Inelastic X-ray scattering measurements of liquid Fe-N alloy under high pressure

*Asaki Iwamoto[1], Yoichi Nakajima[1,2], Daisuke Kinoshita[1], Yasuhiro Kuwayama[2,3], Kei Hirose[3], Daisuke Ishikawa[2,4], Alfred Q.R. Baron[2]

1. Kumamoto University, 2. RIKEN MDL, 3. The University of Tokyo, 4. JASRI

The Earth’ s liquid outer core is composed mainly of iron, alloying with ~5% nickel and ~10% some light elements [1]. Nitrogen is one of candidates for the light elements. The abundance of nitrogen in the silicate mantle relative to that in primordial meteorites is less than those of similar volatile components such as H_2O, C and Ar, so that large portion of nitrogen in bulk Earth can be stored in the core [2,3]. In order to examine the possibility of nitrogen in the core, it is benefit to compare the sound velocity of liquid Fe-N alloy under high-pressure and -temperature relevant to the core conditions with the seismological observations. In this study, we performed inelastic X-ray scattering (IXS) measurements on liquid Fe-N alloy and determined its longitudinal velocity of the liquid Fe-N alloy under high pressure and temperature.

We carried out high-pressure and -temperature IXS measurements using a laser-heated diamond-anvil cell (LH-DAC) at the beamline BL43LXU of SPring-8 [4]. We used an Fe_4N foil (hereafter called $Fe_{80}N_{20}$) as a starting sample and single crystal Al_2O_3 discs as a thermal insulator. We judged the sample melting based on X-ray diffraction measurements during heating and then measured IXS of the liquid sample. The longitudinal sound wave (P-wave) velocity of liquid $Fe_{80}N_{20}$ was determined from the dispersion relation of the longitudinal acoustic phonon mode of the sample. We obtained the velocity of liquid $Fe_{80}N_{20}$ up to 76 GPa and 2200 K. We found that the P-wave velocity of liquid $Fe_{80}N_{20}$ is slightly faster by c.a. 4% than that of liquid Fe [5]. The P-wave velocity of liquid outer core is faster by 4% than liquid Fe [5]. Therefore, the present results give the upper limit of 5.9 wt.% (20 at.%) for the nitrogen content in the outer core.

[1] Stevenson, Science **214**, 611-619 (1981).

[2] Marty, Earth Planet. Sci. Lett. **313-314**, 56-66 (2012).

[3] Li et al., Earth Planet. Sci. Lett. **377-378**, 311-323 (2013).

[4] Baron, SPring-8 Inf. Newsl. **15**(1), 14-19 (2010).

[5] Anderson and Ahrens, J. Geophys. Res. **99**(B3), 4273-4284 (1994)

Keywords: Earth's liquid outer core, Light element, P-wave velocity, High pressure

©2019. Japan Geoscience Union. All Right Reserved.