Evidence for a rosiaite-structured high-pressure silica phase and its relation to lamellar amorphization in quartz

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When affected by impact, quartz (SiO_2) undergoes an abrupt transformation to glass lamellae, the planar deformation features (PDFs). This shock effect is the most reliable indicator of impacts and is decisive in identifying catastrophic collisions in the Earth´s record such as the Chicxulub impact. Despite the significance of PDFs, there is still no consensus how they form. Here, we present time-resolved in-situ synchroton X-ray diffraction data of single crystal quartz rapidly compressed in a dynamic diamond anvil cell. These experiments provide evidence for the transformation of quartz at pressures above 15 GPa to lamellae of a metastable rosiaite ($PbSb_2O_6$)-type high-pressure phase with octahedrally coordinated silicon. This phase collapses during decompression to amorphous lamellae, which closely resemble PDFs in naturally shocked quartz. The identification of rosiaite-structured silica provides thus an explanation for lamellar amorphization of quartz. Furthermore, it suggests that the mixed phase region of the Hugoniot curve may be related to the progressive formation of rosiaite-structured silica.