The sound velocity measurements of FeO at high pressure and temperature: Implications for the low velocity anomaly around the core-mantle boundary

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Wustite, $Fe_{1-x}O$, is one of the most important oxides in the Earth because it is an endmember of ferropericlase, (Mg,Fe)O, which is one of main phases in the Earth's lower mantle. In addition, it is also significant for understanding the composition of planetary cores. Seismological data reveal physical properties of the Earth's interior, such as velocities (V_P, V_S) and density. Although the seismological velocity profile of the Earth's interior can provide us an important knowledge about structure and chemical compositions, there are few experimental reports about the sound velocity of Fe-light elements system including FeO at high pressure and temperature.
Here, we report V_P of FeO up to 86 GPa and 2500 K based on a combination of the laser-heated diamond anvil cell and inelastic X-ray scattering measurements at BL35XU of SPring-8. In this experimental condition, FeO shows B1 phase and rhombohedral one, which has a distorted B1 structure. We find difference in velocity between them.
Based on our results, we could obtain the Birch's law for FeO. This relation is extrapolated to the inner core condition. Combining with Birch's law of Fe, we compared the density-velocity linear relation of Fe-FeO system to PREM. This relation is inconsistent with the seismic data of the inner core. In other words, oxygen is not suitable in the inner core as a major light element.
Seismological observations indicate a chemical heterogeneity in the deep lower mantle, and FeO can play an important role to cause the heterogeneity. Several processes have been proposed to account for formation of the enriched FeO region around the core-mantle boundary.
We can find that the velocity of FeO is smaller than that of lower mantle minerals. That is, an addition of FeO to the lower mantle can make a low velocity anomaly, such as ULVZs (ultra-low velocity zones).

Keywords: FeO, Sound velocity, Density, Inelastic X-ray scattering, X-ray diffraction

