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1. iron hydride
2. rheology
3. inner core

Effect of hydrogen on rheology of hcp-Fe

Among candidates for the light element(s) in the Earth's core, hydrogen is one of the most important candidates. Although many hypotheses have been proposed for the origin of the inner core seismic anisotropy, there is no general consensus for its origin partly due to lack of accurate information of viscosity in the inner core. In this study, we have studied effect of hydrogen on the rheology of iron based on high-pressure and high-temperature deformation experiments.

We have conducted in-situ high-pressure deformation experiments at P = 11.7-16.1 GPa and T = 573-823 K on iron hydride (FeH_x) using D111-type apparatus installed at BL04B1, SPring-8. The FeH_x was synthesized at high-P and high-T by reaction of pure Fe and H_2 released from surrounding hydrogen source NH_3BH_3. Samples with high hydrogen content ($x > 0.7$) were with double hexagonal close-packed (dhcp) structure whereas those with lower hydrogen content were hexagonal close-packed (hcp) structure. Flow-law of dhcp-FeH_x with $x = 0.71$-0.84 was determined as functions of P, T and deviatoric stress. Stress values of dhcp-FeH_x were only slightly lower than those of hcp-Fe at same conditions. Stress values of hcp-FeH_x ($x = 0.19$-0.41) were generally intermediate of pure hcp-Fe and dhcp-FeH_x at given P, T and strain rate conditions. This result suggests that influence of hydrogen on the inner core viscosity is limited. Thus the inner core viscosity may be insensitive to presence of hydrogen.