Lattice thermal conductivity of (Mg,Fe)O solid solutions

Akira Hasegawa*[1], Kenji Ohta[1], Takashi Yagi[2], Kei Hirose[3], and Tadashi Kondo[4]

[1]Department of Earth and Planetary Sciences, Tokyo Institute of Technology – Japan
[2]National Metrology Institute of Japan, National Institute of Advanced Industrial Science and Technology – Japan
[3]Earth-Life Science Institute, Tokyo Institute of Technology – Japan
[4]Department of Earth and Space Science, Osaka University – Japan

Abstract

The Earth is 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 suggests that the MgO–FeO solid solution with various chemical composition exists in the lower mantle as consequenses of iron pertitioning among major lower mantle minerals, crystallization of the basal magma ocean, and so on. Iron-rich (Mg,Fe)O magnesiowustite at the core–mantle boundary 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 structure, geomagnetic field reversal frequency and so on. However, there is no systematic study to examine the effect of iron substitution on the thermal conductivity of (Mg,Fe)O solid solution even at ambient conditions. In this study, we measured lattice thermal conductivity of (Mg,Fe)O magnesiowustite with various iron contents at high pressures, and evaluated its compositional dependence. Our results show much lower lattice conductivity of iron-rich magnesiowustite than that of MgO and FeO endmembers due to strong iron impurity–phonon scattering. Our data are well reproduced by a model which express impurity-phonon scatterinng effect on the lattice conductivity in a soid solution. Our results will help to estimate the thermal conductivity of (Mg,Fe)O with various composition in the Earth's lower mantle.

*Speaker

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