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Density measurement of liquid Fe-Si using X-ray absorption method

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The density of liquid Fe alloys under high pressure is important for estimating the amount of light elements in the Earth's outer core. Here, we performed the density measurement on the liquid Fe-10wt%Si using X-ray absorption method in order to clarify the effect of pressure on the density and to determine the equation of state of the liquid.

X-ray absorption method provided the density of the liquid Fe-10wt%Si at pressures and temperatures up to 3.6 GPa and 2173 K, respectively. The density of the solid Fe-10wt%Si decreased with increasing temperature (1073-1373 K). However, the density of liquid Fe-10wt%Si did not show a clear tendency to the temperature. The thermal derivative of the density of this study was -0.00055 $gcm^{-3}K^{-1}$ at 3.5 GPa, whereas that of ambient pressure was -0.001 $gcm^{-3}K^{-1}$. Therefore, the effect of temperature on the density of the liquid under high pressure is much weaker than that of the ambient pressure. Vinet equation of state yielded isothermal bulk modulus K_{0T} = 59(5) GPa with its pressure derivative K' = 4 at 1873 K. The present results revealed that the substitution of Si into Fe decreases not only the density of liquid Fe but also the bulk modulus of that. Based on the obtained density and bulk modulus of liquid Fe-Si, the bulk sound velocity (V_P) of liquid Fe-Si is lower than that of pure liquid Fe in the range of our experimental condition.

Keywords: high pressure, density, light element, X-ray absorption method, equation of state