Anisotropic thermal conductivity of hcp iron and the implications for the Earth’ s inner core

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At some time in the past, the Earth’ s liquid iron core began to solidify at the center, resulting in a growing solid inner core, which has a key role in powering the Earth’ s dynamo action. The inner core is known to be elastically anisotropic. The cause of the seismic anisotropy in the inner core may be explained by the crystallographic preferred orientation (CPO) of hexagonal closed packed (hcp) iron that is widely believed to be a main component of the inner core. However, it is still unclear how to occur and sustain such CPO of the inner core material although many hypotheses have been proposed.

Anisotropy in the thermal conductivity of hcp iron may have important implications for the structure and thermal evolution of the Earth’ s inner core (Secco and Balog, 2001). However, the conductivity anisotropy in hcp iron has never been examined. The hcp phase of iron is stable above 13 GPa and unquenchable to ambient conditions, so that *in-situ* high-pressure measurement of anisotropic conductivity is required. In this study, we investigated anisotropy in thermal conductivity of hcp iron to 42.9 GPa based on synchrotron X-ray diffraction measurements and the pulsed light heating thermoreflectance technique in a diamond anvil cell. The results demonstrate that the thermal conductivity of hcp iron along *c* axis is three to four times as large as that along *a* axis. Such anisotropic thermal conductivity in hcp iron could sustain crystal alignment in the inner core that causes seismic anisotropy. In addition, the anisotropic conductivity in hcp iron could be a cause of the discrepancy in the experimentally determined thermal conductivities of iron at the core conditions (Konôpková et al., 2016; Ohta et al., 2016).

References

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