Melting temperatures of MgO up to ˜50 GPa determined by micro-texture analysis

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Periclase (MgO) is the second most abundant mineral after bridgmanite in the Earth’ s lower mantle, and its melting temperature (T_m) under pressure is important to constrain rheological properties and melting behaviors of the lower mantle materials. Significant discrepancies exist between the T_ms of MgO determined by Laser-Heated Diamond Anvil Cell (LHDAC) and those based on dynamic compressions and theoretical predictions. We performed a series of LHDAC experiments for measurements of T_m of MgO under high pressure. The melting was detected by using micro-texture observations of the quenched samples.
We found that the laser-heated area of the sample quenched from the T_m in previous LHDAC experiments showed randomly aggregated granular crystals, which was not caused by melting, but by plastic deformation of the sample. This suggests that the T_ms of their study were substantially underestimated. On the other hand, the sample recovered from the temperature higher by 1500-1700 K than the T_ms in previous LHDAC experiments showed a characteristic internal texture comparable to the solidification texture typically shown in metal casting. We determined the Tms based on the observation of this texture up to ˜50 GPa.
Fitting our Tms to the Simon equation yields dT_m/dP of 103 K/GPa at zero pressure, which is consistent with those of the theoretical predictions (90˜120 K/GPa). Extrapolation of the present melting curve of MgO to the pressure of the CMB (135 GPa) gives a melting temperature of ˜7900 K. The high T_ms of MgO suggest the subducted cold slabs should have higher viscosities than previously thought, suggesting that the inter-connecting textural feature of MgO would not play important roles for the slab stagnation in the lower mantle. The present results also predict that the ultra-deep magmas produced in the lower mantle are perioditic, which are stabilized near the core-mantle boundary.

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