Heavy-ion irradiation on crystallographically oriented cordierite and the conversion of molecular CO_2 to CO: a Raman spectroscopic study

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Crystallographically oriented sections of natural gemstone quality cordierite single-crystals have been irradiated with swift heavy ions of GeV energy and various fluences. Irradiation effects on the crystal lattice were investigated by means of Raman spectroscopy. Raman line scans along the trajectory of the ions reveal a close correlation of beam parameters (such as fluence and energy loss d*E*/d*x* along the ion path) to strain due to associated changes in lattice dimensions and defect concentration. The luminescence background also scales with the ion fluence and suggests the formation of point defects, which could also account for the macroscopically observable colouration of the irradiated samples. In addition, changes in the amount and nature of volatile species inside the structural channels are observed. They also scale with d*E*/d*x* and confirm the previously postulated irradiation-induced conversion of CO_2 to CO. Irradiations along the crystallographic *a*-, *b*- and *c*-axis reveal no significant anisotropy effect with respect to lattice alterations. The polarisation characteristics of the Raman-active modes confirm the preferred molecular alignment of CO and CO_2 along the *a*-axis direction.