

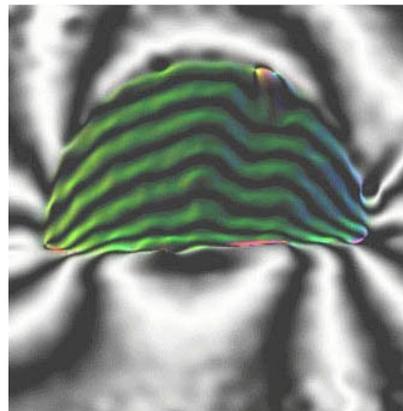
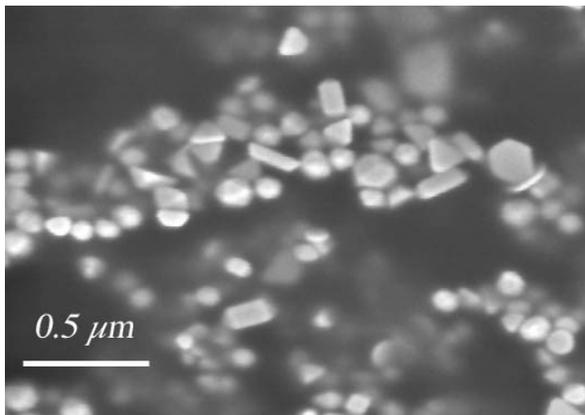


**Analytical Electron Microscopy Facility**

# **The Electron Microscopy Center for Materials Research**

**Materials Science Division  
Argonne National Laboratory**

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## ***AEM Instrumentation Profiles and Access***

The Electron Microscopy Center staff strives to facilitate users' research at Argonne National Laboratory while ensuring that instruments are used in a manner that optimizes and preserves their capabilities for everyone. The EMC Proposal Review Committee decides which instruments are initially appropriate for each particular research proposal. Each electron microscope in the facility has a unique set of distinguishing attributes that characterizes its best operating modes. Thus, for an individual to be granted permission to become a user of a another instrument, it will be necessary to demonstrate to the EMC Staff that the assigned instrument is incapable of producing the needed data. The analytical electron microscopes that are currently in the EMC are documented in Tables 1 and 2.

**Table 1**  
**Nominal Performance Specifications and Characteristics of AEMs**

<b>Instrument</b>	<b>Operating Modes</b>	<b>Specimen Holders</b>	<b>Resolution</b>
Tecnai F20ST (S)TEM 80 – 200 kV Schottky FEG FEI	CTEM, STEM (BF/ADF, HAADF), CBED, SAED, CCD camera (16 Mpixel), EDS (elements with $Z \geq 4$ ), PEELS, spectrum imaging, energy-filtered imaging (EFI), Lorentz magnetic imaging (LMI), electron holographic imaging (EHI).	Compustage. DT holders for EDS: ambient temperature and cooled (93K). Cooling holders: N <sub>2</sub> -cooled (DT) & He-cooled ( $\geq 20$ K, TR). Magnetic field coils holder (ST) Heating holder (1270K, DT) <i>DT = Double Tilt</i> ( $\pm 40^\circ \alpha$ , $\pm 30^\circ \beta$ ) <i>ST = Single Tilt</i> ( $\pm 40^\circ \alpha$ ) <i>TR = Tilt/rotate</i> ( $\pm 40^\circ \alpha$ , $360^\circ$ )	~0.24 nm point ~0.1 nm line Cs obj. $\approx 1.2$ mm Cc obj. $\approx 1.2$ mm probe $\approx 0.2$ – $1$ nm
CM30T TEM $\leq 50$ – 300 kV LaB <sub>6</sub> Philips (FEI)	CTEM, CBED, SAED, fast CCD camera (1 Mpixel, 15 fps), hollow-cone DF, EDS (elements with $Z \geq 4$ ), PEELS, electron dosimetry.	Double Tilt ( $\pm 60^\circ \alpha$ , $\pm 30^\circ \beta$ ): Be cup for EDS; N <sub>2</sub> -cooled (93 K) with Be cup; heating (1270 K). Tilt/rotate ( $\pm 60^\circ$ , $360^\circ$ ) and single tilt holders.	~0.25 nm pt-pt ~0.14 nm lattice probe size $\geq 9$ nm
S-4700-II SEM 0.5 – 30 kV Cold FEG Hitachi	SEI, BEI, EDS (mapping & spectrum imaging; elements with $Z \geq 4$ ).	5-axis motorized stage. Maximum sample size: 27 mm (H) x 150 mm (diameter).	SEI resolutions: 1.5 nm at 15 kV 2.5 nm at 1.0 kV
1540XB FIB 0.2 – 30 kV Schottky FEG Zeiss	Dual-beam FIB with 5 gas injectors & 2 <i>in situ</i> manipulators, SEI, BEI, STEM, EDS (mapping & spectrum imaging; elements with $Z \geq 4$ )	6-axis motorized eucentric stage. Maximum sample size: 100 mm diameter.	SEI resolutions: 1.1 nm at 20 kV 2.5 nm at 1.0 kV
Quanta 400F ESEM 0.2 – 30 kV Schottky FEG FEI	SEI, BEI, STEM, EDS (mapping; elements with $Z \geq 11$ ), specimen chamber pressures $2 \times 10^{-5}$ –2660 Pa (air & water vapor standard)	5-axis motorized stage. Maximum sample size: 100 x 100 mm. Heating stages ( $\leq 1770$ K). Peltier-cooled stage (248–328 K).	SEI resolutions at 30 kV: $\leq 3$ nm at 1330 Pa $\leq 10$ nm at 2660 Pa

**Table 2**  
**Typical Investigations Using AEMs in the EM Center**

<b>Instrument</b>	<b>Typical Investigations</b>
FEI Tecnai F20ST (S)TEM	Magnetic materials imaging by LMI. Structure and chemistry of nanomaterials. Computationally-mediated experiments. EFI and/or spectrum imaging of heterostructures. Tomography, friction measurements, and nano-biasing with user-owned specimen holders.
FEI/Philips CM30T TEM	Nanomaterials investigations. Quantitative EDS & EELS. Morphological and diffraction contrast studies of defects. <i>In situ</i> heating & cooling studies. Electron crystallography. Weak beam studies of defects. Specimen-checking for other AEM instruments.
Hitachi S-4700-II SEM	High-resolution SEI of nanostructures. EDS mapping.
Zeiss 1540XB FIB	TEM sample preparation by FIB with gas injection. Patterning and manipulation for nanomaterials studies.
FEI Quanta 400F ESEM	Investigation of non-conducting materials. Biomaterials/polymers at high water vapor pressures. Oxidation studies. EDS mapping.

## ***Specimen Preparation***

Specimen preparation is an important part of electron microscopy. The EMC maintains an array of specimen preparation capabilities that are available to users. While users are expected to carry out their own specimen preparation, expertise and guidance may be provided by EMC or other MSD staff. The staff in the EMC have developed a number of new methods and approaches to sample preparation. The specimen preparation equipment that is available to users includes light microscopes, diamond-wheel saws, a wire saw, grinding and polishing wheels, electropolishers, a precision lapping machine, dimplers, ion mills, and an ultramicrotome.