I075-P015 Time: May 28 17:00-18:30

Thermal equation of state of stishovite to 23 GPa

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1, Introduction

Stishovite is stable above 10 GPa, which is a high-pressure phase of silica and has rutile-type structure. Density difference of the subducted basaltic materials relative to the ambient peridotitic mantle is very important to understand the geodynamics and chemical evolution of the Earth (e.g., Irifune and Ringwood, 1987). Stishovite is one of the constituent minerals in basaltic conditions (e.g., Ono et al., 2001). In order to study the dynamics of subducted oceanic crust, we have measured lattice parameters of stishovite at wide range of pressure-temperature condition, and determined its thermal equation of state, precisely. Determination of thermal equation of state of stishovite up to 9 GPa carried out by Liu et al. (1990). We tried it at higher pressure using the ability of SPEED-1500 installed at SPring8.

2, Experimental Methods

In situ experiment to determine thermal equation of state of stishovite was performed using multi anvil apparatus SPEED-1500 conducted at the beam line BL04 at SPring8. Sample assembly with LaCrO3 pressure transmitting medium, TiC + diamond sheet heater, W-Re thermocauple and WC cubic anvil (truncation edge length = 3mm) was used. Because stishovite is quite stiff material, careful attention was made to achieve hydrostatic sample environment even at high pressures. Starting material of stishovite, which was synthesized by multi-anvil apparatus at Tokyo Institute of Technology, was mixed with NaCl powder (about 2:1 in volume ratio) and were packed into NaCl sample chamber separately. Pressures were calculated by equation of state (EOS) of Au (Anderson et al., 1989).

3, Results and Discussion

Pressure-volume-temperature (P-V-T) data were collected at 45 conditions up to 23 GPa and 1073K. Derived P-V-T data were fitted to high temperature Birch-Murnaghan EOS (e.g., Funamori et al., 1996).

The derived thermal equation of state of stishovite is consistent with P-V-T data derived at lower pressure conditions (Liu et al., 1999, up to 9 GPa). The room temperature hydrostatic compression data up to 16 GPa (Ross et al., 1900) and thermal expansion data at 1 atm (Ito et al., 1974) are also consistent with present EOS of stishovite. These suggerst present results are quite reliable. Densities of basaltic crust at the lower mantle conditions can be calculated precisely by using present EOS of stishovite.