Diffusion mechanism of metallic elements in forsterite polycrystal

Asako Takamasa[1]; Takehiko Hiraga[2]; Shun'ichi Nakai[1]; Isao Sakaguchi[3]; Sanae Koizumi[4]; Naoki Oohasi[3]; Satoru Sano[5]

[1] ERI, Univ. of Tokyo; [2] ERI; [3] NIMS; [4] Grad. Sch. Sci., Univ. Tokyo; [5] Ube Mterial Lndustries,Ltd.

Composition of the trace elements and these isotopes in the earth materials can tell the geochemical evolution of the Earth. The age of terrestrial core formation can be constrained by Hf-W chronometry; however, most of previous studies assumed achievement of equilibration of the Hf-W system at a giant impact event. In contrast, some studies indicate that a perfect resetting of Hf-W age was not completed.

We analyzed W isotope ratio of numerous rock samples, and examined whether perfect equilibration was achieved during the core formation (Takamasa et al., 2008, Takamasa et al., in preparation). The samples exhibit the same W isotope ratios within the uncertainty of isotope analyses. These results suggest that a perfect equilibration was achieved in the Earth's mantle after the giant impact. Alternatively, our result can be explained by a detection limit of our analytical method to find the W isotopic anomaly. Hayden and Watson (2007) reported higher W diffusivity than that of Pt and Ir. Such diffusion effect might explain the small or lack of heterogeneity in the mantle.

These incompatible elements are expected to be strongly partitioned into the grain boundaries, and thus, these elements can diffuse much faster than compatible elements (Hiraga et al.; 2003, 2007).

In this study, we aim to obtain the grain boundary diffusivities of siderophile elements through diffusion experiments using synthesized highly-dense forsterite aggregates (grain size under 10 µm). So far, we have found extremely high W diffusion at the conditions of 1300 C and one atmosphere. Such result might explain the observed W isotope ratio in the mantle materials.