Newly developed internal-resistive heated diamond-anvil cell with boron-doped diamond: Toward deep lower-mantle petrology

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The development of the diamond-anvil cell (DAC) technique combined with laser heating enabled easy access to the entire lower-mantle pressure and temperature regime at laboratory. However, a number of major issues remain highly controversial, including the location of the post-perovskite phase boundary, solid–liquid iron partitioning, Fe–Mg partitioning among mantle minerals, and melting temperatures of mantle rocks. Although the discrepancies between previous experimental studies on these issues have likely arisen from multiple sources, they could more or less have originated from possible problems in the laser-heated diamond-anvil cell (LHDAC) experiment: inherited temperature gradient in the heated area and temperature fluctuation during heating.

In this study, we developed an internal-resistive heated diamond-anvil cell with a new resistance heater—boron-doped diamond (BDD)—along with an optimized design of the cell assembly, including a composite gasket. We find this heating technique to demonstrate clear advantages over the conventional LHDAC technique, such as (1) ultrahigh temperature generation (>3500 K), (2) long-term stability (>1 h at 2500 K), (3) uniform radial temperature distribution (±35 K at 2500 K across a 40-μm area), (4) chemical inertness (no boron diffusion into the silicate sample), and (5) weak X-ray diffraction intensity from the BDD heater. This newly developed IHDAC with a BDD heater can determine the phase diagrams of silicate/oxide materials with high precision and can be used in deep lower-mantle petrology.

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