Geodynamics Seminar

第339回ジオダイナミクスセミナー

Equations of state of Fe-Ni alloy

Dr. Takeshi Sakai (Assistant Professor, GRC)

主催：愛媛大学地球深部ダイナミクス研究センター
日時：10/19（金）午後 4時30分～
場所：総合研究棟 4F 会議室

EHIME UNIVERSITY GRC GEODYNAMICS RESEARCH CENTER

Abstract

Equations of state of Fe and Fe-Ni alloy are fundamentally important to understand the Earth's inner core. The equation of state of pure iron was reported by several researchers using diamond anvil cell (Mao et al., 1990; Dubrovinsky et al., 2000; Dewaele et al., 2006), but there is a few percent difference in volume at the inner core condition between these studies. Moreover, the compression study of Fe-Ni alloy at multimegabar range was only reported by Mao et al. (1990) which is a cold compression study. Here I report the equations of state of Fe and $Fe_{0.9}Ni_{0.1}$ alloy up to 283 GPa and 276 GPa with the laser annealing technique, and discuss about the effect of nickel on the density. We used a symmetric-type diamond anvil cell with the diamond anvils of culet size of 40, 130 and 300 μm for high pressure generation. Fe (99.9% pure) and $Fe_{0.9}Ni_{0.1}$ reagent (99.99% pure) were used as the starting materials. The sample was sandwiched between layers of sodium chloride and loaded into a sample hole that had been drilled in a precompressed tungsten gasket. The unit cell volume of the sample was determined by the synchrotron X-ray diffraction experiment at the SPring-8 BL10XU beamline, Japan. The experimental pressure was determined by the 3rd order Birch-Murnaghan equation of state (B–M EoS) of NaCl-B2 phase as reported by Sakai et al. (2011). The sample was annealed by a double-sided laser heating method using a fiber laser at the BL10XU in order to minimize the deviatoric stress in the sample. Fe and $Fe_{0.9}Ni_{0.1}$ were compressed to a pressure of 283 GPa and 276 GPa at ambient temperature, respectively. The data sets were fitted using the 3rd order B–M EoS. The density of iron at the inner core boundary pressure is estimated to be 13.95 g/cm^3. Although this value is 1.7% smaller than that by Dubrovinsky et al. (2000), this difference decrease to 0.2% if we consider the effect of the difference of pressure scale. Our result is also consistent with the result of Dewaele et al. (2006) within 0.4%. On the other hand, the density of $Fe_{0.9}Ni_{0.1}$ is 1.8±1.3% denser than that of pure iron at the inner core condition. This result shows that the nickel has a small but clear effect on the density, and it is about two times larger than that expected from Mao et al. (1990).

詳細は当センターホームページ: http://www.ehime-u.ac.jp/~grc/をご覧ください
問い合わせ先：桑山 靖弘（TEL:089-927-8408,e-mail:kuwayama@sci.ehime-u.ac.jp）