The composition of the Earth's inner core inffred from the sound velocity measurement of iron-nickel alloy at high pressure and high temperature

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The Earth's core is composed of iron-nickel alloy with some amount of light elements. Geophysical observation, such as seismological study, gives us physical properties of Earth's core and a comparison with iron-alloys is the best approach to constrain the core composition. Especially, silicon is suggested to be the major candidate as a light element in the core from the aspect of cosmochemical and geochemical arguments. However, physical properties of iron-nickel-silicon alloy under core conditions are still unclear, and the silicon content in the core is a big question. Here we have conducted sound velocity measurement of iron-nickel alloy at high pressure and temperature using inelastic X-ray scattering with laser-heating diamond anvil high-pressure apparatus. We can show an inner core model which corresponds to both of geophysical and geochemical observations. We found a gradation of chemical composition of inner core, and the chemical contrast directly reflects a crystallization process of inner core with cooling. We anticipate our result to be a starting point for sophisticated model for present core evolution and core formation in the early Earth. For example, better-constrained composition of inner core can provide us chemical information of total core including liquid outer core. Furthermore, we can infer core formation process and environmental condition of element partition between metallic and silicate materials in the early Earth on the basis of total core composition. In addition, assuming that chemical heterogeneous structure of the inner core, we can understand seismological anomaly, such as an existence of innermost inner core.