Phase relations in SiC under high pressure and temperature and compression behavior in rock-salt-type phase

*Yuto Kidokoro[1], Kei Hirose[2], Yoichi Nakajima[3], Ryosuke Sinmyo[2], Yasuo Ohishi[4]

1.Department of Earth and Planetary Sciences, Tokyo Institute of Technology, 2.Earth and Life Science Institute, Tokyo Institute of Techlorogy, 3.RIKEN SPring-8 Center, 4.Japan Synchrotron Radiation Research Institute

Although planets in the solar system are oxygen-rich compared to the carbon, the exoplanets may have fundamentally different chemistry. For example, recently found super-Earth, 55 Cancri e is orbiting around the host star, which has particularly high C/O ratio. According to the mass-radius relations (McArthur et al., 2004; Winn et al., 2011; Demory et al., 2011), the interior of 55 Cancri e is expected to be carbon-rich similarly with the host star, and is possibly constructed from iron, silicon-carbide (SiC) and carbon (Madhusudhan et al., 2012). However, the physical property of SiC is so far poorly understood under high pressure conditions, although it is essentially important to know the internal structure of the super-Earth.

SiC is known to have polytypes such as 3C and 6H at ambient condition. It is reported that zincblende type 3C phase undergoes phase transition to rock salt type phase under high pressure. However, the phase transition pressures are inconsistent between theoretical prediction and experimental results. *Ab initio* calculation showed that the 3C phase transformed into the rock salt type phase at 66 GPa (Chang et al., 1987; Karch et al., 1996). In contrast, the previous experimental study observed the phase transition at 100 GPa or higher (Yoshida et al., 1993).

In this study, we have examined the phase relations of SiC under high pressure and temperature conditions by a combination of laser-heated diamond-anvil cell and *in-situ* X-ray diffraction (XRD) measurements at BL10XU of SPring-8. In addition to the phase relations, the compression behavior of rock salt type phase was firstly determined by means of experimental method. The XRD data were obtained up to around 100 GPa and 3500 K. The results showed that the rock salt type phase is stable above about 74 GPa and 2000 K, which is significantly lower pressure than the previous study without annealing. Obtained results showed that the rock salt type phase is 19.4 % denser than 3C phase at about 74 GPa. Such large increase of density may have a strong effect on the estimation of the internal structure of super-Earth, such as 55 Cancri e.

Keywords: silicon carbide, carbon planet, super-Earth, high-pressure phase transition, X-ray diffraction, laser-heated diamond-anvil cell

