Crystal growth of stishovite and its application to Si-self diffusion measurements

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Large (over 1 mm) high-quality single crystals of deep mantle phases are necessary for accurate determination of physical properties of the Earth mantle, such as elasticity, plasticity, element diffusivity, and electrical and thermal conductivity. Since most of mantle minerals decompose during ascent to the Earth surface, a single crystal growth using a large-volume HPHT apparatus is only technique providing such specimens. Single crystals of stishovite were successfully synthesized at 11 GPa from silica solution in water using a Kawai-type high-pressure apparatus. Potential of both slow cooling (SC) and thermal gradient (TG) growth methods were examined. TG method provided crystals, up to $0.8*0.8*1.3$ mm in size, grown at 1350 degree Celsius using stishovite as a silica source. Use of quartz as a source leads an appearance of numerous stishovite crystals in the solution interior which limit space for a large crystal growth. That is probably caused by significant difference between metastable quartz and stishovite solubility in water estimated to be 85.3 - 5.6 = 79.7 wt.%SiO_2 at 1000 and 11 GPa. Crystals dimensioned up to $0.8*1.3*1.5$ mm were also grown by means of slow cooling of the system SiO_2+14.7 wt.%H_2O from 1650 to 1000 degree Celsius with a rate of 2 degree/min.

The size of obtained single crystals was large enough to curry out a silicon self diffusion experiments which were performed at pressure of 14 GPa and temperature ranging from 1400 to 1800 degree Celsius.

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