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Swift heavy ion-irradiated calcite (CaCO3) analyzed by UV-C Laser excited Fluorescence-Spectrometry

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The mineral calcite (CaCO3, rhombohedral cell, 3 2/m symmetry, large band gap) is known to exhibit luminescence caused by electron excitation (cathodoluminescence), accelerated ion excitation (ionoluminescence), UV-light, and laser excitation. In most cases, the resulting wavelength can be traced back to impurities in the crystal lattice that act as luminescence centres. These impurities could be Pb2+, Mn2+, Ce3+, Sm3+, Nd3+, Dy3+, Eu3+, or radiation induced CO33-. The influence of natural radiation on luminescence behaviour of calcite leads to the assumption that it might be possible to determine the defect concentration, and therefore, the fluence applied to irradiated calcite crystals, by measuring the intensity change of the luminescence peaks. This could be a promising, non-destructive analytical technique to quantify defect concentrations that are caused by heavy ion-irradiation in condensed matter, in general.
This poster addresses the relationship of artificially generated defect concentration by swift heavy ion irradiation and UV-C laser excited luminescence spectra of the mineral calcite.
A new mobile UV-C laser excited fluorescence spectrometer system was build to be used at different irradiation beamlines (M-3 branch, SIS-18, and CRYRING) at GSI, Darmstadt, for online and in-situ measurements. The system consists of a Crylas 266-200 UV-C pulsed laser (of ⍰=266 nm, 160 µJ/pulse, 60 Hz), a beam splitter, newly designed sample holder on a software driven 3-axis piezo-stage (PI Q521-300), a mirror, a UV-C beam dump, a longpass filter, two different optical fibres and two UV/Vis spectrometer. The Ocean Optics USB 4000 UV/Vis Spectrometer is used if the material under investigation provides high photon release. The Horiba Jobion Yvon iHR 320 spectrometer with a Pelletier cooled camera is used for low photon counts as it has a very high signal to noise ratio.
Calcite crystals irradiated with 11.1 MeV/u Au ions of fluences between 1 x 106 and 1 x 1012 ions/cm2were investigated with the new system. In comparison to non-irradiated calcite crystals, the following changes can be seen with increasing fluence:
- Increasing intensity of peaks and the appearance of new peaks.
- Non-irradiated: Intensity increase in the region of 500 to 600 nm for irradiated calcite (108 ions/cm2) compared to non-irradiated samples.
- For fluences between 108 and 1012 ions/cm2 intensity increase in the region of 550 to 700 nm.
The presentation will provide insight into the new analytical set-up and the first data on calcite irradiated with swift heavy ions.

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