Is thermal conductivity of hcp iron anisotropic?

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Abstract

At some time in the past, the Earth's liquid iron core began to solidify from the inside out, 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 can 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 *Can. J. Earth Sci.*). However, the conductivity anisotropy in hcp iron has never been examined partly because the hcp phase of iron is stable above 13 GPa and unquenchable to ambient conditions. In this study, we investigated anisotropy in thermal conductivity of hcp iron to 35 GPa based on synchrotron X-ray diffraction measurements and the pulsed light heating thermoreflectance technique in a diamond anvil cell. We found that the thermal conductivity of hcp iron along c axis is about twice larger than that along a axis at 35 GPa. 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 may resolve the problem in the conductivity of iron at the core conditions (Ohta et al., 2016 *Nature*; Konôpková et al., 2016 *Nature*; Dobson, 2016 *Nature*).

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