Experiment Brief

Metro Camera

Title

Capturing high-quality electron-counted diffraction at low dose with the Metro camera

Gatan instrument used

The Metro® camera enables **low-dose** imaging and **diffraction** at low kV **via real-time electron counting** with a simple user interface.

Background

Selected area electron diffraction (SAED) patterns present a challenge for any recording medium. The variation of intensity from the bright center spot to faint high-frequency ones can be extreme, spanning multiple orders of magnitude and resulting in saturation and undetected spots. Accurately capturing SAED patterns can be quite difficult for a scintillator-based detector, as it requires high dynamic range, high sensitivity, and low noise (high signal-to-noise ratio (SNR)). The Metro camera uses direct detection electron counting and is optimized for diffraction imaging with a background free of noise and other imaging artifacts; it does not require a beam stop and, compared to scintillator-based cameras like the OneView®, can detect high-intensity and faint diffraction spots with a superior SNR and sharper diffraction peaks.

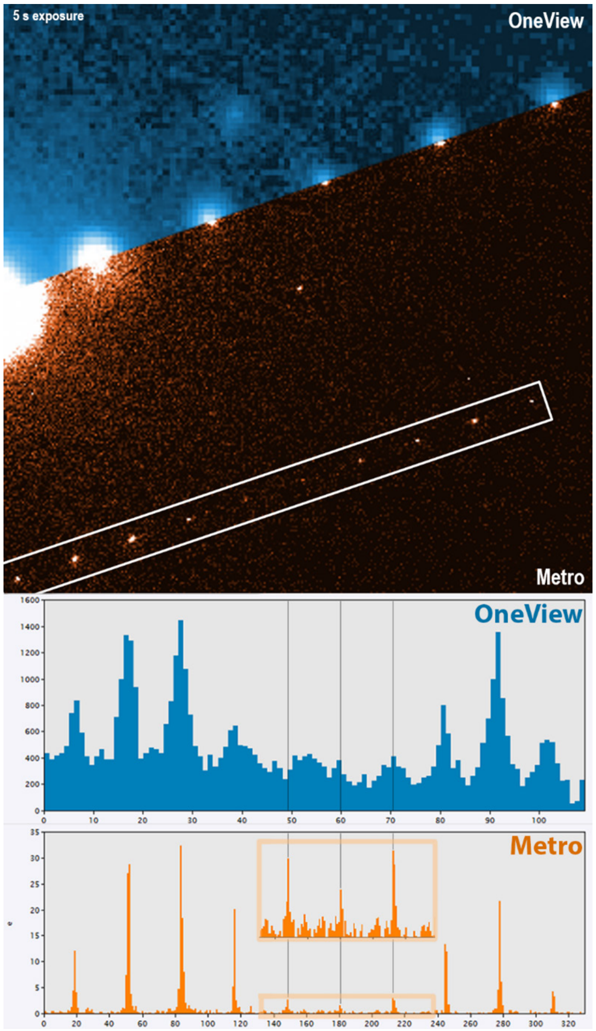

Figure 1. Direct comparison of low-dose diffraction patterns from a zeolite sample captured using the OneView (blue) and Metro (orange) cameras, showing the sharper point-spread and reduced noise of the electron counted pattern captured with the Metro. The profiles are both from the same section of the pattern, indicated by the white rectangle.

Materials and methods

The zeolite structure here is a hydroxycancrinite nanorod. A JEOL F200 with a cold field emission gun operated at 200 kV was used. The Metro and OneView cameras were installed on this TEM and used to capture back-to-back diffraction patterns with 5 s exposures without modifying the configuration of the TEM. The dose rate on the sample was 0.083 $e^-/Å^2/s$, and the total dose used to capture each pattern was thus 0.41 $e^-/Å^2/s$. Using such a low dose prevented significant beam damage on this zeolite structure.

Comparing SAED patterns from the two cameras (as shown in Figure 1), the SNR of the faint diffraction spots captured by the OneView camera is rather low (<2), while the SNR of even the faintest peak captured here by the Metro camera is >5. The diffraction peaks are also sharper in the Metro image, with the full-width at half-max (FWHM) being 1 or 2 pixels for all the peaks as opposed to the ones in the OneView image, where the FWHM is 3 – 4 pixels. This is unsurprising since the scintillator and fiber optics tend to scatter some signal to adjacent pixels. (Note that the physical pixels of the OneView are also 3x larger than the Metro camera pixels (15 vs. 5 µm), which makes it more likely that a single OneView pixel could span the entire diffraction spot if there was no scattering in the camera.) Together, the higher SNR and smaller FWHM in the Metro image allow the faintest peaks to be accurately and precisely located. For more on the Metro camera's diffraction performance, see the application note *Acquiring counted electron diffraction data without a beam stop with Gatan electron counting direct detectors*.

Summary

The Metro camera was used to capture SAED patterns at an extremely low electron dose rate and compared to those collected with OneView. While the OneView camera could not resolve low-intensity high-resolution spots at these imaging conditions (because of both blurring and background noise inherent to scintillator-based detectors), these sharp spots were easily recorded with high SNR on the Metro camera.

Credits(s)

Zeolite sample courtesy of Shery Chang, University of New South Wales