Sound velocity of Fe₃C and Carbon in the Core

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Sound velocity is one of the most important physical properties to understand the Earth’s interior. Sound velocity of Fe₃C was measured by the inelastic X-ray scattering (IXS) method. The high pressure was generated using a symmetric-type diamond anvil cell. The Fe₃C foil was sandwiched between NaCl layers, which served as a pressure-transmitting medium and as a thermal insulator. The sound velocity of Fe₃C was measured by the inelastic X-ray scattering method at BL35XU [1] and BL43LXU at SPring-8 [2]. Sound velocity measurements at high pressure and temperature were conducted at BL35XU by a double sided laser heated DAC using a fiber laser, the COMPAT system [3]. IXS measurements were carried out from 32.8 GPa to 85.8 GPa and the temperature range from 300 K to 2300 K. The present measurements revealed that the Birch’s law, the density and $V_p$ relation, has almost no temperature dependency. Present estimations of $V_p$ and $V_s$ of Fe₃C were 12 % and 48 % faster than those of PREM at 329 GPa and 5000 K. The equation of state of Fe₃C can be accounted for the density of the inner core at ICB (329 GPa and 5000 K), however the present results on sound velocity of Fe₃C indicate that we need to introduce the premelting effect on $V_p$ and $V_s$ in order to account for the sound velocity of the inner core by Fe₃C.