

Compact micro-CT/micro-XRF system for non-destructive 3D analysis of internal chemical composition.

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We developed a compact laboratory scanner, which combines X-ray microtomography (micro-CT) with 3D X-ray microfluorescence (micro-XRF). This dual-modality scanner opens possibilities for nondestructive three-dimensional volumetric analysis of internal local chemical compositions, enhanced by morphological information provided by the built-in micro-CT system.

Unlike known micro-XRF methods based on collimated beam and detector [1,2], our micro-XRF scanner uses full field (two-dimensional) acquisition system with 512x512 pixels energy-sensitive detector operated in photon-counting mode. It allows detecting two-dimensional photon energy maps in the range of 3...20keV. Pinhole optics with round aperture and conical opening on both sides is used. The micro-XRF scanner contains two powerful X-ray sources for excitation and the full-field XRF detector placed in between. The micro-CT scanner contains a microfocus X-ray source and a high-resolution X-ray camera at opposite side of the object. The object is mounted on a rotation stage to collect the necessary angular views.

For XRF imaging, the operator can select up to 8 sets of energy windows, which will be collected independently and simultaneously. By object rotation the scanner acquires all necessary angular two-dimensional projections in transmission and fluorescence modes for 3D reconstruction. The system is built and configured in such a way that micro-CT scan and micro-XRF scan match each other exactly in position, magnification and spatial orientation. This makes image registration much easier and more accurate. Micro-CT data is reconstructed with a modified Feldkamp algorithm [3]. All micro-XRF datasets are reconstructed by a maximum likelihood iterative algorithm [4]. Micro-CT images can be used for absorption correction during micro-XRF reconstruction. For visualization, the XRF images revealing chemical information can be shown in color overlaid on micro-CT images shown in grayscale.

Good performance of the system has been demonstrated with phantom measurements and scanning of different types of samples.

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3. L.A. Feldkamp, L.C. Davis and J.W. Kress. J.Opt.Soc.Am.A, **1**, 6 (1984), pp.612-619.
4. L. Shepp and Y. Vardi, IEEE Transactions on Medical Imaging, **1**, 2 (1982), pp. 113-122.