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Elastic wave velocities of stishovite at high pressures

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Stishovite is an important constituent of the Earth's mantle transition region, and therefore elastic wave velocity of stishovite, in conjunction with seismological observations, should give constraints on the mineralogy of the mantle transition region. Previous studies have measured elastic wave velocities of stishovite at high pressures to 3 GPa by ultrasonic technique (Li et al., 1996) and to 12 GPa by Brillouin scattering measurement (Jiang et al., 2009). However, the results are inconsistent each other. In addition, these studies were carried out at pressures lower than that of mantle transition region. We therefore need further elastic wave velocity measurement of stishovite at the pressure and temperature conditions of the mantle region.

Here we carried out elastic wave velocity measurement on sintered polycrystalline stishovite from 10.3 GPa to 17.5 GPa at room temperature by using ultrasonic technique in conjunction with synchrotron X-ray measurement. The polycrystalline stishovite sample was hot pressed at ~16 GPa and ~1470 K in a 3000-ton Kawai-type apparatus using SiO₂ glass rod as starting material. The bulk density measured by Archimedes method before high pressure experiment was 4.29(2) g/cm³, which was same density as that determined by X-ray diffraction measurement (4.280 g/cm³).

Simultaneous ultrasonic and in situ X-ray measurements were carried out at BL0401 beamline in SPring-8. Ultrasonic elastic wave velocity measurements were conducted using the pulse reflection method. Sample lengths at high pressures were directly determined from the X-ray radiography image. Pressure was determined by self-consistent manner using obtained elastic wave velocity and density of stishovite.

Pressure-volume relation of stishovite measured in this study is consistent with these of previous studies (e.g. Lakshtanov et al., 2005; Nishihara et al., 2005). Our obtained elastic wave velocities of stishovite are higher than that of low pressure ultrasonic measurement to 3 GPa (Li et al., 1996). For instance, P wave velocity (VP) at 3 GPa estimated from our high pressure data is 12.02 km/s, but that of Li et al. (1996) less than 11.8 km/s. In contrast, our results are almost consistent with previous Brillouin scattering measurement on single-crystal stishovite up to 12 GPa (Jiang et al., 2009).

Keywords: stishovite, elastic wave velocity measurement