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Prospects for Atomic-Resolution Chromatic Aberration Corrected Transmission Electron Microscopy in Lorentz Mode on the Titan PICO Microscope

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In the most recent generation of transmission electron microscopes, chromatic aberration correction promises to provide improved spatial resolution and interpretability when compared with the use of spherical aberration correction alone, as the improved temporal damping envelope of the objective lens, especially at lower accelerating voltages. The reduced dependence of image resolution on energy spread in a chromatic aberration corrected microscope offers benefits for conventional bright-field and dark-field imaging as a result of the decreased influence of inelastic scattering on spatial resolution, even when using zero-loss energy filtering. Less refocusing is also necessary when moving between regions of different specimen thickness, while for energy-filtered TEM chromatic aberration correction allows large energy windows and large objective aperture sizes to be used without compromising the spatial resolution of energy-loss images.

Here, we assess the benefit of combined chromatic and spherical aberration correction of the Lorentz lens of the Titan PICO TEM in Forschungszentrum Juelich for magnetic-field-free imaging with the conventional microscope objective lens switched off. We use Fourier transforms of spherical and chromatic aberration corrected lattice images taken in Lorentz (magnetic-field-free) conditions to demonstrate a spatial resolution of better than 0.5 nm. We present an experiemntal and theoretical study of the benefit of chromatic and spherical aberration correction for studies of magnetic microstructure in materials, both at domain walls and at surfaces and interfaces in materials. We also discuss the factors that presently limit spatial resolution in Lorentz mode in the Titan PICO microscope and propose approaches that can be used to resolve these limitations.