QUANTITATIVE X-RAY PHASE-CONTRAST MICROSCOPY AND MICROTOMOGRAPHY USING AN SEM

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The projection method for X-ray microscopy is very simple in principle and enables X-ray imaging at sub-optical resolution without the need for any focusing X-ray optics. The use of an SEM to provide an electron beam focussed on a target as a source of X-rays for imaging was described as early as 1945[1]. In this and subsequent works, the mechanism for contrast formation and interpretation was based on absorption.

Our approach to projection X-ray microscopy is to take advantage of the phase distortions imposed on an X-ray wavefront passing through an object, which, in combination with Fresnel diffraction leads to phase contrast in the resulting X-ray image.[2,3] We have developed an X-Ray ultra-microscope (XuM) based on an SEM as host (in the present case an *FEI XL-30 S-FEG SEM*) which is designed to take advantage of both phase and absorption contrast and has the capability for X-ray imaging at around 50 nm line pair resolution with X-rays from 0.8-15keV in energy. This system uses a scientific grade CCD in direct mode to give high signal to noise and optionally also an energy resolving capability for the transmitted beam. Images acquired using this system can be post-processed using combined phase-retrieval and deconvolution algorithms to produce very high resolution quantitative information about the sample[4-6].

This technique has particular strengths which are applicable to a wide range of microscopy- and microtomography-based studies of materials and devices. A number of examples of microtomography studies using the XuM will be presented including studies of manufactured devices, nanocomposites based on polymers, corrosion effects and biological samples.

References

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