

The effect of Ni and C on sound velocity of liquid Fe at high pressure

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Nickel is a highly plausible element in the terrestrial core together with iron. However, the effect of Ni on elastic properties of liquid Fe at high pressure has not been reported. It is important to study the effect of Ni together with light elements on the sound velocity of liquid Fe to give a constraint on the liquid core composition of terrestrial planets by comparing with the observed seismic data. In this study, we focused on the effect of Ni and C on the P-wave velocity and elastic properties of liquid Fe up to 6.5 GPa.

High pressure experiments were carried out using 1500 ton Kawai-type multi-anvil press at BL04B1 beamline, SPring-8 synchrotron facility. P-wave velocity (V_P) was measured using pulse-echo overlap method. Used sample compositions were Fe-10wt%Ni and Fe-10wt%-4wt%C. The sample pellet was sandwiched by single crystal sapphire buffer rods for the V_P measurement. The experimental pressures and temperatures were determined based on lattice volumes of MgO and BN, which were used as a pressure marker, combined with their equations of state. The measurements were performed up to 6.5 GPa and 2100 K.

Obtained V_P of liquid Fe-Ni is located slightly lower and aligned almost parallel to the V_P curve of liquid Fe as a function of pressure. This suggests that alloying 10 wt% of Ni into liquid Fe slightly decrease the V_P but little influence on the bulk modulus and its pressure dependence. Alloying C slightly increases the V_P of liquid Fe and it is also found that the effect of temperature on the V_P is not negligible. In the presentation, we will compare these results with the reported results of other light element such as S in the sound velocity-density relation (Birch plot) and discuss a clue to constrain the core composition of small terrestrial planets.

Keywords: Sound velocity, Fe alloy, Core, High pressure