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Behavior of hydrogen defect and framework of Fe-bearing wadsleyite and ringwoodite at high temperature and high pressure

Yang Jin[1], Weihua Huang[1], ZhongPing Wang[2], Wei Sun[3], Yan Liu[1], Qunke Xia[1,†], and Yan Yang[1,*]

[1]Institute of Geology and Geophysics, School of Earth Sciences, Zhejiang University, Hangzhou 310027, China
[2]Department of Physics, University of Science and Technology of China, Hefei, Anhui 230026, China
[3]State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences, Wuhan 430074, China

Abstract

The transition zone is dominated by polymorphs of olivine, wadsleyite, and ringwoodite, which are to date considered the main water carriers in the Earth's mantle. Despite considerable studies on water solubility and its impact on physical properties of the two minerals, knowledge of their hydrogen defects and framework behavior at high temperature and high pressure is still lacking. Here, we systematically assess this issue, by in situ high-temperature (20–800 °C) infrared spectroscopic studies, in situ high-temperature (20–800 °C) and high temperature-pressure (14.27 and 18.84 GPa, 20–400 °C) Raman spectroscopic studies on the iron-bearing wadsleyite and ringwoodite. The results show that dehydrogenation in wadsleyite happens at a higher temperature than in ringwoodite. The infrared absorption patterns of hydrogen defects in wadsleyite and ringwoodite are temperature sensitive, resulting from hydrogen defects transfer and site-specific stabilities. As for the framework, it is more sensitive to temperature and pressure for ringwoodite than wadsleyite. These results provide new knowledge about hydrogen defects and framework of wadsleyite and ringwoodite at high temperature and high pressure, which is indispensable for understanding water solubility and its impacts on physical properties of these two minerals.

Keywords: Wadsleyite, ringwoodite, hydrogen defect, framework, mantle transition zone