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Density measurement of liquid Fe-O at high pressure and high temperature using an X-ray absorption method

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The Earth's outer core is thought to be composed of liquid iron alloys with a small amount of light elements, such as sulfur, oxygen and silicon. Existence of a liquid core is also suggested to other terrestrial planets (Mars and Mercury).Thus the effect of light elements on the density of liquid iron is fundamental to understand the composition and structure of the planetary cores.

The densities of liquid Fe-S, Fe-Si, and Fe-C have been reported using X-ray absorption method (Nishida et al., 2011; Sanloup et al., 2004; Terasaki et al., 2010). As a result, it was revealed that the rate of density decrease is quite different depending on the dissolving light element. Hence, it is important to figure out the effects on liquid iron by individual light elements. Although oxygen is one of the most popular candidates of the light elements in the Earth's outer core, the effect of oxygen on the density of liquid iron has never been reported to date. In this study, we have measured the density of liquid Fe-O (O = 0.5 wt%) up to 3 GPa and 2250 K using X-ray absorption method at BL22XU, SPring-8 synchrotron facility. The obtained density of this study is 6.65(3) g/cm^3 at 3 GPa and 2005 K. Compared to the density of pure liquid iron at the present experimental condition, the density of liquid Fe-O is about 7% smaller than that of liquid iron and thermal expansion coefficient of liquid Fe-O is similar to that of liquid iron.

Keywords: core, oxygen, density, high pressure and high temperature, synchrotron