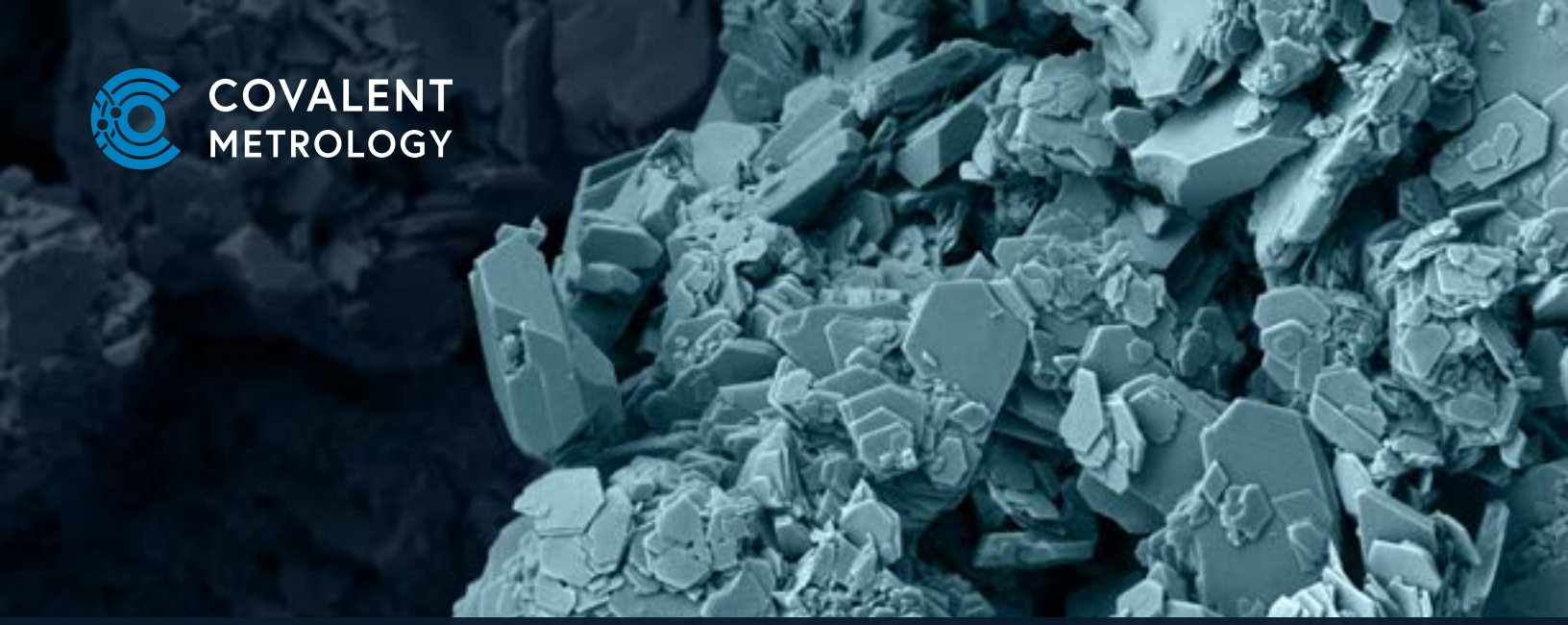

COVALENT ACADEMY Q&A

Episode 18: Expert Lessons in Electron and Ion Beam Imaging and Interpretation

Presented By:

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01

Q: How do you prevent sample charging in a standard SEM (not the Environmental SEM!) when you can't deposit a protective coating on the top surface (i,e. sputtered Au, etc)?

A: There are many "tricks" that an experienced microscopist can use to prevent charging of insulating samples when no sample modification is allowed. In one way or another, they all balance the amount of charge arriving at the sample from the electron beam and the electrons leaving the sample from back scattered, secondary, Auger, etc. The beam energy can be reduced to change the secondary electron yield. There are flood illumination electron sources that dose the surface with low energy electrons. Low pressure gases can be introduced to the chamber. Sometimes, microscopists will expose a large field of view for a time and quickly zoom in to take a high-magnification image with limited charging.

02

Q: Can one rely on the SEM microscope calibration when using EBSD?

How accurate can be the measurement of a given structure size? I was told it was a “more-or-less” relative measurement and was not exact due to the mode of image acquisition (scattered electrons).

To sum up: could I accurately measure, for example, mitochondrium length using EBSD? Or is it substantially less accurate than TEM?

A: The short answer is that you can count on the calibration because the calibration determines the deflection of the incident beam, and this does not change regardless of the detector used for imaging. The longer answer is that it depends. For all digital microscopy techniques, measuring an object means determining the calibrated distance between two features - say edges of an object. Determining the "true" location of the edge involves a bit of arbitrary decision making, e.g. half way through the edge profile, 90% through the profile, etc. Changing the detection mode can also shift the location of the apparent edge a modest amount. As long as you are consistent with the imaging conditions and method as well as the edge determination method, you should be OK.

03

Q: Can you use the STEM detector in a SEM?

A: Yes! At Covalent, we have multiple SEM's with STEM capability. We can also make lamella for STEM image in multiple instruments. We are able to image both bright and dark field with our STEM detector.

04

Q: Can you talk about mixing SEM images with EDS Data?

A: Our SEMs allow us to mix data from multiple sources to create richer composite images. Mixing SEM with EDS is powerful because it correlates SEM location information with EDS elemental identification information.

05

Q: For a wafer with the front- and back-sides coated with a dielectric material and a patterned e-beam resist: what beam settings would you recommend to prevent charging of the dielectric and enable the tool to use its auto-focus feature?

A: It is difficult to say without working with the sample. Often very low beam energies can be helpful. To recover some of the loss of resolution from low beam energy, the sample working distance and beam current can be reduced.

06 **Q: How long does it take for someone to learn how to set conditions correctly and interpret an SEM image with confidence?**

A: On a modern instrument, an operator can perform straightforward imaging with a couple hours of training. Challenging samples can be difficult for experts with years of experience. Experts with decades of experience often consult with imaging and interpretation challenges.

07 **Q: How do you form TEM sample? By FIB or Mechanical wedge?**

A: At Covalent, we typically prepare TEM lamella with focused ion beams (FIBs).

08 **Q: How would you produce a transverse cross section of a coating sample as is without cutting process?**

A: As with the SEM, the FIB can modify the beam current and beam energy. An experienced operator can predict how these parameters will impact a particular sample type to obtain best results. Sometimes some trial and error is required. Usually, there is a first-pass rough cut followed by a finer cut to obtain a nice cross section for analysis.

09 **Q: Why are some materials more sensitive to these black squares after long imaging?**

A: Sometimes one material is more sensitive to beam damage than another. Sometimes a sample has more hydrocarbon contamination on it. Sometimes the SEM chamber is cleaner than others. It depends. Steps can be taken to eliminate the beam exposure effects, but it is nearly impossible to eliminate.

About Covalent Metrology

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