Sound velocity of liquid Fe-Si alloy under high pressures

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Silicon is the most favorable candidate for the light elements of the Earth's core. Recent core formation models [1,2] and Si isotope measuremetns on terrestrial and meteoritic samples [3,4] suggested that large amount of Si could have been incorporated into the core forming metal in the early stage of the Earth. Among those studies, however, the estimates on the Si content of the core lie on a wide range from 1 to 17%. Seismological sound velocity and density of the core are also important observational constraints on the chemical composition of the Earth's core. In 4order to constrain the Si content of outer core, we have determined the sound wave velocity of a liquid Fe-Si alloy under high pressures and high temperatures. Starting material $Fe_{84}Si_{16}$ (9 wt.% Si) alloy was melted in the laser-heated diamond-anvil cell. The longitudial acoustic phonon exitations of the liquid was measured up to 52 GPa and 3200 K by using a high resolution inelastic X-ray scattering spectroscopy at the beamline BL35XU of the SPring-8 synchrotoron facility. Our results show that silicon significantly increases the P-wave velocity of liquid Fe. Seismological observations exhibit that the P-wave velocity of outer core is faster by 3−4% than that of pure iron. Extrapolating the present results to core pressures and comaparing with the seismological observations, the silicon contetent of the outre core is estimated to be at below 2 wt.%. However, this small amount of silicon may not take into acount for the 10% core density deficit.

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