Online Raman on M-branch: First results *

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Raman spectroscopy, as a tool to determine material change caused by accelerated ions or natural radioactive decay, is widely used in geoscience and material research. Due to many issues in the current workflow with standard equipment, in 2014, an online and in-situ Raman system to irradiate matter with swift heavy ions has been developed. The Raman system is established at the 400 mm spectroscopic chamber of the M3-branch and is fed with accelerated swift heavy ions by the UNILAC. For technical details see the associated report in this volume [1].

To test the system's ability to detect changes in the properties of the irradiated material, calcite has been chosen for first experiments, because calcite reacts very sensitive to ion irradiation and the changes of calcite in Raman spectra are known [2,3]. The calcite crystals from Chihuahua, Mexico were irradiated at the M3 - branch of the UNILAC, GSI with Au^{+26}, 4.8 MeV/u, 2 Hz and an extraction time of 1.2 ms.

After calibration, alignment and focusing of the system, one calcite crystal has been irradiated with Au ions in steps from 1 x 10^9 ions/cm^2 until a fluence of 1 x 10^{12} ions/cm^2. Raman spectra were taken after each irradiation step with 20 s acquisition time with 3 repetitions.

A first brief analysis of the Raman spectra of calcite show four major changes during irradiation (Fig. 1). The two peaks at 156 and 284 cm^{-1} at the beginning of the spectra are decreasing in intensity with increasing fluence, but they are still visible at 1 x 10^{12} ions/cm^2. The next change in the spectra is the peak at 437 cm^{-1}. It arises with increasing fluence and is visible for the first time at 2 x 10^{10} ions/cm^2. Its intensity is increasing after this fluence, but it reaches its maximum at 5 x 10^{11} ions/cm^2. The last peak to be mentioned is the biggest peak of the spectra at 1087 cm^{-1}. It is getting wider with increasing fluence, starting at 5 x 10^{11} ions/cm^2.

In conclusion, the first results of the new online Raman system at M3 are very promising. The system works and the results are in quality and quantity comparable with the results of established methods with all the advantages of o online Raman system with its in situ measurements. After eliminating some minor problems, a powerful tool to measure various materials before, during and after the irradiation with swift heavy ion is at hand. A more detailed analysis of the obtained data is in progress.

[1] S. Dedera et al., "Online Raman Measurements on M-Branch", GSI Science Report 2014

[2] S. Dedera et al., "Online Raman Measurements of Calcite and Malachite during Irradiation with Swift Heavy Ions", in prep.

[3] S. Pabst et al., Swift heavy ion induced damage in calcite, aragonite and dolomite: a Raman spectroscopic study", in prep.

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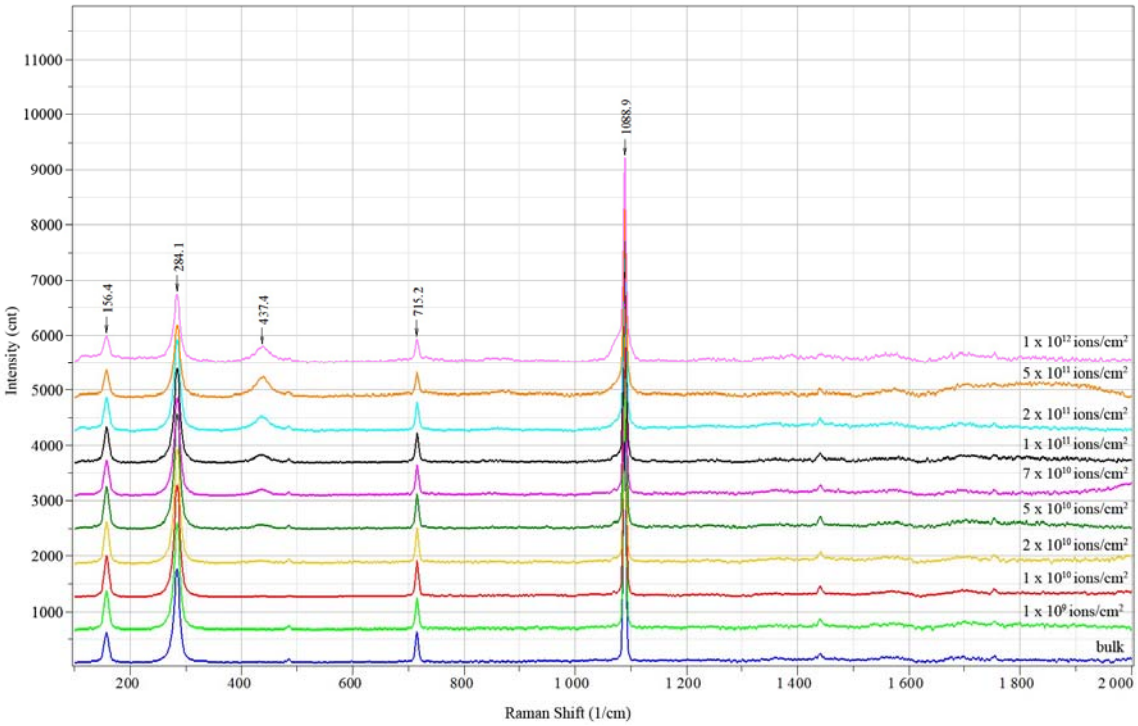

Figure 1: Raman spectra of calcite, taken with the new online Raman system on M3-Branch

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