Sound velocity measurements on liquid Fe-P alloy under high pressure

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The Earth’s outer core occupying 95 vol.% of the entire core is molten. The outer core is composed mainly of iron, and containing some lighter elements. The nature of the light element is a key to understand the core formation, its chemical and thermal evolutions, and the present dynamics. The core composition can be constrained by comparing the seismological observations and the sound wave velocity of possible Fe alloys under relevant high-pressure and -temperature conditions in the core. Phosphorous is one of the candidates for the light elements in the core because it is found in iron-meteorites and depleted in the silicate mantle relative to chondrites [e.g. 1]. In this study, we determined the P-wave velocity of liquid $Fe_{75}P_{25}$ up to 60 GPa and 2700 K, using laser-heated diamond-anvil cells combining with high-resolution inelastic X-ray scattering (IXS) spectroscopy. IXS measurements were performed at a beamline BL43LXU [2] of the RIKEN SPring-8 Center in Japan. We observed the longitudinal acoustic phonon mode of liquid $Fe_{75}P_{25}$ in a momentum transfer range of 3-5.7 nm^{-1} at each pressure-temperature condition. The P-wave velocity was determined from the dispersion relation. Comparing the present results of $Fe_{75}P_{25}$ and that of pure Fe [3], we found that phosphorous has negligible influence on the sound velocity of liquid Fe. On the other hand, the elastic parameters based on the present study indicate that phosphorous decreases both density and bulk modulus of liquid Fe under the present experimental conditions.

References

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