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APPLICATION OF WAVELENGTH-DISPERSIVE SPECTROSCOPY AT ID21 X-RAY MICROSCOPY BEAMLINE OF ESRF: NEW POSSIBILITIES FOR MICRO-FLUORESCENCE AND MICRO-XANES ANALYSIS

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The ESRF ID21 beamline relies on a submicrometer X-ray probe in the energy range between 2 keV and 7.2 keV and is mainly oriented to micro-X-ray fluorescence and micro-XANES analysis. Increasing demands for developing new and complementary x-ray techniques to be used in different applications (*e.g.* semiconductor nano-technology, biology, geology, archaeology) are presently focused on high-resolution and sensitivity x-ray fluorescence techniques combined with a narrow, down to the sub-micrometer range, x-ray beam excitation. Until now, the ID21 beamline relied on several solid-state detectors, which are complementary in terms of count-rate throughput and solid-angle collection efficiency. However, the attainable energy resolution (120–180 eV) of such energy-dispersive detectors is often inadequate to permit unequivocal elemental and chemical speciation. To improve the energy resolution of fluorescence detection of the X-ray microscope, a new x-ray wavelength dispersive spectrometer (WDS) have been developed for the micro-fluorescence analysis [1].

The spectrometer employs a polycapillary optics that gives a large (20°) collection solid angle for X-ray fluorescence. Such collimating polycapillary optics outputs a quasi-parallel beam which is directed onto plane crystal analyzer and recorded by a gas-proportional counter. In order to record the x-rays in energy range between 0.5 keV to 7 keV four different crystals are employed. The simple design results in a compact spectrometer, which fits a limited space available around immediate sample environment of the X-ray Microscope.

We present the construction details, operational characteristics, and the performance achieved with the new spectrometer. In particular, the spectral energy resolution, line shapes and throughput are compared with results from Monte Carlo simulations.

The examples of application of the spectrometer in the measurements combining two-dimensional imaging with a high spectral resolution will be discussed. The advantages of using WDS micro-fluorescence and micro-XANES for analysis of the cultural heritage and geological samples (see Fig. 1) will be demonstrated. Further possibilities for improving the energy resolution, down to the ~1 eV level, will be discussed and preliminary results from tests made using a double-crystal geometry will be given. The latter provides the measurements of absorption spectra which are free of the lifetime-broadening.

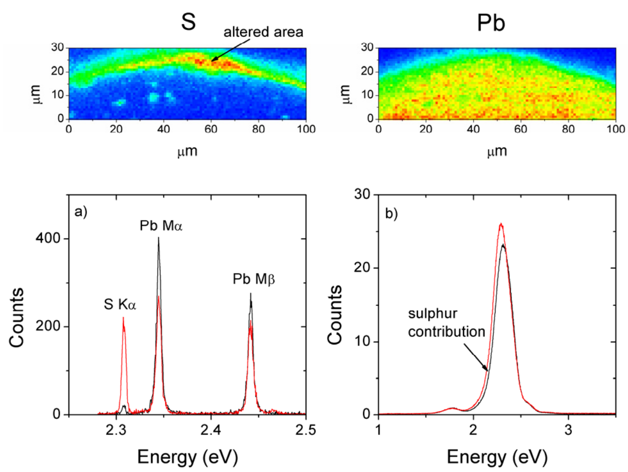

Figure 1. Top panels: X-ray fluorescence maps of S and Pb in the painting cross section containing the altered area. (a) The polycapillary-based WDS X-ray fluorescence spectrum recorded in the altered (red) and safe (black) areas. (b) The same as (a) but acquired using a Si drift diode detector.

References

[1] J. Szlachetko, M. Cotte, J. Morse, M. Salomé, P. Jagodzinski, J.-C. Dousse, J. Hoszowska, Y. Kayser, J. Susini, "Wavelength-dispersive spectrometer for X-ray microfluorescence analysis at the X-ray microscopy beamline ID21 (ESRF)", *J. Synchrotr. Rad.* **17** (2010) 400.