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Sound velocity of liquid Fe-Ni-C alloy at high pressure and temperature

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Sound velocity is important to understand the composition of the Earth's and lunar core because it can be directly compared with seismological data.

Carbon is a plausible candidate as a light element in the core due to its high cosmic abundance and high affinity to liquid Fe [e.g., Wood, 1993]. However, the effect of carbon on the sound velocity (V_P) of liquid Fe-Ni alloy has not been investigated. In this study, we have measured the V_P of liquid (Fe-10wt.%Ni)-4wt.%C alloy at around 4.7 GPa and 1563-1788 K.

High-pressure experiment was performed using a 1500-ton multi-anvil apparatus (SPEED-1500) installed at BL04B1 of the SPring-8 synchrotron radiation facility. Experimental pressure was determined from the lattice constants of MgO and hBN. We have used a cylindrical graphite heater and temperature was monitored using a W5%Re-W26%Re thermocouple. V_P measurements were carried out by the pulse-echo-overlap method using a $LiNbO_3$ transducer for generating and receiving P-wave signals. Used frequencies of the wave signal were 37 and 21 MHz. The sample length was measured from an X-ray radiography image of the sample.

The observed V_P of liquid Fe-Ni-C decreases with increasing temperature. Comparing the V_P of Fe-C calculated from the previously reported densities and bulk moduli of liquid Fe and Fe-C [Anderson & Ahrens, 1994; Shimoyama et al., 2013; Terasaki et al., 2010], V_P of liquid Fe-C or Fe-Ni-C decrease with increasing carbon content.

Keywords: Carbon, Eatth's outer core, Light element