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Sound velocity measurements of hcp Fe-Si alloy at high pressure and high temperature by inelastic X-ray scattering

Takanori Sakairi[1], Tatsuya Sakamaki[1], Eiji Ohtani[1,2,*], Hiroshi Fukui[3,4], Seiji Kamada[5], Satoshi Tsutsui[6], Hiroshi Uchiyama[6], and Alfred Q.R. Baron[4]

[1]Department of Earth and Planetary Materials Science, Graduate School of Science, Tohoku University, Sendai 980-8578, Japan
[2]V.S. Sobolev Institute of Geology and Mineralogy, Siberian Branch, Russian Academy of Sciences, Koptyuga Ave. 3, Novosibirsk 630090, Russia
[3]Center for Novel Material Science under Multi-Extreme Conditions, Graduate School of Material Science, University of Hyogo, Kamigori, Hyogo 678-1297, Japan
[4]Materials Dynamics Laboratory, RIKEN SPring-8 Center, Sayo, Hyogo 679-5148, Japan
[5]Frontier Research Institute for Interdisciplinary Sciences, Tohoku University, Sendai 980-8578, Japan
[6]Japan Synchrotron Radiation Research Institute (JASRI), Hyogo 679-5198, Japan

Abstract

The sound velocity of hcp $Fe_{0.89}Si_{0.11}$ (Fe-6wt% Si) alloy was measured at pressures from 45 to 84 GPa and temperatures of 300 and 1800 K using inelastic X-ray scattering (IXS) from laser-heated samples in diamond-anvil cells (DACs). The compressional velocity (v_P) and density (ρ) of the Fe-Si alloy are observed to follow a linear relationship at a given temperature. For hcp $Fe_{0.89}Si_{0.11}$ alloy we found $v_P = 1.030\ (\pm 0.008) \times \rho - 1.45\ (\pm 0.08) + [3.8 \times 10^{-5}(T - 300)\times(\rho - 15.37)]$, including non-negligible temperature dependence. The present results of sound velocity and density of hcp $Fe_{0.89}Si_{0.11}$ alloy indicates that 3~6 wt% of silicon in the inner core with additional amount of Ni can explain the compressional velocity (v_P) and density (ρ) of the "preliminary Earth reference model" (PREM), assuming a temperature of 5500 K and that silicon is the only light element in the inner core

Keywords: Sound velocity, Fe-Si alloy, high pressure, high temperature, inelastic X-ray scattering, inner core, Birch's law, silicon