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Characterization of Micro Pore Optics for Full-field X-ray Fluorescence Imaging

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Elemental mapping images can be achieved through step scanning imaging, static pinhole optics imaging or static imaging by micro pore optics (MPO). The MPO square micro pores act as waveguides for the X-ray photons, with the maximum angle for total refection of photons depending on the photon energy [1]. X-ray optics can be manufactured with different micro-channel geometries like square (MPO [2]), hexagonal or circular channels. Each optic geometry creates different imaging artefacts. Square micro pores generate a high intensity central spot due to two reflections via orthogonal channel walls inside a single channel - which is the desirable part for image formation - and two perpendicular lines forming a cross due to just a single reflection on a channel wall, as seen in Figure 1.

We have studied usage of an MPO in a full-field XRF imaging system. It consists of a commercially available MPO provided by Photonis and a Timepix3 readout chip with a 55 µm pixel pitch silicon detector. The flat MPO has a thickness of 1.2 mm, 20 µm square channel width and 25 µm channel pitch. The channel walls are coated with a ˜25 nm iridium layer to achieve a flat surface and hence improve the optical properties.Imaging of fluorescence from small metal particles reveals the expected distinct cross patterns, as shown in Figure 1. Transmission through MPO channels and variation of critical reflection angle are characterised by measurements of metal fragments with different fluorescence energies. The experimental setup will be discussed in detail. To further characterise channel transmission and energy dependence of total reflection of the square MPO, it is mounted aligned with a 10 µm circular lead glass polycapillary array [3, 4].

This paper is a continuation of the previous work by the authors, where an X-ray optic with circular channels was compared with a pinhole optic [3]. Our purpose is to identify elemental imaging applications and spatial resolution limitations for an XRF instrument using these novel square pore MPOs.

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