Progress, prospects and challenges for achromatic imaging of electron energy loss spectroscopy

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Energy-filtered transmission electron microscopy (EFTEM) is an effective method to acquire chemical information from samples with high spatial resolution in the transmission electron microscope (TEM) with parallel beam illumination. However, the main challenges of EFTEM are low dose efficiency, poor energy resolution (which is related to the slit width of the energy window), poor signal-to-noise ratio, and limited spatial resolution caused by chromatic/spherical aberration. Spatially resolved energy loss electron spectroscopy (SR-EELS) [1] is the method that collects the spatial information and spectrum simultaneously at an energy-dispersive plane under parallel beam illumination. However, the spatial resolution of spectrum imaging is limited by spherical (Cs) and chromatic (Cc) aberrations. Thanks to the development of the Cs/Cc corrector, the spatial resolution of inelastic scattering imaging is promoted to the atomic scale and the atomic-plane-resolved EELS (APR-EELS) can be achieved [2]. In this work, we achieved the achromatic APR-EELS imaging of $SrTiO_3$, $CaTiO_3$, and $SrTiO_3$-$CaTiO_3$ superlattice with different experimental conditions, such as crystal orientation, focus values. Combined with dynamic diffraction calculation and experiment data analysis, we explored the optimized experimental conditions to access atomic-plane-resolved chemical information in APR-EELS. We also show the application of APR-EELS on collecting electron magnetic circular dichroism with atomic plane resolution to understand the magnetic, chemical, and structural information in the examples of complex oxides Sr_2FeMoO_6 [2]. We would like to further discuss the progress, prospects, and challenges of APR-EELS.

References

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