Confocal x-ray fluorescence microscopy at the Advanced Photon Source sector 20

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X-ray fluorescence (XRF) is a powerful technique for elemental analysis in part owing to its minimal sample preparation requirements and sub-ppm-sensitivity. However, conventional XRF imaging generally requires thin samples, which is not always desirable or possible, e.g. for brittle samples or when non-destructive analysis is required. Non-destructive 3-D confocal XRF microscopy allows spatial discrimination of XRF photons in all three dimensions and enables high resolution x-ray spectroscopy, such as XANES, to be performed directly on a small region of interest within large samples. Polycapillaries are the most common collection optics used for a confocal XRF microscopy, but limit the technique to depth resolution of upwards of 10 μm at 10keV. The new confocal XRF microscopy capability at sector 20-ID, enabled by CHESS micro-channel arrays (CCA), [1] are capable of achieving depth resolution of 2 - 5 μm. CCAs provide both an improvement in resolution and, in addition, invariant spatial resolution with the x-ray fluorescence energy. This capability has applications in environmental science, biology, and anthropology. Recent experiments include studies on mineral inclusions, human teeth, fish embryos, plants, and cultural artifacts. The sector 20-ID microscopy station is a KB mirror based microprobe providing a focus in the range 2-5 microns, and we can match the beam sizes to the CCAs spatial resolutions. We will present detailed current capabilities of the confocal technique at Sector 20-ID and show how we utilized the technique to understand the transport of metals in plant.

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[1] David N Agyeman-Budu, Sanjukta Choudhury, Ian Coulthard, Robert Gordon, Emil Hallin, Arthur R Woll, AIP Conf. Proc., 2016, 1764, 020004-0200011.