Si diffusion in γ-iron at high pressure

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γ-iron, which is fcc structure, is the most candidate for the stable phase of the metallic core in smaller planets such as Mercury, Mars, and satellite (Sohl and Schubert, 2007). Even under Earth's inner core conditions, there is a slight possibility that fcc structure becomes stabilized with possible chemical impurities such as Ni and Si (e.g. Kuwayama et al., 2008). In addition, Silicon is one of candidates for light elements in planetary core. During growth of metallic inner core, chemical heterogeneity would be developed with change of outer core compositions. On the other hands, atomic diffusion process is the important mechanism to homogenize chemical composition of inner core. In order to understand physical and chemical properties of planetary inner core, diffusion coefficient of γ-iron is one of important parameters. Therefore Annealing experiments up to 15 GPa and 1673 K were conducted to determine pressure and temperature effect on Si diffusion in fcc iron between a pure iron and 1wt.% Si doped iron. The diffusion profiles for the recovered samples in each experiment were measured by EPMA. The pressure and temperature effect of diffusion is described by $D = D_0 \exp(-(E^*+PV^*)/RT)$ where D is diffusion coefficient, D_0 is rate constant, P is the pressure, R is the gas constant and T is the absolute temperature, with $E^* = 318 \pm 18$ kJ/mol and $V^* = 4.1 \pm 0.2$ cm^3/mol. Diffusion lengths on Mercury's and Mars's core conditions are around 50 –100 m and 1 –60 m with 100Myr, respectively. These diffusion lengths are quite smaller than inner core size. Only by atomic diffusion, chemical heterogeneity of small planetary inner core formed by solidification of inner core could not be homogenized.

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