

Coherence of inelastic scattering near the edge of a sample

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Using a combination of electron holography and energy filtering coherence of inelastic scattering near the edge of a sample is measured. As is well known, inelastic scattering does not abruptly terminate at the sample edge but extends into vacuum near the edge. Surprisingly, while the intensity of the scattered electrons decays, their degree of coherence increases with the distance from the object before it vanishes in noise (figure). The observed phenomenon is independent on the specific mechanism of energy loss (as bulk, surface plasmons or ionization of atoms). These experimental results are reproduced theoretically in the density-matrix formalism. Qualitatively, the phenomenon can be understood in terms of a Feynman two-slit gedanken experiment with ambiguous which-way registration of electrons.

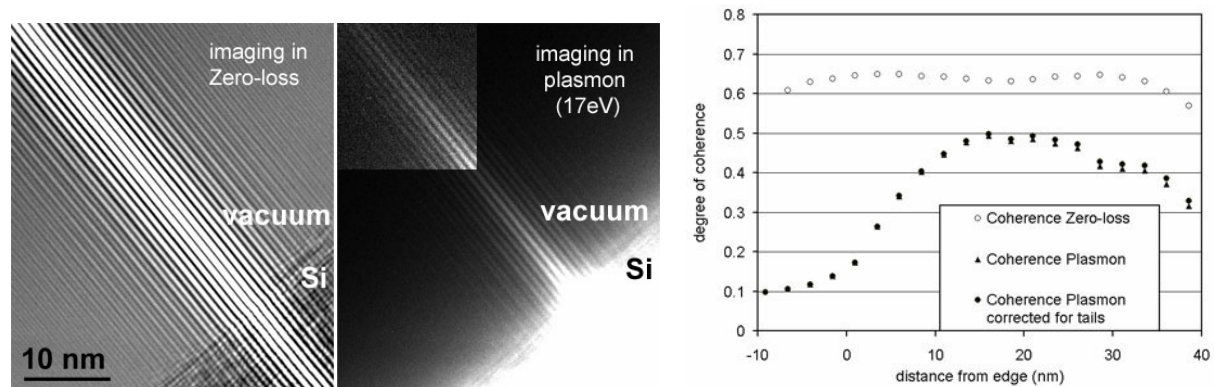


FIG. : (left) The elastic interference fringes near the edge of a Si sample. (middle) The inelastic interference fringes propagating towards vacuum. (right) Degree of coherence in inelastic scattering increases when moving from the edge towards vacuum.