JEOL 7900FLV

Field Emission Gun SEM

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- Welcome, Naima Hilli!
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7900F Special Features

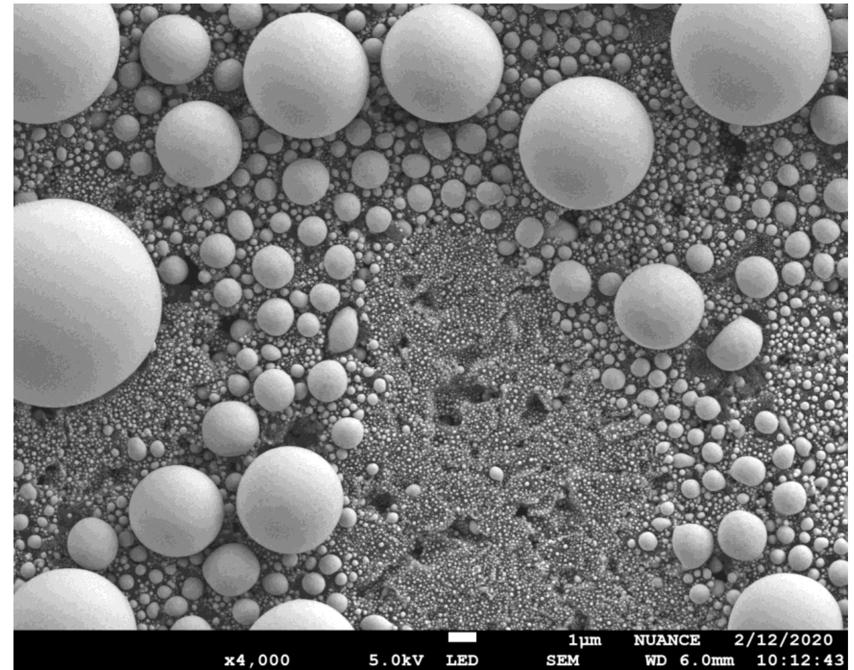
- JEOL Super Hybrid Lens (SHL)
  - Reducing the chromatic and spherical aberrations improves the resolution, especially at low accelerating voltages. The SHL does not exert magnetic field influences on the specimen, so observations of magnetic materials
- High resolution SEM
- Variety of detectors
- High resolution, super low kV imaging
- Low kV STEM imaging
- Variable Pressure Mode
- Beam deceleration (up to 5 kV)
- Oxford 65 mm^2 EDS AND Oxford WDS

Detectors

- **LED** – Lower Electron Detector
- **UED** – Upper Electron Detector
- **BED-C** – Retractable Backscattered Electron Detector
- **LVBED-C** – Low Vac Backscatter Electron Detector

LED – Lower Electron Detector

- Images will show directionality with LED making it ideal for:
  - Topography
  - Surface Detail
  - Shape
- Collection efficiency increases at longer working distances
  - Decreases at shorter
- Will show fewer charging artifacts than UED

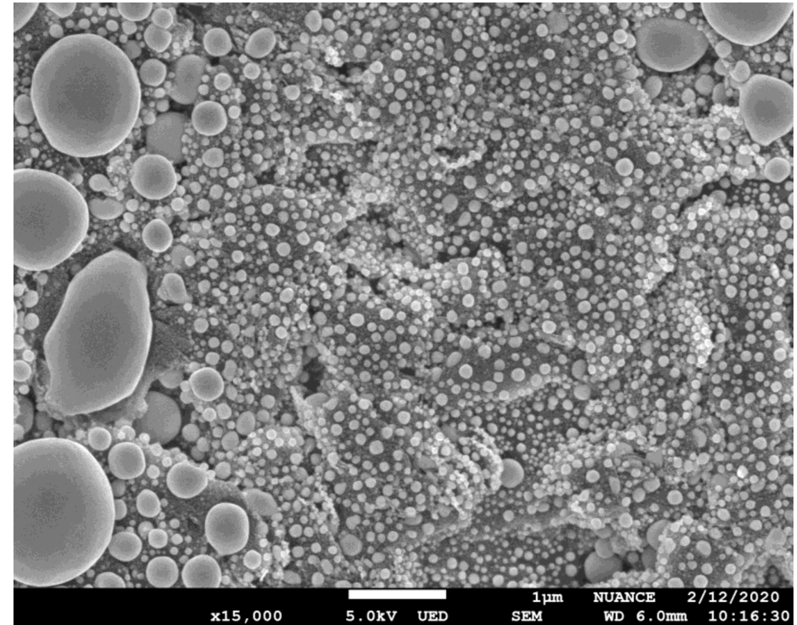


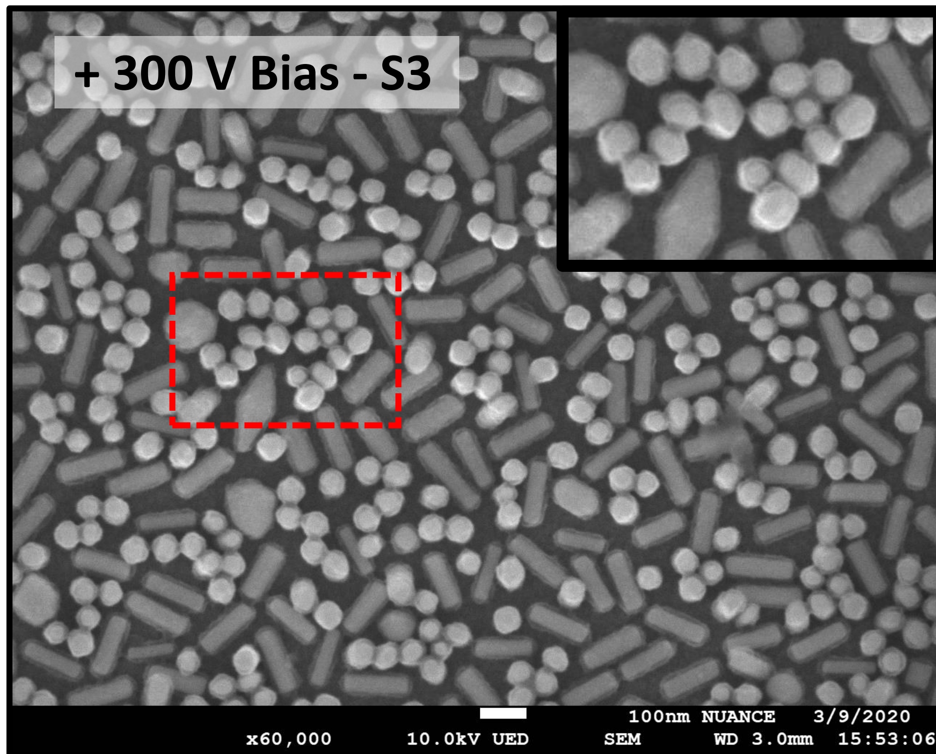
UED – Upper Electron Detector

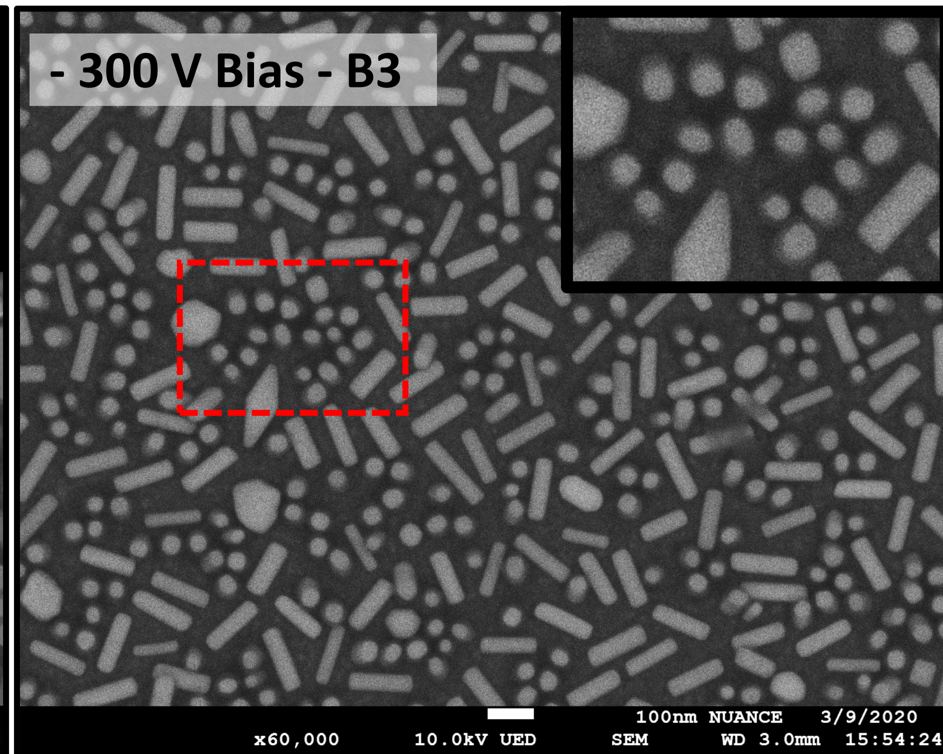
- High-resolution Through The Lens detector – located above the pole piece inside the column

  1. Secondary electron imaging
  2. Backscatter electron imaging
  3. A mixture via energy filter
     - You can select the energy range of emitted electrons that reach the detector

- Used for Gentle Beam mode







Sample provided by the one and only, Dr. Ben Myers

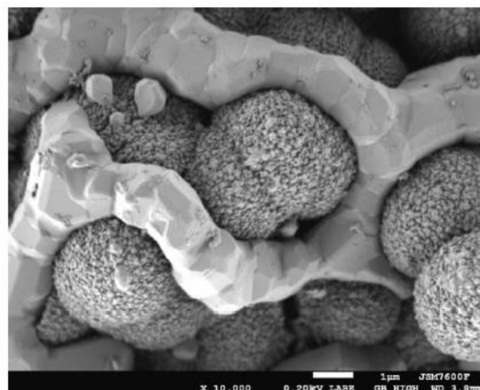
Left: Gold nanoparticles embedded in SiO2 using S3 (more secondary electrons) to get surface information. **Right**: using B3 (more BSE information) to see compositional contrast. Low Z SiO2 surface no longer visible

- Applied positive or negative voltage to filter to detect secondary electrons or backscattered electrons
- Why use this over dedicated BSE detector?
  - Allows for surface sensitive information while incorporating some compositional information

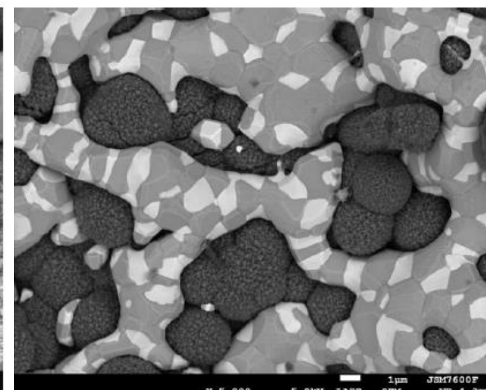
This is also available on the Hitachi SU-8030 and S-4800 CFEG!!!

BED (Retractable)

- Located below pole piece (when inserted)
- BED can display variety of information:
  - Atomic-number contrast
  - Topographic contrast
- High signal sensitivity for low kV and low current imaging



Low-kV BED



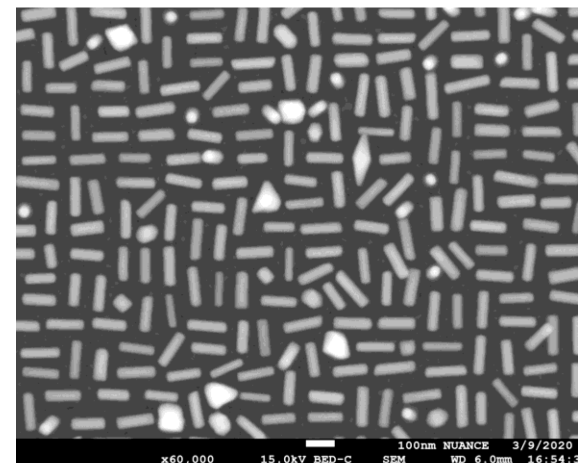
High-kV BED

BSE images of the same material at 0.2 kV and 5.0 kV

BSE contrast depends on the kV selected

Higher kV yields more Z contrast, lower kV yields more topography

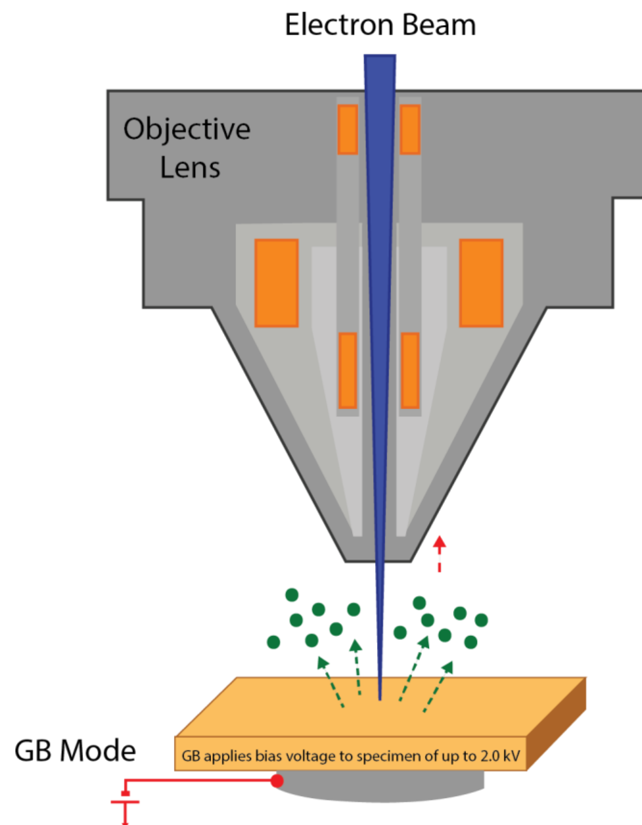
Uncoated ceramic/eutectic



Gentle Beam Mode

- Beam deceleration function that allows high resolution, surface sensitive imaging
  - Works best on flat(er) surfaces
- Reduces lens aberrations and accelerates SE from the specimen to lens

- Example: Landing voltage is 2 kV, gun voltage is 4 kV, specimen voltage is -2 kV
- Ultra-low accelerating voltages (10 V) can be achieved in this mode



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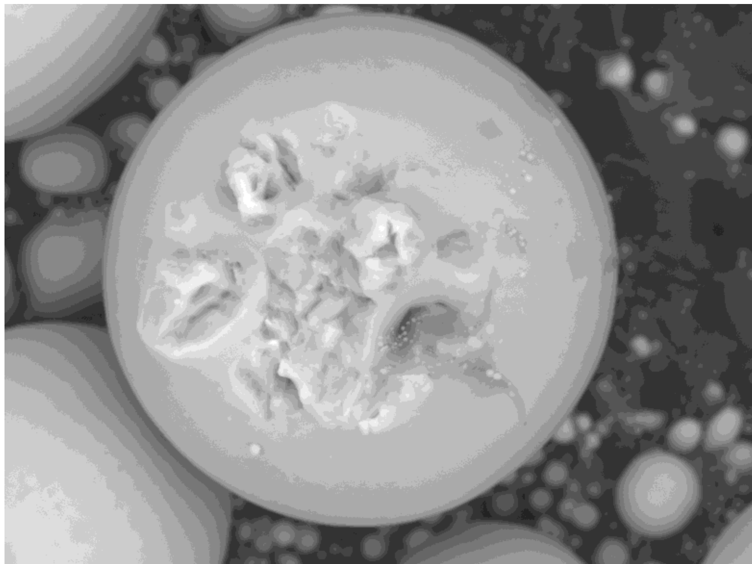
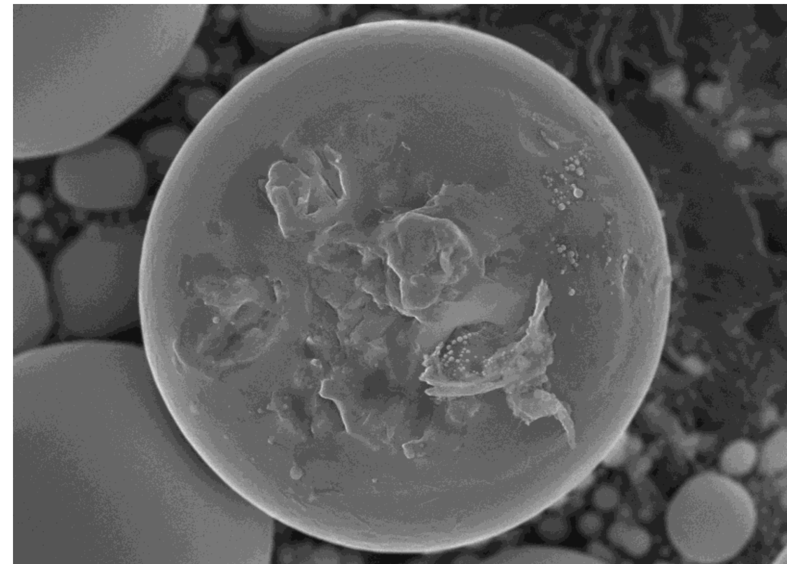
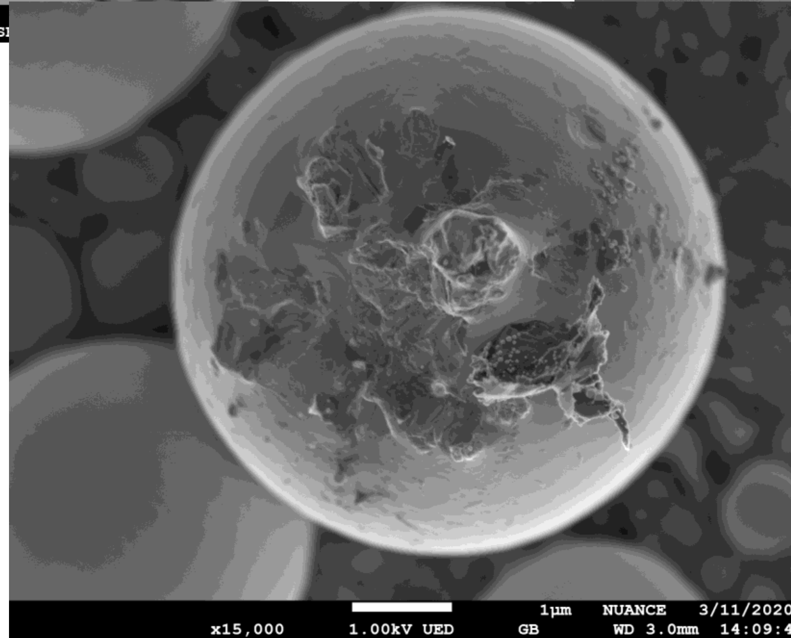


10 kV, BED-C ↑
Signal from deeper in sample, less surface sensitivity



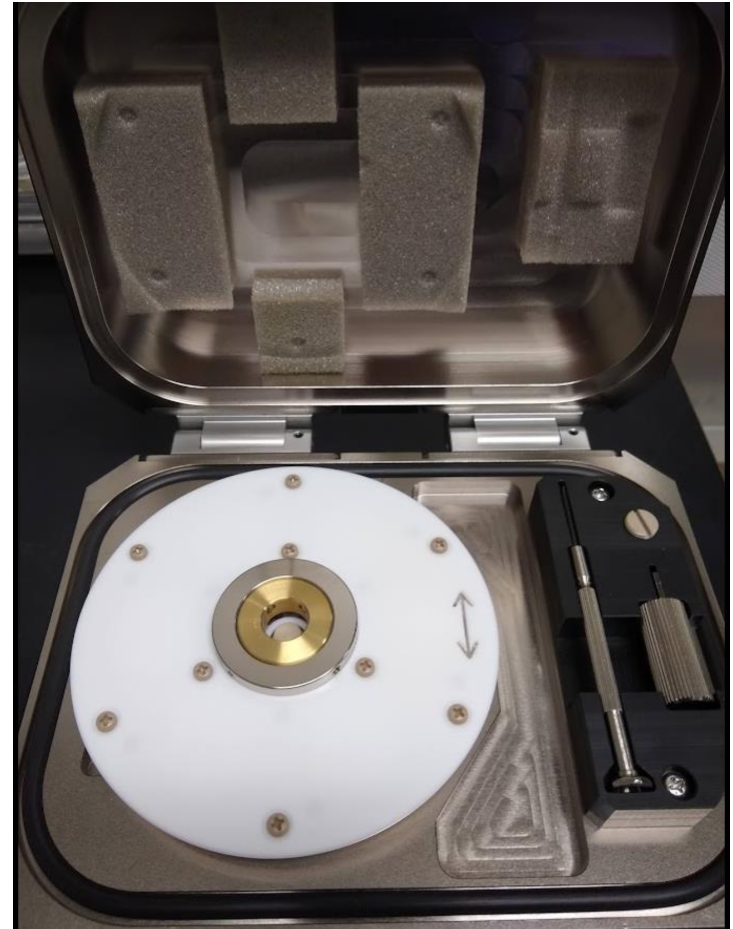
10 kV, UED ↑
Better surface sensitivity, still some deeper SE2 noise



← 1 kV with 2 kV deceleration
Very surface sensitive signal, primarily SE1

Gentle Beam Super High - GBSH

- A bias of 2.1 – 5.0 kV can be applied to your sample at ANY kV
- Ultra-low kV (10 V) with even better resolution!
- Requires a special holder



STEM-in-SEM Holder

- Holder for obtaining low kV bright-field STEM
- Uses LED
  - e- transmitted through sample, strike a polished mirror (Au) surface below sample and are converted to SE
  - Au has a very high SE yield

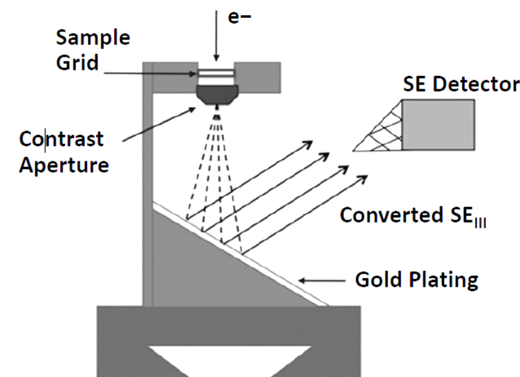
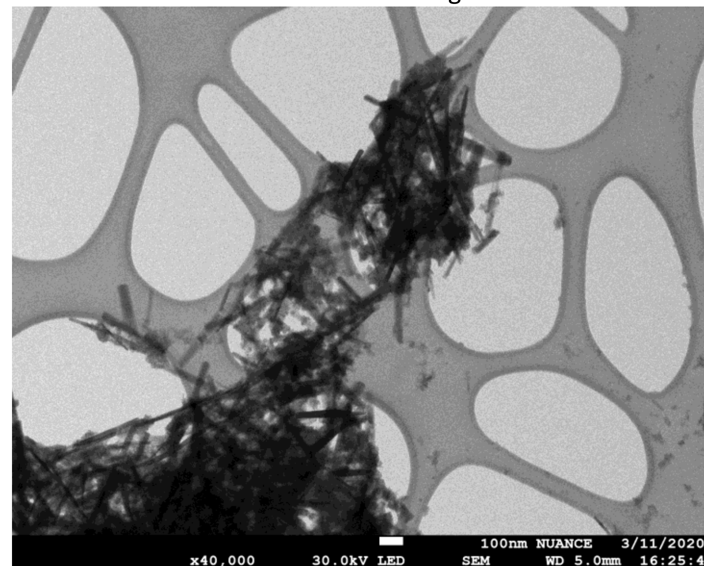


Figure from JEOL



Low Vacuum SEM (JEOL)

- Pressure limiting aperture (LV orifice) inserted at the bottom of the lens

- LV mode used for
  - Insulating specimens
  - Wet(ish)/oily(ish) specimen observation

Please talk to staff before observing wet samples

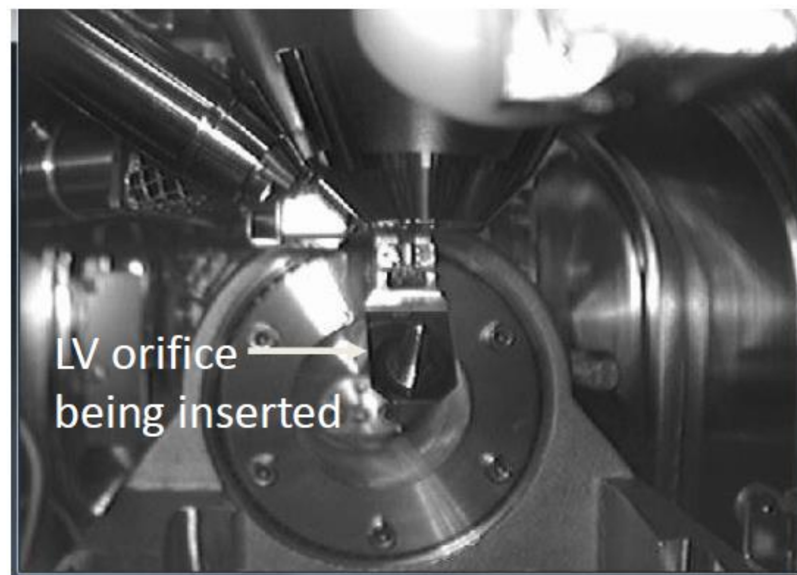
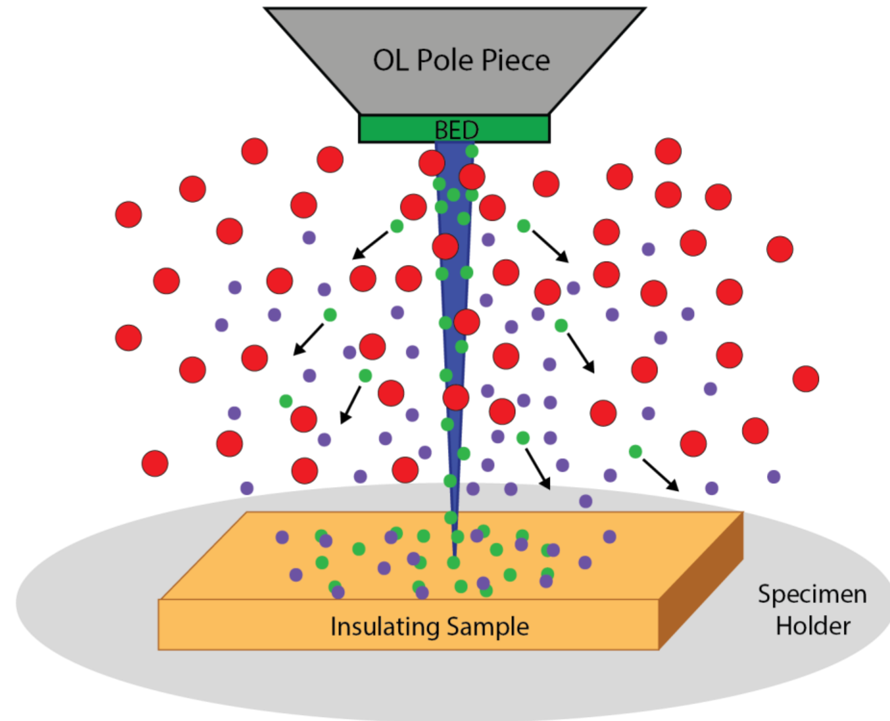
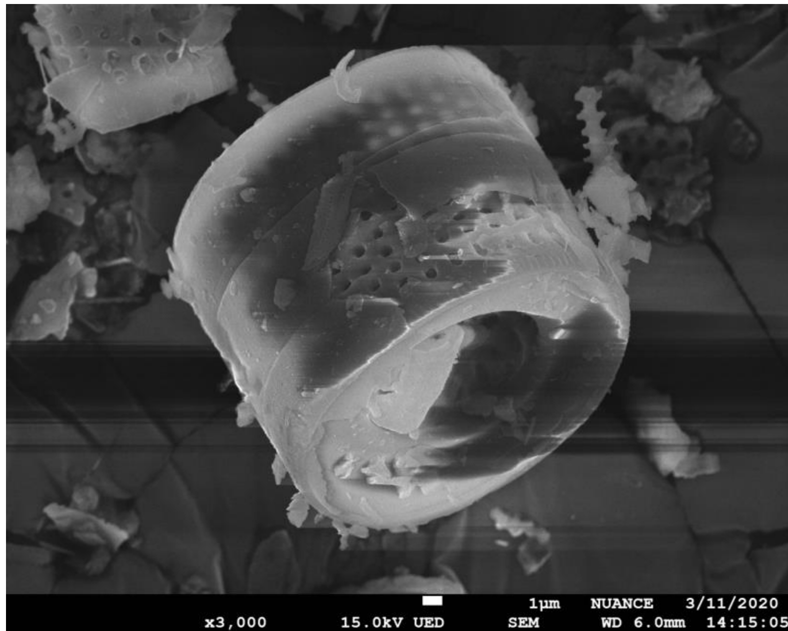


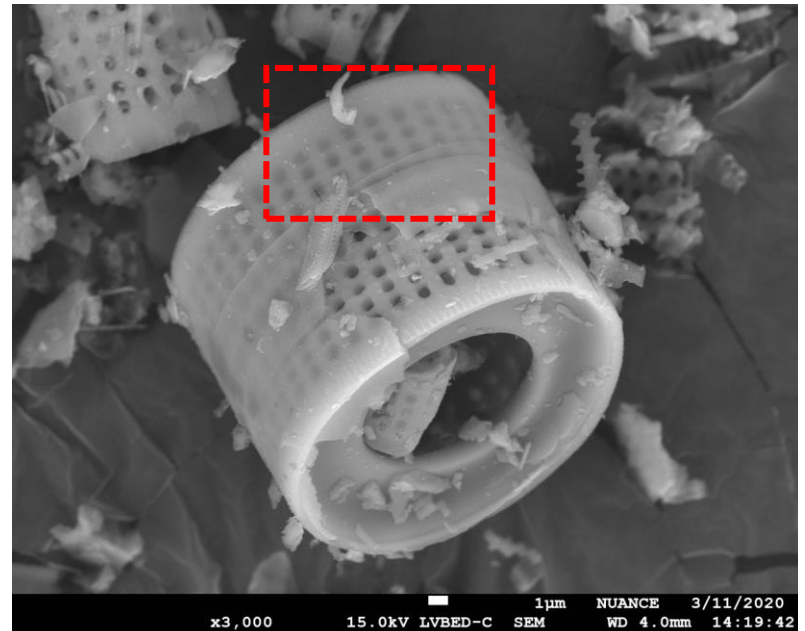
Figure from JEOL

1. Beam electrons cause a negative charge to build up on the specimen
2. Some gas molecules are introduced into the specimen chamber
3. High-energy beam electrons collide with gas molecules
4. Gas molecules are ionized; positive ions are produced
5. Positive ions neutralize negative charge on the speicmen surface



This SEM introduces N gas into the chamber. The electron beam will interact with and ionize the gas, producing positively charged ions. Those positively charged ions fall to the surface of the sample and reduce negative charge build up.



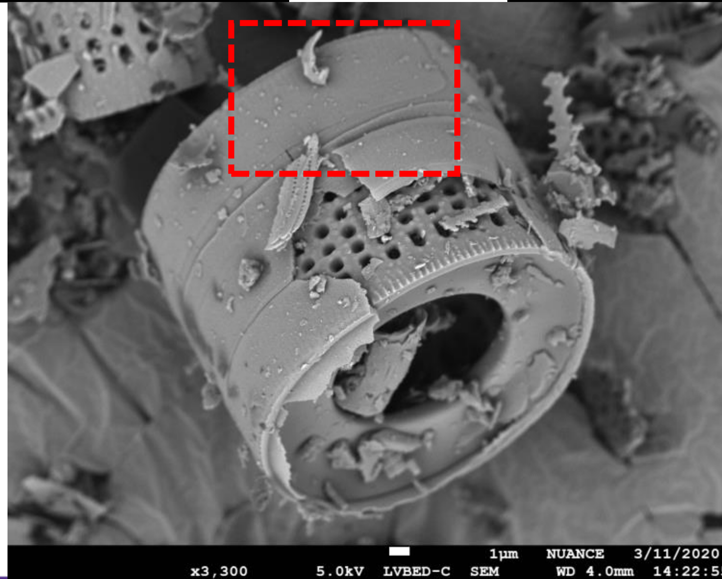


15 kV UED

Sample is SiO2 and is charging at the surface = artifacts in slow scan image

15 kV LVBED-C

Nitrogen gas in the chamber at 30 Pa. Surface charge reduced. Signal from deeper in sample due to interaction volume at high kV.



5 kV LVBED-C

More surface sensitive information at lower kV due to smaller interaction volume

What's next?

- JEOL Specialist on site
  - **~~User Q&A at 1:30 pm in Tech JG21 3/13~~**
  - **~~User Demo with Tirzah – Tomorrow at 1:30 pm~~**
  - **Contact Tirzah about Demo and/or Training!**

- Future additions to SEM lab
  - Soft X-ray Emission Spectrometer (SXES) – low kV 0.3 eV resolution elemental analysis (light elements!)
  - Cathodoluminescence for SEM

If you would like to see anything added to the SEM facility, please talk to facility staff!

THANK YOU!