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Ultra-Fast and Sensitive Element Distribution Measurement using µ-XRF

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Elemental distribution measurement allows a better characterisation of materials than point analysis. For that purpose different analytical methods are in use. Micro X-ray fluorescence (MXRF) has the advantage of high sensitivity for trace analysis but of limited spatial resolution. It has been developed in the last years as a powerful analytical tool for in material science, quality control, forensics and archaeometry. The analytical performance in particular for distribution analysis is determined not only by the size of the analysed area but also on the step size and the measured intensity. The spot size is given by the performance of x-ray optics [1, 2]. But step size can be significantly smaller than spot size to improve the spatial resolution. This will be demonstrated with dedicated measurements. Another important feature is the intensity in every pixel. Only in case of high intensities the contrast between pixels can be larger than statistical fluctuations. But the accumulation of high intensities even with shortest measuring time down to few ms per pixel requires a fast data compression and saving.

These considerations require the combination of a highly efficient X-ray excitation and detection technology for high count rates together with a high-speed scanning and data processing technology for a considerable progress of micro-XRF. A detailed discussion of these parameters will be performed and a demonstration their influence to the quality of elemental distributions is given.

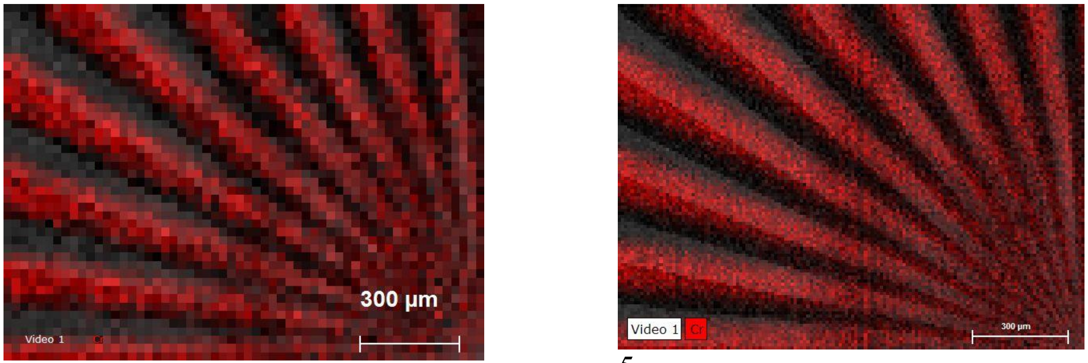
Another important feature of the examination of elemental distributions is the handling and presentation of measured data. In case of a position tagged spectroscopy for all pixels a complete spectrum is saved. This produces large data bases but offers different benefits for data evaluation and presentation. So it will be possible to calculate distribution for different energy ranges – both for particular elements or for scattered radiation of different energies. Because radiation of different energies are scattered in a different depth of the sample these distributions allows a view into different sample depth. Examples for 2D distributions for both topological information and distributions on the sample surface but also the ”look” into the sample are given. For that purpose examinations of samples from electronics, geological and archeometric objects will be presented.

References:

[1] Kanngießer, B. Haschke,M, in Handbook of Practical X-Ray Fluorescence Analysis
Eds by Beckhoff, B.; Kanngießer, B.; Langhoff, N.; Wedell, R.; Wolff, H.
Springer 2006, ISBN: 3-540-28603-9

[2] Microscopic X-Ray Fluorescence Analysis,
Eds. by Koen H.A. Janssens, Freddy C.V. Adams and Anders Rindby,
John Wiley & Sons 2000, 420 pages, ISBN: 0-471-97426-9

The spatial resolution depends on step size for the data accumulation. This can be demonstrated with help of a SiemensStar - a coating structure of Cr like a star. Image 1 show this structure measured with step sizes of 25 and 5 µm.



25 µm

5 µm

Fig. 1: Elemental distribution of a SiemensStar

The distribution of a small printed circuit board of a digital watch for different energy ranges (elements and scattered radiation) is displayed in the figure 2.

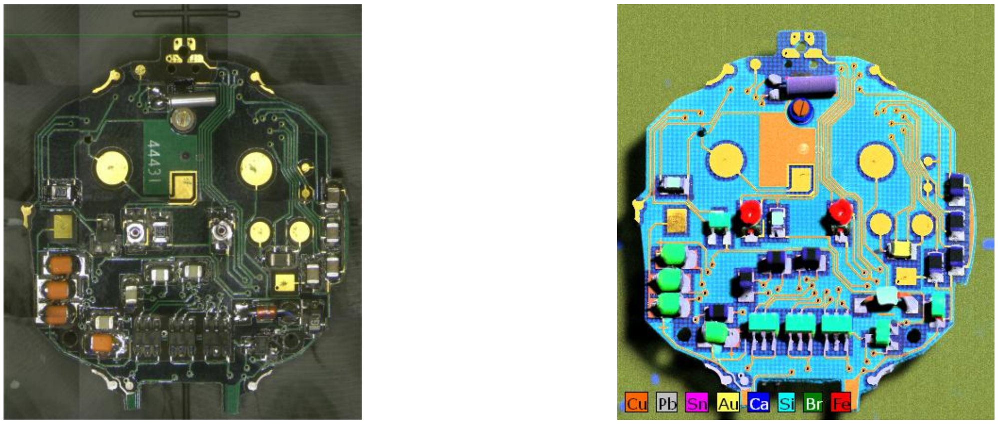
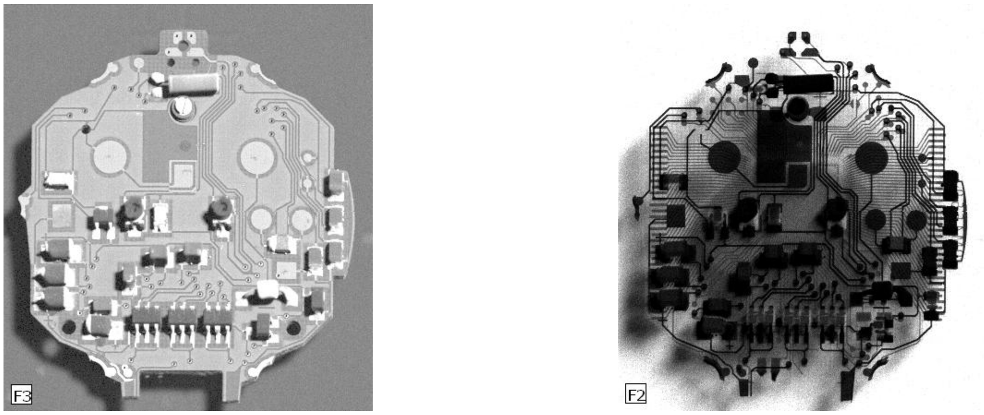


Photo of the PCB

Element distribution of some displayed elements



Scattered Rh-L radiation gives an overview for the sample surface

Scattered Rh-K-radiation gives an view inside the sample

Fig. 2: Elemental distribution of a PCB of a digital watch