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Sound velocity measurement of hcp-Fe at high pressure and temperature

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Eiji Ohtani[1*], SHIBAZAKI, Yuki[1], SAKAI, Takeshi[1], FUKUI, Hiroshi[2], TSUTSUI Satoshi[4], BARON, Alfred B[5]
OHTANI, Eiji[1*], SHIBAZAKI, Yuki[1], SAKAI, Takeshi[1], FUKUI, Hiroshi[2], TSUTSUI Satoshi[4], BARON, Alfred B[5]

[1]Tohoku University, [2]University of Hyogo, [3]University of Tokyo, [4]JASRI, [5]RIKEN
[1]Tohoku University, [2]University of Hyogo, [3]University of Tokyo, [4]JASRI, [5]RIKEN

The sound velocity is one of the most important physical properties which can be assessed by seismology. In spite of its importance, the technical difficulty provides limitation of the measurements under the core conditions. Here we show the results of measurements of the sound velocity of hcp-iron by the inelastic X-ray scattering (IXS) method using DAC at high pressure and temperature. Inelastic X-ray scattering spectra were taken at BL35XU, Spring-8. The dispersion of longitudinal acoustic phonons of hcp-Fe was measured by three spectrometers for 4 values of the momentum transfer. The average acoustic sound velocities were thus simply fitted by the sine curve using the equation with free parameters of Vp and Qmax (Fiquet et al., 2001). We used the symmetric diamond anvil cell for the measurements at high pressure and room temperature. Whereas we used the external heating diamond anvil cell for the measurements at high temperature.

We made the inelastic scattering measurements of hcp-iron at pressures up to 167 GPa at room temperature, which is the highest pressure for the IXS measurement. Sound velocity measurements at high pressure and temperature were made at 53 GPa and 87 GPa at 400 K, 54 GPa and 91 GPa at 700 K, and at 62 GPa and 1000 K using the external heating diamond anvil cell. The pressure scale used is a Pt scale by Matsui et al. (2009). When we plot sound velocity and density of hcp-Fe measured in this work in the Birch diagram, we found that the Vp-density relation at 300 K is consistent with the trend reported by Mao et al. (2001) by NIRIXS, and slightly higher in velocity compared to that reported by Fiquet et al. (2001) using IXS method. The temperature dependency obtained in this work shows almost no temperature effect, i.e., the Birch law is applicable up to the temperature at least 1000 K up to c.a. 100 GPa contrarily to the previous NIRIXS work by Lin et al. (2005).

Reference:
Matsui et al. J. Appl. Phys. 105, 013505 (2009).
Mao et al., Science, 292, 914-916 (2001)
Fiquet et al., Science 291, 468 (2001);DOI: 10.1126/science.291.5503.468
Lin et al. Science 308, 1892 (2005); DOI: 10.1126/science.1111724

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