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Elastic Constants of Single Crystal Stishovite Determined by Resonant Ultrasound Spectroscopy (RUS)

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Elastic properties of minerals plays an indispensable role in the studies of Earth's interior as it is essential for interpretation of seismic velocity structure of the Earth, due to its feasibility of comparison with the seismological observations. And it also provides information on structure, bonding, and the nature of phase transitions in minerals. Resonant Ultrasound Spectroscopy (RUS) has been one of the leading methods of determining elastic constants of materials by measuring number of natural vibration modes. Owing to developments of high frequency RUS up to 50 MHz (HRUS), it emerge as a powerful technique in study of high pressure phases of mantel minerals in which samples are restricted to be sub millimeter size.
In this study stishovite was selected due to exceptional interest on it as a prototype phase of the lower mantle silicates, because it exhibits silicon in six-fold coordination. Large single crystals (up to 0.8x0.8x1.5mm) of stishovite were synthesized at 12 GPa from single crystal quartz and water (SiO2+15wt% H2O) by slow cooling method (from 1450 C to 800 C) in Kawai-type uniaxial split sphere apparatus (USSA5000). Quality of the crystals was confirmed by polarized microscope study, micro focus x-ray diffractometry and precision x-ray diffractometry. From FTIR measurements water content in synthesized crystals was confirmed to be less than 7 wt. ppm. Crystal was grind and polished in to a rectangle, parallel to crystallographic axis having edges of 2 30x290x500 micron meter. Then it was measured with HRUS for 15 resonance peaks in 6-20 MHz region. From these peaks six independent ambient pressure elastic constants C11 = 468 GPa, C33 = 752 GPa, C12 = 211 GPa, C13 = 192 GPa, C44 = 250 GPa and C66 = 326 GPa were calculated

Keywords: high pressure, resonant ultrasound spectroscopy, Stishovite, ekastic constant