論文 / 著書情報
Article / Book Information

題目(和文)	地球深部を成す物質の熱伝導率測定: コアとマントルの熱進化への解明への貢献
Title(English)	Thermal conductivity measurements on deep Earth ’ s materials: Contributions to elucidation of evolution of core and mantle
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論文要旨

THESIS SUMMARY

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要旨（英文800語程度）
Thesis Summary（approx.800 English Words ）

The Earth has been cooling since its birth. The thermal conductivities of Earth's core and mantle constrain important events for global thermal evolution, such as the inner core age, and unclear temperature structure in the deep Earth. It has been technically difficult to measure thermal conductivity at the high pressure and temperature (high *P*-*T*) conditions corresponding to the deep Earth, and the existing methods for the measurement have technical problems. In Chapter 1, as an overall introduction of this thesis, I introduce the importance of thermal conductivities of deep Earth' s materials, the overview of studies on the thermal conductivity determination, and the problems of the studies. In Chapter 2, I developed a new apparatus for high *P*-*T* thermal conductivity measurements and demonstrated the measurements on Pt and Fe samples using the apparatus at mid lower mantle conditions. The uncertainties in the pressure and the temperature are estimated to be approximately 10%, and that in the thermal conductivity is estimated to approximately 15%. In Chapter 3, I measured thermal conductivity of pure Fe up to 180 GPa and 3000 K. At the conditions of the top of core, the thermal conductivity and Lorenz number (a constant that represents the relationship between the thermal conductivity and electrical resistivity of a metal) of hcp Fe are found to be about 200 W/m/K and 14 ~ 36% lower than the ideal value of 2.44×10^{-8} WΩ/K^2. My obtained thermal conductivity is inconsistent with the reported values of pioneering thermal conductivity measurements at the core conditions, but it is as high as recently expected from electrical resistivity measurements and computational studies, which supports the high thermal conductivity of the core and the young inner core. In Chapter 4, I measured thermal conductivity of MgO up to 140 GPa and 2000 K. A number of computed works reported the thermal conductivity of it because of the simplicity of the crystal structure as a demonstration of new approach to the calculation of the thermal conductivities of lower mantle minerals. There is a difference of about 3 times in the values, however, and the difference provides the uncertainty to reveal temperature structure and thermal evolution of deep Earth. In this study, the pressure condition for high temperature thermal conductivity measurements, which was limited to about 30 GPa, was expanded to 140 GPa corresponding to the lowermost mantle. My obtained high *P*-*T* thermal conductivity of MgO is in harmony with its calculated thermal conductivity using lattice dynamics calculations and the linearized phonon Boltzmann transport equation. The calculation method and the measurement method of this study should be useful for the thermal conductivity determination of lower mantle minerals. In Chapter 5, I measured thermal conductivity of (Mg,Fe)O ferropericlase (Fp) up to 140 GPa and 2000 K. Fp is considered to be the second most abundant mineral in the lower mantle. The important characteristics of Fp in the deep mantle is the occurrence of Fe spin crossover, which affects its thermal conductivity. However, the thermal conductivity of Fp in the low-spin state has not yet been measured at high *P*-*T* conditions. I measured thermal conductivity of Fp in the low-spin state at lowermost mantle pressure and up to 2000 K and elucidated its temperature dependence as $T^{0.45}$. The thermal conductivity of the lowermost mantle was calculated by combining the present thermal conductivity of Fp with the conductivities of other major mantle constituents. At lowermost mantle conditions, my thermal conductivity value of lowermost mantle aggregate is 7.1 ~ 13.3 W/m/K, which is close to the conventionally used conductivity value of 10 W/m/K. However, the previous estimation is based on mineral combinations assumed prior to the discovery of $MgSiO_3$ perovskite, which differs from those currently proposed. The consistency of thermal conductivity is a coincidence. In the last chapter (Chapter 6), I combined the core and mantle thermal conductivities data to estimate the temperature structure of the thermal boundary layer above the core-mantle boundary (CMB). As a result of simulation using the finite element method, it was found that the thickness of the thermal boundary layer on the CMB is less than 250 ~ 350 km. The thickness is similar to that of the D" layer. I suggested the possibility that the D″ layer is the thermal boundary layer which is formed on the CMB, which has been proposed from seismic wave velocity profile. This study is the first to support this hypothesis based on the measured heat transport properties of the mantle and core minerals.

備考 ： 論文要旨は、和文2000字と英文300語を1部ずつ提出するか、もしくは英文800語を1部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).