COVALENT METROLOGY

Covalent Academy Episode 31 Q&A

# Advanced Analytical STEM and Future Directions


***Presented By:*** ***Patrick Phillips, PhD***

*Assistant TEM Product Manager,*
*JEOL USA*


JEOL Solutions for Innovation

01

Q: What is the typical thickness of a STEM sample for low-voltage imaging?

**Answer:** Sample thickness can be highly dependent on the constituent elements, as well as the imaging voltage in question. For example, most 30 kV STEM is performed on 2D materials, which are by nature very thin. For something like a semiconductor sample, I would estimate 10-20nm is an appropriate thickness for 30 kV STEM. For a slightly higher voltage, like 80 kV, I would estimate you could get away with a sample on the order of 50-80nm.

02

Q: What software is being used for the segmented STEM?

**Answer:** JEOL Software, within the STEM imaging operation.

03

Q: How long would it take to obtain a 3D tomography image?

**Answer**: This is highly dependent on the acquisition parameters (e.g., tilt range, number of images within that tilt range, size of the ROI, etc.).

04 Q: You showed an example for 3D STEM-EDS imaging: in the finFET structure shown, what was the technology node - 16 nm?

**Answer:** I apologize, I cannot provide these additional sample specifics.

05 Q: What software is used to do the reconstruction of STEM-EDS tomography? If it is available for use on other systems, how can users access this software?

**Answer:** The software is called TEMography (https://temography.com/en/) by System in Frontier, Inc.

06 Q: Sometimes EELS analysis fails to detect a lightweight element, such as Boron. Can you share any suggestions for improving accuracy when analyzing lightweight elements with EELS?

**Answer:** Sample preparation could be critical here, especially to ensure the sample is thin enough.

07 Q: Why is it that we can sometimes see Si signal in samples without any Si content, when these samples are loaded on a lacy Carbon-coated, Copper, or Gold TEM grid? Is there any artifact source related to the microscope compartments?

**Answer:** Not that I can think of. Please feel free to email me at pphillips@jeol.com for additional discussion if desired.

08 Q: Can you share another summary of what OBF is, in a bit more detail? Are there other materials we can review to better understand this technique?

**Answer:** Please see the following paper: https://doi.org/10.1016/j.ultramic.2020.113133

09 Q: How could a user apply OBF to current JEOL 200CF and DM 3.5 systems?

**Answer:** To enable OBF, a segmented STEM detector and the OBF software would need to be installed. These items can be retrofit to many existing JEOL instruments.

10 Q: Why is contrast inversion performed during OBF imaging?

**Answer:** Please see the following paper: https://doi.org/10.1016/j.ultramic.2020.113133

11

Q: What will be the best temporal resolution for electric- and magnetic-field mapping, and charge-density mapping using 4D-STEM or iDPC, using Cs-corrected STEM such as JEM ARM 300CF2 equipped with an ETA corrector?

**Answer:** I am not sure I completely understand the question; please email me directly for additional discussion if desired, pphillips@jeol.com

12

Q: Is it possible to make these measurements faster? How can you optimize for speed when doing tomography or OBF experiments?

**Answer:** It is possible to speed up the imaging by using a faster scan or limiting your ROI. It will be a trade-off between time and quality of data output. Having said that, JEOL (as well as many camera companies) continue to improve detector technology/speed.

13

Q: For 3D EDS, it's understood that you need good software and that it helps to have a large-area EDS detector (more than 70 mm or more). What is the detector and software configuration on the JEOL microscope?

**Answer:** The F200 used for these experiments has two 100mm2 EDS detectors and TEMography software for reconstruction (https://temography.com/en/)

14

Q: How reliable is EDS data is for quantitative analytical applications, where we want to understand the chemical composition of the sample?

**Answer:** EDS in the TEM is notoriously tricky for quantitative work. There are many variables which must be accounted for, which are quite difficult to accurately characterize. For example, sample characteristics/shape, detector metrics, etc. Having said that, JEOL strives to use the best possible quantification routines for EDS.

15

Q: How would you recommend handling sample drift during atomic-resolution EDS mapping?

**Answer:** JEOL has recently introduced "Lossless Drift Correction", which is essentially a live-image drift correction routine. It works well for atomic-resolution EDS mapping.

16

Q: Can you provide an example of ELNES structures for a higher energy range (such as Cu, Co, Ni)?

**Answer:** Many examples of this type currently exist in published literature.

 

17

Q: How important is spherical aberration correction (Cs) in an uncorrected STEM? (It was surprising to see probe current and probe size discussed without mentioning aberration)?

**Answer:** I am not sure I fully understand the question; please feel free to email me at pphillips@jeol.com if desired.

18

Q: Can this method be used to view defects such as dislocations or stacking faults?

**Answer:** I am afraid I do not have the context for this question; please feel free to email me at pphillips@jeol.com if desired.

 