

Sound velocity and density measurement of alloy liquid under pressure

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Sound velocity and density of liquid alloys under high pressure are important physical properties for understanding the light element(s) in the terrestrial molten outer core by comparing with the seismological data. We have developed the system for sound velocity (V_P) and density (ρ) measurements combined with X-ray computed micro-tomography (CT) at high pressure and high temperature. V_P of Fe-S liquid has been recently reported up to 5.4 GPa (Nishida et al., 2013). The terrestrial core is likely to contain 5-10 wt% of Ni. In order to clarify the Ni alloying effect on the V_P and ρ , we have measured the V_P and ρ of Ni-S liquid at high pressure and temperature. V_P was measured using ultrasonic pulse-echo overlap method and ρ was measured using X-ray absorption method.

High pressure experiment was performed using 80-ton uni-axial press (Urakawa et al. 2010) installed at X-ray CT beamline (BL20B2), SPring-8. High pressure was generated using opposed cupped anvils. The Ni-S with an eutectic composition was enclosed in hBN capsule and single crystal sapphire rods were placed at top and bottom of the sample for ultrasonic measurement. P-wave signals with frequencies of 37 MHz were generated by LiNbO₃ transducer. The echo signals from the sample were detected using high-resolution digital oscilloscope. CT measurement was carried out by rotating the press from 0 to 180 degree with 0.2-0.3 degree steps. Monochromatized X-ray of 51 keV was used. X-ray absorption profile was obtained from the X-ray radiograph and the sample thickness in X-ray direction was directly measured from the CT slice image.

Sound velocity and density measurements at room temperature was performed up to 1.4 GPa and those at high temperature was carried up to 0.4 GPa and 1673 K. P-wave signal was clearly observed at the present conditions. V_P of Ni-S suddenly dropped after melting of the sample. The V_P of liquid Ni-S decreases slightly with increasing temperature in the range of 1273-1673 K. Density of Ni-S decreased slightly after melting. The present measurement can provide the relationship between V_P and ρ for alloys under pressure.

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