Applications of Bragg Backscattering from Crystalline Quartz

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The backscattering silicon single crystals normally used for energy analysis in hard X-ray inelastic scattering suffer from parasitic reflections and gaps in photon energy where no backscattering reflection exists. Sapphire has been proposed as an alternative because its trigonal lattice has lower symmetry than silicon's fcc lattice. The lower symmetry means both that fewer reflections are forbidden and that multi-beam cases are less likely to arise when one approaches a backscattering Bragg reflection. However, crystal quartz, which is also trigonal, has a larger number of backscattering reflections predicted to have energy widths of 6 meV at photon energies between 5 and 12.5 keV, and has peak reflectivities comparable to those of sapphire. Such photons have less energy than those now normally used in X-ray inelastic scattering, but using them would allow scattering at smaller momentum transfers to be explored. Furthermore, some new synchrotron sources are optimized for 10-12 keV photons, for which silicon backscattering analyzers cannot provide energy resolutions below 5 meV.

At present it is not certain if quartz crystals with sufficiently low distortion can be found for use as backscattering analyzers. Therefore, we have measured the energy width of several backscattering reflections in quartz, and have performed X-ray topography on several samples. Though the results do not match those predicted for perfect crystals, meV energy resolutions were attained.

Keywords: high-resolution x-ray diffraction, quartz, inelastic x-ray scattering