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X-ray Micro-Tomography using fluorescence from a metal foil as a light source combined with X-ray Micro-Diffraction

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Micro-X-ray computed tomography is a well established 3D imaging method that plays an important role in fields like materials science, food research, and bio-medical imaging. It is interesting to combine tomography with other techniques, such as X-ray diffraction, for assessing physical properties (density and crystallography) of materials that are heterogeneous on the micrometer scale. The challenge lies in reconciling the needs of both methods, whereby tomography typically requires a large beam and micro-diffraction requires a small beam.

To bridge this gap, a study was conducted at the MX1 beamline. Tomographic imaging was realised by placing a metal foil upstream from the sample thus generating a diverging fluorescence wavefront (1). This wavefront was propagated through the sample onto the beamline's CCD detector for absorption contrast imaging. The relatively small beam (~150mu) was used for simultaneous small-scale illumination for micro-diffraction.

To explore some of the possibilities of the combined method, imaging results from different density materials will be presented. Parallel micro-diffraction is demonstrated using an Egyptian faience bead, and elemental contrast imaging is explored by imaging Ni and Cu metal meshes. This study highlights possibilities to obtain three-dimensional structural information simultaneously on micrometer and crystallographic length-scales. The results show promise for further developments in element contrast imaging, and results from the work also inform possible extensions to phase contrast imaging.
(1) P.Kappen, B.Arhatari, M.B.Luu, E.Balaur, and T.Caradoc-Davies, Rev. Sci. Instrum. 84, 063703 (2013).

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Summary

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