Proton conduction of hydrous forsterite aggregate under different buffer conditions

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Water in nominally anhydrous minerals (NAMS) (e.g. olivine) is known to increase electrical conductivity, which is presumably caused by diffusion of hydrogen. To quantify its influence, total water content calculated from FTIR and SIMS was usually adopted. However, recent study implied its inaccuracy since hydrogen diffusion rate was site-dependent *(Padron-Navarta et al., 2014)*. Hydrogen in M site used to be the best candidate to link lattice hydrogen diffusion and proton conduction. Recent FTIR assignment indicated that hydrogen associated to M site in forsterite was negligibly small *(Ingrin et al., 2013)*. Therefore, the other hydrogen-related defect is required to explain proton conduction in olivine. To clarify the contribution of hydrogen in association with different sites, we measured the electrical conductivity of forsterite as a function of water content under different buffer conditions (MgO buffer and SiO_2 buffer).

Forsterite aggregate with water content ranging from 100 to 1500 ppm were synthesized under MgO and SiO2 buffered conditions at 1373 K and 4 GPa in a multi-anvil apparatus. The electrical conductivity measurements were performed at the same pressure and various temperatures from 500 to 750 K. The water content of the sample both before and after electrical conductivity measurement was determined by FTIR using Paterson calibration. Absorption peaks of FTIR were assigned to different sites and water contents in each specific site were calculated.

The maximum water content in the MgO buffered sample (1500 wt. ppm) was found to be nearly 10 times larger than the SiO_2 buffered sample, indicating its superior water storage capacity. Incorporated water was exclusively resided in T site (~80%) and interstitial site (~20%) for forsterite buffered by MgO; whereas for forsterite buffered by SiO_2, water was distributed among M site (~60%), T site (~38%) and I site (~2%). The electrical conductivity of forsterite increases with increasing water content in both buffered condition with similar activation enthalpy (~0.7 eV). Because of its higher water content, conductivity of forsterite buffered by MgO was higher than that buffered by SiO_2. Their conductivity difference might be explained by hydrogen on M and interstitial sites. However, high resistance of forsterite close to the background insulation prohibited us to obtain good data. Therefore, electrical conductivity measurement of forsterite with higher water content synthesized at higher pressure will be conducted to verify this speculation.