Coupling SEM and Raman spectroscopy a powerful tool for geological materials characterisation

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SEM and elemental analysis techniques (EDS, WDS) are widely used for geological materials analyses for providing morphological and chemical information. Other techniques coupled to SEM are also useful, such as cathodoluminescence, EBSD…

Raman micro-spectroscopy is also a useful technique for geomaterials characterisation. This technique is based on the study of the inelastic diffusion of the light. The interaction of vibrational energy levels of molecules and incident beam photons provides a spectra which permits to provide structural information on the sample atomic structure. In particular, Applying Raman spectroscopy to geological samples allows differentiating between different polymorphs (same elemental composition, different crystallography), between oxide and hydroxide or to check the level of order of the crystal.

Therefore, Raman spectroscopy and SEM/EDS are complementary techniques. Data collected from these techniques are essential for many studies in different fields of geosciences (mineralogy, petrography, soil pollution, environmental science …). Moreover, these informations can be obtained at a similar scale (micrometre). But, in numerous cases, it is difficult to collect information on the same object, for several reasons : differences of imaging mode (optical microscopy for Raman, SE/BSE imaging for SEM) which make difficult to connect optical and electronic imaging observations, size of the analysed object vs resolution of optical microscopy…

In 1988, Truchet and Delhaye [1] proposed a description of an optical system for simultaneous Raman spectroscopy and elemental analysis in an electron microprobe. Such system is now available for installation on any SEM. This combination offers new opportunities for analysing the same object at the same scale without facing the problems associated with using separate tools. Thus, coupling this two techniques in the same system constitute a powerful analytic set which allows to save time in the analytical process. But the main interest is that this coupled system allows to perform analyses at the same scale, coupling information on morphology, elemental chemistry and structural chemistry. Such a combined system has been successfully used on different fields like forensic applications [2], biological samples characterization [3,4].

The aim of this study is to present the value of combining SEM and Raman analysis of geological samples characterisation. We will describe the system combining a Raman spectrocope installed on a Low Vacuum FEG-SEM and the interest in combining Raman spectra with SE/BSE/CL images and EDS/EBSD data. We will present several applications examples of the combined use of Raman and SEM on geological samples such as natural asbestos fibres identification, minerals identification or biominerals analyses.

References