

· 专题 1: 矿物结构与矿物表面过程 ·

## A New High-Pressure Polymorph of $\text{MgSiO}_3$ Enstatite

XU Jingui<sup>1,2,3</sup>, Dongzhou Zhang<sup>2</sup>, Przemyslaw Dera<sup>2</sup>,  
Jin S. Zhang<sup>4</sup>, Yi Hu<sup>2</sup>, ZHOU Wenge<sup>1</sup>, FAN Dawei<sup>1\*</sup>

1. 中国科学院 地球化学研究所 地球内部物质高温高压重点实验室, 贵阳 550081;

2. Hawaii Institute of Geophysics and Planetology, School of Ocean and Earth Science and Technology, University of Hawaii at Manoa, 1680 East West Road, POST Bldg, Honolulu, HI 96822, USA; 3. 中国科学院大学, 北京 100049;

4. Institute of Meteoritics, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico, USA

Pyroxene (Ca-poor and Ca-rich) is a group of important rock-forming silicate minerals found in many igneous and metamorphic rocks. In the upper mantle, orthoenstatite, i.e., Ca-poor pyroxene is thought to be an important phase in the harzburgite or the “depleted” mantle composition, which may present an average chemical composition for continental lithosphere, thereby making it a major component in subducting oceanic slabs. Therefore, the knowledge of the thermoelastic properties of orthoenstatite under appropriate conditions are important for the modeling of density profiles for understanding the thermal and chemical structures of the upper mantle and subducted slabs, and to characterize the temperature and chemical heterogeneities in the upper mantle and subducted slabs.

Synchrotron-based high-pressure and temperature single-crystal X-ray diffraction experimental studies were conducted on hydrous enstatite [ $\text{MgSiO}_3$ ] using a large-opening angle diamond anvil cell (for ambient temperature experiments) and an externally heated diamond anvil cell to 29 GPa and 700 K. Two phase transitions were observed at 13.5 GPa ( $\beta$ -En) and 29.1 GPa ( $\beta$ -En II), the former is consistent with pre-

viously described orthopyroxene to  $\beta$ -opx transition, while the latter is different from previous studies. The orthorhombic symmetry did not show up in the second transition, instead of, the  $\beta$ -En underwent a monoclinic to monoclinic isosymmetric ( $P2_1/c$ ) transition with a displacement of 25% of Si along the  $c$ -direction. We suggest  $\beta$ -En II is an intermediate phase between the monoclinic to orthorhombic transition of orthopyroxenes. Thermal equation of state studies obtained  $V_0 = 832.4(1) \text{ \AA}^3$ ,  $K_{T_0} = 107(1) \text{ GPa}$ ,  $K'_{T_0} = 7.6(5)$ ,  $(\partial K_0/\partial T)_P = -0.045(8) \text{ GPa K}^{-1}$  and  $\alpha_0 = 5.4(5) \times 10^{-5} \text{ K}^{-1}$  for En and  $V_0 = 807(6) \text{ \AA}^3$ ,  $K_{T_0} = 165(24) \text{ GPa}$ ,  $K'_{T_0} = 3(1)$ ,  $(\partial K_0/\partial T)_P = -0.031(13) \text{ GPa K}^{-1}$  and  $\alpha_0 = 3.5(8) \times 10^{-5} \text{ K}^{-1}$  for  $\beta$ -En.  $730 \times 10^{-6}$  water in the enstatite structure could possibly slightly change the second phase transition at high pressure conditions, and could increase the thermal expansion, but has negligible effects on the bulk modulus and the pressure of the first transition. Our results would be of implication for modeling the geophysical behaviors of subducted slabs.

基金项目: 国家自然科学基金项目(41374107); 国家自然科学基金委-中国科学院大科学装置联合基金项目(U1632112); 中国科学院地球化学研究所“青年创新科技人才培养计划”项目

第一作者简介: 许金贵(1990-), 男, 博士研究生, 研究方向: 高温高压矿物学. E-mail: xujingui1990@126.com.

\* 通讯作者简介: 范大伟(1982-), 男, 副研究员, 研究方向: 地球深部物质科学. E-mail: fandawei@vip.gyig.ac.cn.