Lattice thermal conductivity of (Mg,Fe)O

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The Earth has been cooling since it was born about 4.6 billion years ago. To decipher the thermal history of the Earth, thermophysical properties of the lower mantle materials that constitute more than half the volume of the Earth is of great importance. A number of research has suggested the possibility that (Mg,Fe)O ferropericlase, one of the main constituent minerals of the lower mantle, exists with very iron-rich chemical composition at the Earth' s core-mantle boundary (CMB). Such iron-rich (Mg,Fe)O magnesiowüstite at the CMB may cause regional variation of thermal conductivity of the lowermost mantle due to its distinct iron concentration, which potentially influences the mantle convection style, inner core age, inner core structure, geomagnetic field reversal frequency and so on [e.g. Olson, 2016]. However, there is no systematic study to examine the effect of iron on the thermal conductivity of (Mg,Fe)O solid solution under high pressure. In this study, we measured lattice thermal conductivity of FeO wüstite and (Mg,Fe)O magnesiowüstite with various iron contents at high pressures, and evaluated their pressure and compositional dependence. As a results, the thermal conductivity of FeO decreased in the range of 33 to 60 GPa where is in a stability field of the rB1 structure. In the B1 and rB1 structures, the pressure dependence of the thermal conductivity is obviously different. In order to evaluate the effect of iron incorporation on thermal conductivity, we measured lattice thermal conductivity of (Mg,Fe)O which has same crystal structure as CMB conditions. Our results show much lower lattice conductivity of iron-rich magnesiowüstite than that of MgO and FeO due to strong iron impurity phonon scattering, which would help to estimate the thermal conductivity of the expected iron-rich region in the lowermost mantle.

Reference: Olson, P. Mantle control of the geodynamo: Consequences of top-down regulation, *Geochem. Geophys. Geosys.* 17, 1935–1956, (2016).

Keywords: thermal conductivity, lower mantle, magnesiowüstite, wüstite

