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IMPROVING THE EFFICIENCY OF ELECTRON HOLORAPHY BY COMBINED OFF-AXIS AND INLINE HOLOGRAPHY

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Abstract

Electron holography is a very powerful technique providing information about structure, as well as electrical and magnetic properties of materials. Both of the main variants of electron holography, off-axis and inline holography, have advantages and also shortcomings. Off-axis holography is able to reliably reconstruct low spatial frequency phase information but has comparatively poor signal-to-noise properties at high spatial frequencies due to the need of recording very fine interference fringes at a sufficiently high spatial sampling. Missing low spatial frequency information, on the other hand, is the most important problem which has to be overcome for inline holography. In this study we combine inline and off-axis holography.

To combine these two methods, the reconstructed wave function obtained from off-axis holography, acquired with the objective lens, was used as an initial guess in an inline holography reconstruction algorithm. This flux-preserving iterative reconstruction algorithm refined the exit face electron wave function based on a focal series acquired from the same specimen area, but with the bi-prism turned off. In this way, both low and high spatial frequencies were reconstructed very reliably and with low noise.

In our experimental example the combination of these two methods decreased the noise level of the phase image almost 2 times with respect to the off-axis holography reconstruction, much more than would be expected if the same dose was used only for additional off-axis holograms. In addition the exposure time and illumination conditions effects on the reconstruction quality have been studied. In summary, this synergistic hybrid technique improves the weak points of both techniques, off-axis and inline holography, by combining the advantages of the two methods.