Type of presentation: Poster

IT-1-P-2198 The effect of Detector Thickness on Direct Detector Performance

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Direct detection refers to a detection system where signal is generated in the sensor chip directly by the imaging electrons; indirect systems generate photons in a scintillator from the imaging electron and it is these photon which are coupled to the sensor chip that generate signal. One of the key advantages of a direct detection system is the possibility of producing thin detectors; these are desirable as a thin detector has improved detection performance in terms of Modulation Transfer Function (MTF) and Detective Quantum Efficiency (DQE) [1]. This improvement arises from the fact that many electrons will pass all the way through the sensor and escape the detector system generating signal along the way, before large lateral scattering has occurred.

We have taken a prototype CMOS based direct detector featuring full frame resolution of 1024 by 1024 pixels, with a pixel size of 20µm and readout of 30fps [2]. Two different versions of the detection chip were produced. The first is a 20µm thick p^- active layer on a p^+ substrate mechanically thinned to 50µm. The second was made from silicon on insulator (SOI) wafer with a 20µm device layer with the handle wafer removed using a chemical etch. For each of these detectors the MTF and DQE were measured using standard techniques [3] at 80 and 200kV. Here we shall present the characterisation data along with images of gold particles on an amorphous substrate to show how thinner detectors lead to improved detector performance, allowing images taken at lower magnification to have improved resolution.

[1] G. McMullan, et al, Experimental observation of the improvement in MTF from backthinning a CMOS direct electron detector, Ultramicroscopy, 109 (2009).
[2] A.J. Wilkinson, et al, Direct Detection of Electron Backscatter Diffraction Patterns, Phys. Rev. Lett. 111 (2013).
[3] R. R. Meyer, et al, Experimental characterisation of CCD cameras for HREM at 300kV, Ultramicroscopy, 85 (2000).

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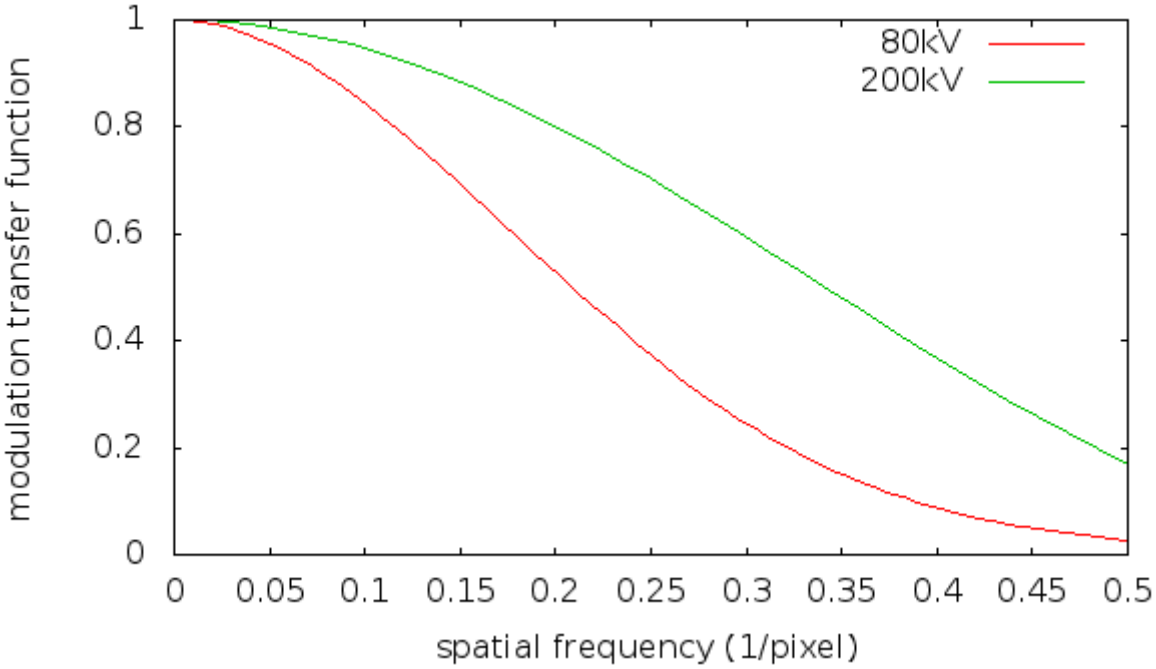

Fig. 1: MTF of a 20µm thick detector at 80 and 200kV.

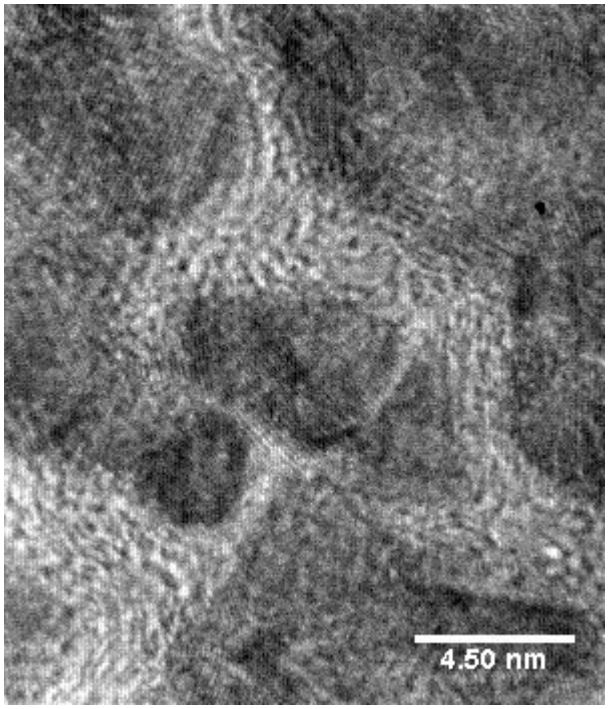

Fig. 2: Au on amorphous Carbon at 80kV and 120,000x magnification taken with a 20µm thick sensor chip.

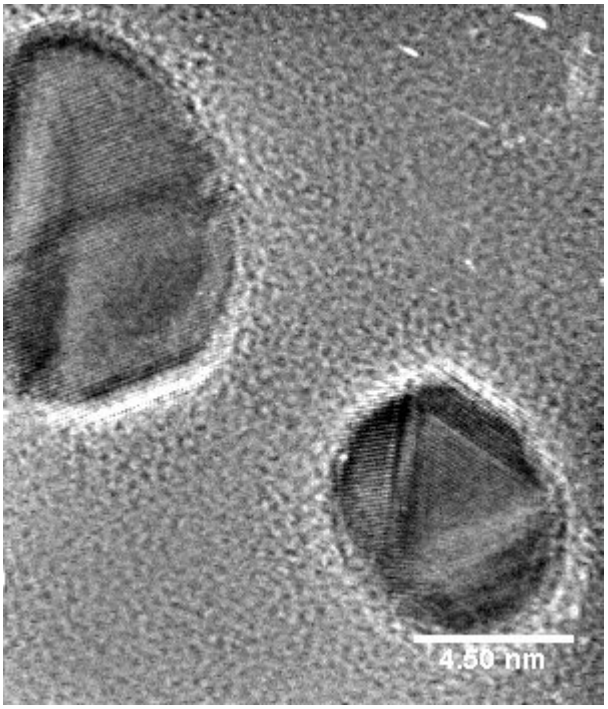

Fig. 3: Au on amorphous Ge at 200kV and 120,000x magnification taken with a 20µm thick sensor chip.