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High-pressure electrical conductivity and elasticity of iron-bearing δ-AlOOH

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Abstract

The electrical conductivity and elasticity of deep hydrous phases are essential to constraining water distribution, as well as deciphering the origins of conductivity anomalies in the lower mantle. To uncover the impact of iron-bearing δ-AlOOH on the geophysical properties of the lower mantle, we carried out synchrotron X-ray diffraction and electrical conductivity measurements on δ-$(Al_{0.52}Fe_{0.48})OOH$ and $(Al_{0.95}Fe_{0.05})OOH$ in diamond-anvil cells at pressures up to 75 GPa at room temperature. A sharp volume reduction of ~6.5% was observed in δ-$(Al_{0.52}Fe_{0.48})OOH$ across the spin transition at 40.8–43.3 GPa, where its electrical conductivity increases steadily without abrupt changes. The electrical conductivity of δ-$(Al_{0.52}Fe_{0.48})OOH$ is greater than that of pure δ-AlOOH at high pressure, suggesting that both small polaron and proton conduction mechanisms dominate in iron-bearing δ-AlOOH. Furthermore, the high-pressure electrical conductivity profiles are comparable between δ-$(Al_{0.95}Fe_{0.05})OOH$ and δ-$(Al_{0.52}Fe_{0.48})OOH$, indicating that high-iron content only marginally influences the conductivity of iron-bearing δ-AlOOH. Notably, the electrical conductivity of iron-bearing δ-AlOOH along the North Philippine geotherm is greater than the average 1D electrical conductivity profile in the mantle (Ohta et al. 2010a). This result suggests that δ-(Al,Fe)OOH is a promising candidate to account for high conductivity in some subducting slabs.

Keywords: Hydrous minerals, spin transition, high pressure, X-ray diffraction, electrical conductivity