditions in the upper mantle. Thermal properties of jadeite, an analogue material of pyroxene, were also measured, however, the thermal properties of pyroxene under pressure have not yet been well elucidated. Antigorite, a high-temperature form of serpentine, has low thermal diffusivity and low thermal conductivity which are much lower than those of olivine. All the experiments were conducted at pressures up to 10 GPa and temperatures to 1100 K, therefore, another cell assembly is needed to expand the pressure range of measurement.

A new pressure-cell assembly similar to our previous one is designed for a sample of 3 mm in diameter and 0.7 mm in thickness. This smaller cell is immediately necessary for measurement of pyroxene of which sample size is limited owing to use natural single crystals of this mineral. In addition, this cell enables us to make measurements of thermal properties at pressures exceeding 15 GPa, which will covers the condition in the mantle transition zone. The measurements will be conducted using the Kawai-type apparatus at the Institute for study of the Earth's interior, Misasa.

We obtained preliminary results using this cell for the garnet sample. The thermal diffusivity showed lower value (~15 %) and the thermal conductivity was slightly high value compared with the previous results using the large cell, although their pressure derivatives consist with the previous ones. The precision of measurements will be improved by well-controlled machining of the cell assembly and by refining the data acquisition system. Heat capacity data with far precision are required for discussing the equations of state in the Earth's interior. For this purpose assessment by a finite-element method is a promising tool to optimize the cell assembly.

キーワード: 熱拡散率, 熱伝導率, 比熱, 高圧力, マントル鉱物
Keywords: thermal diffusivity, thermal conductivity, heat capacity, high-pressure, mantle minerals