OH-defects in high pressure silica polymorphs

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High pressure silica polymorphs like coesite and stishovite are common mineral phases of subducting slabs that are stable at great depths in the Earth's interior. Similarly to quartz, these phases can incorporate hydrogen and other trace elements (eg.Al, Li and B) in their structure as point defects. Consequently, coesite and stishovite may serve as important carriers of light elements into deep Earth and thus become an interesting subject of study for experimental research. In this work we aimed to reproduce the chemical evolution of silica polymorphs during the subduction of a continental crust, based on examples such as the Dora and the Kokchetav massifs. In this study, coesite crystals were grown from a tourmaline-granite starting material with 1.5-6 wt% water at 900-950°C and 4-7 GPa in a multi anvil apparatus. All the run products consisted of coesite and quench material. Muscovite was also found in the experiment performed at 6 GPa. Individual crystals were handpicked, oriented parallel to (010) and (100) and polished on both sides. Polarized IR measurements were successively performed along the main refractive indices nα, nβ and nγ. Although IR measurements were always performed on a clear area of the crystal, a large isotropic absorption band was detected in all the IR spectra, probably caused by fluid and/or melt inclusions. Coesite synthesized at 4 GPa did not show any absorption band in the OH-stretching region of the IR spectrum, suggesting that OH content was probably below the detection limit (<10 wt ppm). On the other hand, IR absorption spectra of coesite synthesized at higher pressures revealed absorption features that can be assigned to the hydrogarnet (4H)Si (3573, 3523 and 3459 cm^{-1}) and the BOH (3538 and 3500 cm^{-1}) defects. A positive correlation between OH content and pressure was observed, from 41 at 5 GPa to 67 wt ppm at 7 GPa (using the extinction coefficient from [1]). Future work will be focused on the synthesis of stishovite at pressures between 8 to 10 GPa and a trace element analyses on coesite and stishovite by LA-ICP-MS.

[1] Thomas et al. (2009), Phys Chem Minerals 36, 489-509.