X-ray Raman Scattering of SiO_2 Polymorphs – Quartz and Stishovite

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The earth lower mantle predominantly consists of silicate minerals. We have performed XRS measurements to silica polymorphs as the simplest silicates. The polymorphs are quartz, which consists of corner-sheared SiO_4 tetrahedra, and stishovite, with edge-sheared SiO_6 octahedra. XRS spectra for these SiO_2 were obtained with respect to Si L_{III}- and *K*-edges and O *K*-edge.

The samples were powder of grained reagent quartz sand and a polycrystalline chunk of stishovite synthesized at ISEI, Okayama University. The thickness is 0.55 and 0.33 mm for quartz and stishovite, respectively. The scattered X rays were monochromatized to 9888 eV and detected by a Si PIN diode. The inelastic spectra were obtained by scanning the incident X-ray energy. The scattering angle was 20 degrees for Si *L*-edge and 40 degrees for O *K*-edge to collect the spectra under dipole approximation (low Q setting). The spectra of stishovite were also obtained at a dipole invalid condition, where the scattering angle was 145 degrees (high Q setting).

Figures 1, 2, and 3 show obtained XRS spectra with respect to O *K*-edge, Si *L*-edge at low Q setting, and Si *L*-edge at high Q, respectively. Each polymorph shows unique spectra at all conditions. The signals of quartz is larger than those of stishovite in the case of spectra obtained at low Q setting. This is probably deu to self absorption of X rays by samples. Stishovite has larger density than quartz and was well-sintered while quartz was powder. On the other hand, the signals obtained at high Q setting shows comparable intensity for both polymorphs. The feature shown around 115 eV in Fig.2 became brurry in Fig. 3. This is probably because the contribution of monopole transition appers around that energy range in high Q measurement. The comparison with calculated partial density of state for electrons is required to understand the extent of this contribution.

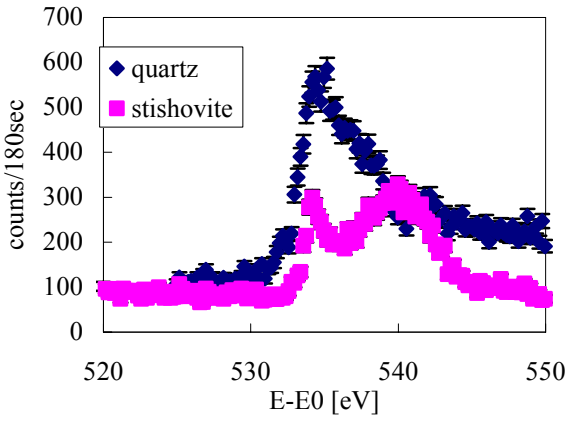

Figure 1. XRS spectra with respect to O *K*-edge

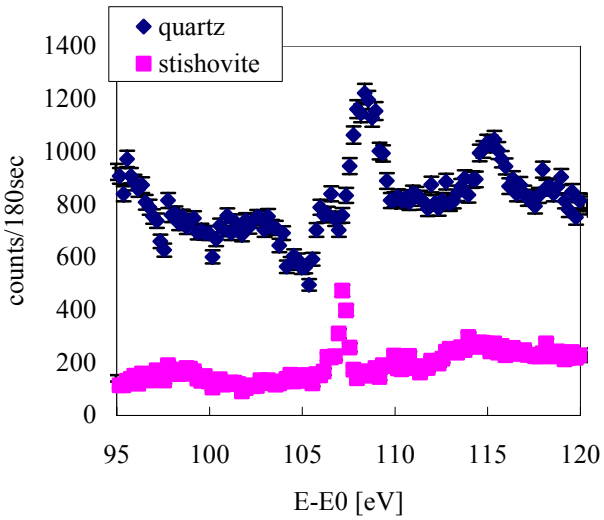

Figure 2. XRS spectra with respect to Si *L*-edge at low Q setting. Fine structures are seen around 115 eV for quartz.

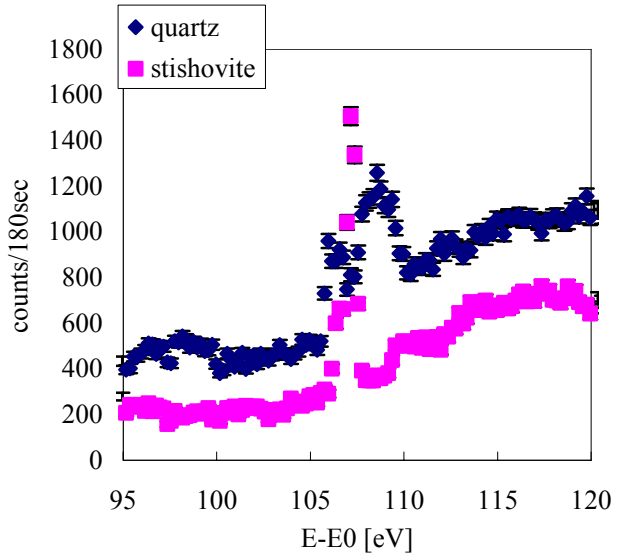

Figure 3. XRS spectra with respect to Si *L*-edge at high Q setting. The S/N ratios are much stronger than those shown in Fig.2.