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OPTIMISING ELECTRON HOLOGRAPHY IN THE PRESENCE OF PARTIAL COHERENCE AND INSTRUMENT INSTABILITIES

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Abstract

Off-axis electron holography provides a direct means of retrieving the phase of the wavefield in a transmission electron microscope, enabling the measurement of electric and magnetic fields at length scales from microns to nanometers. To maximise the precision of the technique, it is important to acquire holograms using experimental conditions that optimise the phase resolution for a given spatial resolution. These conditions are determined by a number of competing parameters, especially the spatial coherence and the instrument stability.

Here, we describe a simple, yet accurate, model for predicting the dose rate and exposure time that give the best phase resolution in a single hologram. Experimental studies were undertaken to verify the models of spatial coherence and instrumental instabilities that are required for the optimisation. The model is applicable to holography in both standard mode and Lorentz mode, and it is relatively simple to apply.

We also extend our analysis to the case of multiple holograms, where we present a quantitative analysis of the optimum parameters for maximizing the phase precision. In this context, we evaluate the performance of a state-of-the-art direct detection camera for electron holography, and compare its performance in various operational modes with a conventional integrating charge coupled device camera.