Electrical conductivity of Ti-bearing hydrous olivine aggregates at high temperature and high pressure

代立东[1*] Karato Shun-ichiro[2]

1 中国科学院地球化学研究所 贵阳 550081; 2 Department of Earth and Planetary Sciences, Yale University New Haven 06520

The role of hydrogen to enhance many defect-related properties such as high-pressure experiments from the electrical conductivity and plastic deformation in olivine is well established. A large number of previous available investigations are mainly concentrated on the effects of hydrogen on high-pressure physical properties of olivine, and the influence of impurities other than hydrogen have not been studied in any detail. However a series of papers suggested the importance of some charged impurities such as Ti on hydrogen dissolution. We investigated the electrical conductivity of Ti (titanium) -H (hydrogen) doped synthetic olivine aggregates at 4 GPa, 873-1273 K and controlled oxygen fugacities using three different solid oxygen buffers (e.g. Re-ReO2, Ni-NiO and Mo-MoO2). Under a given pressure and temperature, electrical conductivity depends both on hydrogen and Ti content, but these samples show different conductivity behavior from that observed in Ti-poor sample (San Carlos olivine; ~20-30 ppm wt TiO2). We found that when Ti content is comparable to or larger than hydrogen content, Ti has notable effects on electrical conductivity, but the effects of Ti is different between the H-rich and the H-poor regimes. In the H-rich regime, electrical conductivity of olivine is weakly dependent on Ti content, but has different sensitivity to water content than a Ti-poor olivine. In contrast, in the H-poor regime, electrical conductivity of Ti-rich olivine is substantially higher than the conductivity of Ti-poor olivine. As a consequence, the effect of hydrogen for the Ti-rich synthetic olivine on electrical conductivity is smaller than for the Ti-poor (natural) olivine for the modest H content expected in the asthenosphere, whereas in the H-poor lithosphere Ti will enhance the electrical conductivity substantially. Possible models to explain these observations are proposed including the interaction of Ti-related defects and H-related defects as well as the charge transfer caused by the hopping conduction due to trivalent titanium and tetravalent titanium under the H-poor conditions. We conclude that the addition of Ti to olivine affects the behavior of H-related defects and therefore the applications of results from Ti-rich olivine samples to the Ti-poor real Earth need to be made with a great care.