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Density measurement of liquid Fe-C at high pressure and Implication for Earth's Outer core

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Seismological and experimental studies show that the Earth's outer core is approximately 10% less dense than molten iron at corresponding pressure and temperature conditions, implying that some light elements exist in the core. Carbon is one of the plausible candidate of the light element in the core, because that the volatility of carbon is only significant at pressures less than 10^{-1} bar and the solubility of carbon in molten iron is large even at 1 bar. Based on the effect of pressure on carbon solubility into iron and thermodynamic calculation, 2-4 wt% carbon is estimated to be in the core. In this study, we measured the density of liquid Fe-3.5wt%C , which corresponds nearly eutectic composition, at 5-9GPa and 1923K using sink/float method. This method is applied using composite density marker which composed of Pt disk core and Al_2O_3 tube mantle. The present results revealed that the effect of pressure on the density of liquid Fe-C. If the density and the bulk modulus(K) are known, the compressional wave velocity, V_P, can be calculated. Therefore, comparing the calculated V_P value of liquid Fe-C with that of the PREM model (Dziewonski and Anderson, 1981), and we evaluated a possibility of existence of carbon in the core. The obtained results revealed that the addition of carbon to liquid Fe decreased the density whereas it did not affect the bulk modulus.

Keywords: high pressure, density, Bulk sound velocity, liquid Fe-C