# Measurement of heat capacity of mantle materials under high pressure

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Heat capacity data of materials of the earth's mantle are vital not only for investigating dynamic aspects and for tracking thermal regime of the earth but also for constructing equations of state of the earth's interior. Since measurement of heat capacity of mantle materials under high pressure has not yet been conducted, such experimental work will lead to new development for mineral physics. Unlike the case of transport coefficient such as thermal conductivity, the heat capacity can be estimated to an approximately limited value from theoretical considerations. Heat capacity should be, however, determined because a calculation such as Debye's approach shows discrepancy to 10 % with observed value. Pressure derivative of heat capacity relates to thermal expansion through the identity of thermodynamics. If we observe heat capacities of the materials of the earth's interior under high pressure with sufficient precision, we can obtain valuable constraints for the equations of state of the earth's interior.

Measurements under high-pressure have a disadvantage that insulation of heat flow cannot be ideal because of a pressure medium surrounding the sample, and accordingly, it is hard to measure the heat capacity by a rise in temperature for an amount of heat transmitted into the sample. If measurement of the other thermal properties is applicable to tell heat capacity, this could be a hopeful method to determine heat capacity under high pressure. The authors have been measured thermal diffusivity and thermal conductivity simultaneously under high pressure for mantle materials using a pulse-heating method. Heat capacities of olivine and garnet were determined from data of thermal diffusivity, thermal conductivity, and density. Their values extrapolated to zero-pressure agreed to those of literatures within 5 %. Furthermore, a change in temperature of the heat capacity of olivine at pressure of 8.3 GPa was calculated. The values for the three crystallographic axes of olivine (intrinsically these should correspond) showed a tendency toward small from those at zero pressure, although a few scattering data points were seen at high temperatures. This is consistent to the case that the thermodynamic identity indicates the decrease in heat capacity with pressure increase.

Improvement in the remarkable precision is necessary when the measurements of heat capacity are applied for examination of the equations of state of mantle materials under high pressure. In the previous measurements of thermal diffusivity or thermal conductivity, refinements for acquisition of data have been performed to eliminate noises and drifts affecting the signals from a thermocouple and to devise a method for data analysis. Nevertheless, the pressure derivatives from the thermal diffusivity and the thermal conductivity are considerably different from that obtained by thermodynamic calculations using thermal expansion data under high pressure. Moreover, the pressure derivatives show significant difference among the runs of measurement. This is probably caused by slight variation in sizes or positions of the sample and the surrounding components in the cell assembly. Furthermore, such errors could be also caused by unexpected deformation of the sample assembly at the initial stage of compression, in particular, a subtle mutual displacement of the sample, the impulse heater and the thermocouple. It should be needed to decrease in systematic errors by improving machinery precision of the sample assembly. Basically, this impulse method of thermal property measurement requires a condition that the sample has the infinite area. Preliminary heat flow analysis for the sample assembly indicates that this condition is sufficiently satisfied for the ratio of thickness to area in the sample used for the measurements. In order to improve the accuracy of the measurements, the sample assembly should be further optimized by using heat-flow simulation.