Application note

EDS mapping using a mask for high-dead-time (heavy-element) regions

If a specimen studied by EDS mapping contains regions with heavy elements, those regions generate many X-rays. This increases dead time as X-rays can pile up faster than the detector can separate them. In extreme cases, the EDS map may show almost no X-rays at all in such regions even while the rest of the sample is mapped accurately.

With Dose Painting using EDM Synchrony, the user can define an arbitrary "mask," freely and independently controlling the beam current in every pixel. This lets you reduce the current in heavy-element regions, reducing pile-up and allowing EDS acquisition from light-element and heavy-element regions in a single scan.

Figure 1 shows the result of EDS (FEMTUS™) mapping of the tungsten (W) distribution in a semiconductor specimen using a beam current of 1 nA. Some regions are unexpectedly dark, indicating that X-rays could not be detected due to count loss from pile-up. We were able to solve this problem using Dose Painting EDS mapping.

First, we acquired a HAADF image of the same field of view. The contrast in this image reflects the atomic weight of the constituent elements (Z-contrast). The grayscale of the image was then inverted and its brightness adjusted to create a "mask" in which heavy-element regions were dark (low irradiation current) and light-element regions were bright (high irradiation current) (**Fig. 2**). Using this mask, we performed Dose Painting EDS. As a result, the regions containing W could be correctly mapped (net count mapping) (**Fig. 3**).

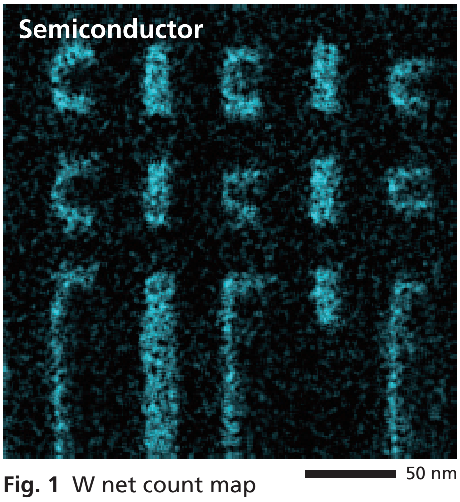


Fig. 1 W net count map

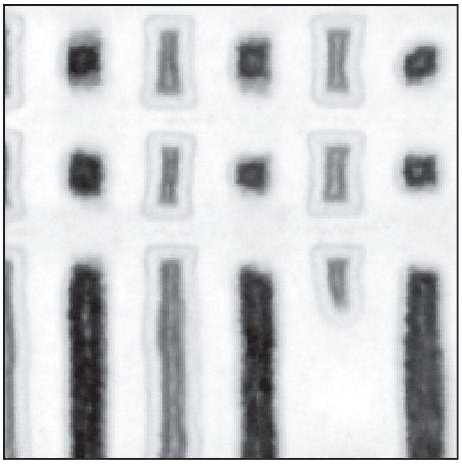


Fig. 2 Mask by contrast-inverted ADF image

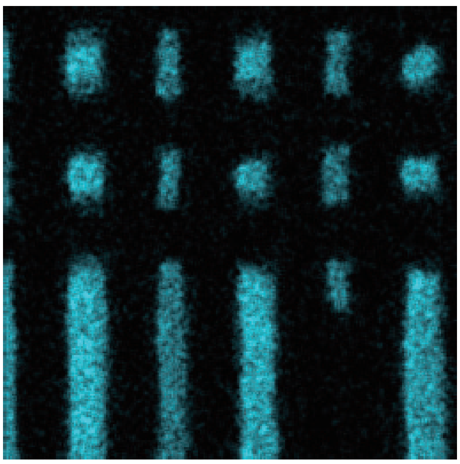
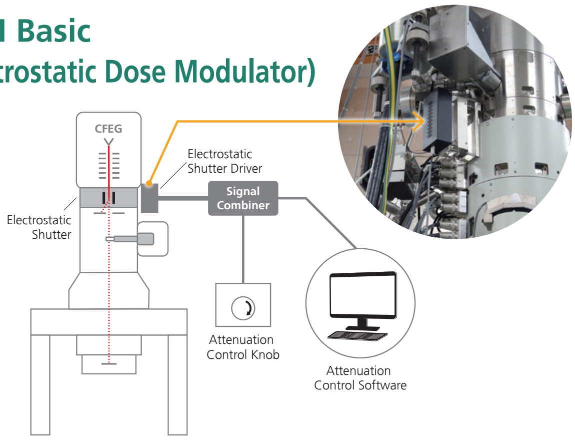


Fig. 3 W net count map by Dose Painting using the mask from Fig. 2

Note: Dose Painting is a function of EDM Synchrony. Since the EDS analysis system itself does not recognize the irradiation current at each coordinate position, it is not currently compatible with quantitative analysis using the ζ- factor method.

EDM Basic (Electrostatic Dose Modulator)



The Electrostatic Dose Modulator (EDM) is a fast beam blanking system with a pre-sample electrostatic deflector, including electronics and software control. With EDM, the 100,000x improvement in blanking speed immediately improves the clarity of data taken at fast exposure times. EDM can also attenuate electron illumination without affecting imaging conditions, giving TEM and STEM users exceptional control over the dose on their samples.

Programmable STEM with EDM Synchrony

The optional Synchrony upgrade takes EDM's timing and synchronization capabilities to the next level. Synchrony can coordinate with a STEM controller, tracking the probe beam location as it scans across the sample. EDM's lightning-fast electrostatic blanking turns the beam on for a specified time at each pixel, or keeps the beam blanked to completely exclude sensitive regions from dose.

Pulse System

PULSE turboTEM

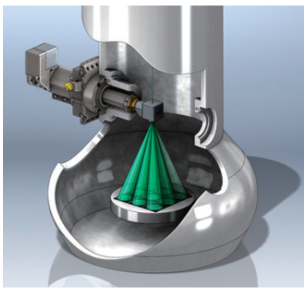
JEOL is pleased to offer Pulse for STEM. Pulse is a real time signal processor that enables digital imaging using standard analog STEM detectors. The device simply plugs in between your STEM detector and data acquisition system to deliver improved signal to noise ratios in your STEM images, particularly in low-dose or high-speed imaging modes.

TEMPO

TEMPO turboTEM

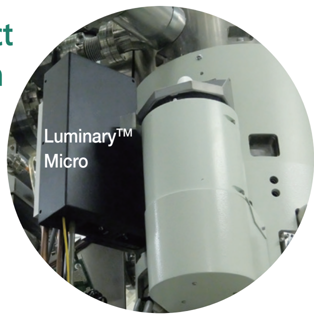
This is a completely new approach to STEM which inverts the typical approach to image formation by using the time required to reach a fixed number of electrons as the basis for pixel intensity rather than the number of electrons detected in a fixed amount of pixel dwell time. Once the desired number of electrons have been counted in a given pixel, the electron beam can then be rapidly blanked resulting in a significant reduction in overall dose applied to a specimen.

Relativity™ Electrostatic Subframing System



The IDES Relativity™ Electrostatic Subframing System multiplies the frame rate of cameras on JEOL TEMs. Microscopes equipped with Relativity™ achieve exceptional time resolution, data throughput, and advanced automation capabilities.

Luminary™ Micro Compact Specimen Photoexcitation System



Luminary™ Micro is a Compact Specimen Photoexcitation System (CPXS) for JEOL TEMs. With Luminary™ Micro, users can study laser-induced phenomena in situ using fast cameras. Combined with IDES/JEOL EDM fast shutter and/or Relativity™ subframing systems, Luminary™ Micro allows users to perform time-resolved studies using pump-probe methods on the microsecond time scale.

EM-IDES-008

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