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Measurements of high pressure-temperature thermal conductivity of the Earth's lower mantle minerals in a laser-heated diamond anvil cell

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The thermal transport properties of the Earth's constituents are important information to understand thermal evolution and the heat budget of the Earth. Thus, the experimental determination of thermal conductivity of deep Earth materials are required. The diamond anvil cell (DAC) is capable of accessing the pressure-temperature conditions of the Earth's deep interior, and is compatible with laser optical techniques. The pulsed light heating thermoreflectance (TR) method has been applied to a DAC in order to measure thermal conductivity and diffusivity of condensed material [1,2]. This TR with DAC method successfully obtained the thermal conductivity of the Earth's lower mantle minerals to the pressure condition equal to the Earth's core-mantle boundary (135 GPa) but at room temperature [3]. To extend measurable temperature range, the TR method may be combined with a laser-heated DAC (LHDAC) technique that is able to generate the pressure-temperature condition equivalent to the center of the Earth.

We recently developed a new instrument to measure the thermal diffusivity (and thus thermal conductivity) of sample *in-situ*at high pressure and temperature based on the combination of the TR method and the LHDAC system. We use a double-sided high-power CW laser heating technique to generate stable high temperature conditions of sample in a DAC. A pulsed pump laser and a CW probe laser are also irradiated to the sample to determine heat diffusion time through the sample via the thermoreflectance phenomena. Details of the thermoreflectance technique in a DAC may be found in our previous studies [2]. Using the developed method, we measured the thermal conductivity of the main minerals in the Earth's lower mantle, MgO periclase, $MgSiO_3$bridgmanite, post-perovskite and $CaSiO_3$ perovskite*in-situ*at high pressures and high temperatures. These are the first experimental demonstrations of thermal conductivity of the lower mantle minerals at the conditions below the mid-part of the Earth's lower mantle. The new thermal conductivity measurement system will shed light on the controversial thermal transport properties of the Earth's deep interior [4].

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