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# Si and Mg diffusion in aluminous perovskite at 25 GPa

SHIMOJUKU, Akira[1*], KUBO, Tomoaki[2], KATO, Takumi[2], YOSHINO, Takashi[1], YAMAZAKI, Daisuke[1], NAKAMURA, Tomoki[3], OKAZAKI, Ryuji[2], CHAKRABORTY Sumit[4]

[1]Okayama Univ., [2]Kyushu Univ., [3]Tohoku Univ., [4]Ruhr Univ. Bochum

Silicate perovskite is thought to be a major constituent mineral in the lower mantle. In order to understand rheological properties of the lower mantle, it is essential to determine the diffusion rates of the slowest diffusing species which control high-temperature creep processes involving diffusion creep and climb-controlled dislocation creep. It has been reported that Si diffusion rates in $MgSiO_3$ perovskite and Mg-Fe interdiffusion rates in $(Mg,Fe)SiO_3$ perovskite are almost comparable (Yamazaki et al., 2000; Holzapfel et al. 2005). In addition, O diffusion rates in $MgSiO_3$ perovskite are faster than Si diffusion and Mg-Fe interdiffusion rates (Dobson et al. 2005). Thus, Si or Mg is a candidate for the rate-controlling species in perovskite. In this study, we determined Si and Mg diffusion rates simultaneously in $(Mg,Fe)(Si,Al)O_3$ perovskite by utilizing $^{25}Mg$ and $^{29}Si$ enriched $(Mg,Fe)(Si,Al)O_3$ thin film as diffusion source. Based on the result, we discuss the rate-controlling species in $(Mg,Fe)(Si,Al)O_3$ perovskite and rheological properties in the lower mantle.

High-temperature and high-pressure experiments were performed using a Kawai-type high-pressure apparatus. Starting material of polycrystalline $(Mg,Fe)(Si,Al)O_3$ perovskite was synthesized from San Carols orthopyroxene powder at 25 GPa and 1973K. Surface of the polycrystalline perovskite was polished and then coated with $^{25}Mg$ and $^{29}Si$ enriched $(Mg,Fe)(Si,Al)O_3$ thin film using pulsed laser deposition (Dohmen et al. 2002). Diffusion experiments were conducted at 25 GPa and 1773-2073K. After the diffusion experiments, concentration profiles of $^{25}Mg$ and $^{29}Si$ were obtained by the depth-profiling mode using secondary ion mass spectrometry.

It was found that Si and Mg diffusion rates in $(Mg,Fe)(Si,Al)O_3$ perovskite are almost comparable under our experimental conditions. Thus, Si and Mg are likely to be rate-controlling species in $(Mg,Fe)(Si,Al)O_3$ perovskite. Si and Mg diffusion rates in $(Mg,Fe)(Si,Al)O_3$ perovskite could be slightly slower than previously reported Si diffusion rates in $MgSiO_3$ perovskite.

Keywords: perovskite, lower mantle, diffusion, rheology