SPOKED CHANNEL ARRAYS FOR 3D MICRO CONFOCAL X-RAY FLUORESCENCE

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Confocal X-ray Fluorescence Microscopy (CXRF) employs overlapping focal regions of two x-ray optics—a condenser and collector—to directly probe a 3D volume in space. In general, polycapillaries are used as the collector owing to their large solid angle of collection. Here, we report the practical demonstration of spoked channel arrays (SCAs), a novel x-ray collection optic for confocal x-ray fluorescence microscopy (CXRF). The optic consists of micron-scale, lithographically-fabricated arrays of collimating channels (Fig. 1), all directed towards a single source position. In contrast to polycapillaries, the spatial resolution of these optics is nearly energy-independent. Most recently, we have fabricated a set of optics made from germanium substrates, and successfully demonstrated (Fig. 2) their operation at 3-μm and 7-μm depth resolution from 2-20 keV. Among other benefits, this allows direct, 3D mapping of light elements such as P, K and Ca at the micron scale for the first time. The feasibility of these optics for confocal XRF and XAFS on a variety of different sample types were recently tested at APS beamline 20-ID-B, where they are now available to general users. The optic mounts in a custom-built holder, designed to mate easily to a single-element Vortex EX detector. Opportunities for future development will be discussed, including operation up to 30 keV, and operation in conjunction with pixel-array-based energy dispersive detectors, such as the Maia. The later combination would allow fast, 3D mapping of samples not suitable for computed tomography, and suggests the possibility of simultaneous, parallel detection of emission from different depths in a sample, e.g. for fast 3D mapping of major elemental consitutents, or time- and depth-resolved, in-operando studies of chemical reactions in layered systems.

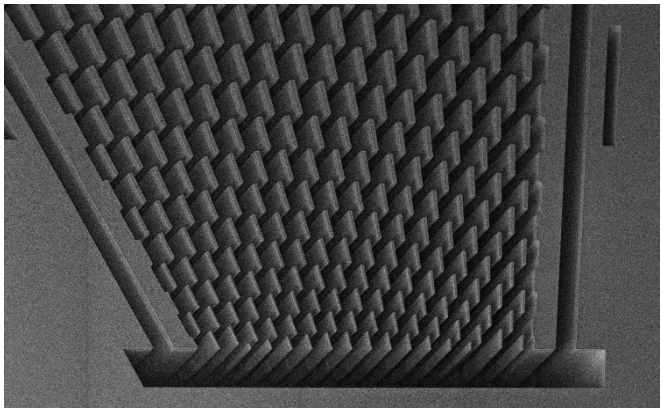

Figure 1: Scanning electron micrograph of a lithographically-patterned channel array.

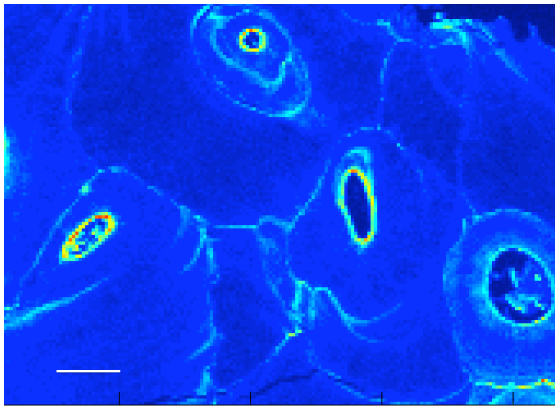

Figure 2: 2D map of Pb Lα fluorescence in an un-thinned bone sample, obtained using confocal XRF with a spoked channel array as the collection optic. Scale bar is 100 μm.