Argonne NATIONAL LABORATORY

Analytical Electron Microscopy Facility

The Electron Microscopy Center for Materials Research

Materials Science Division
Argonne National Laboratory

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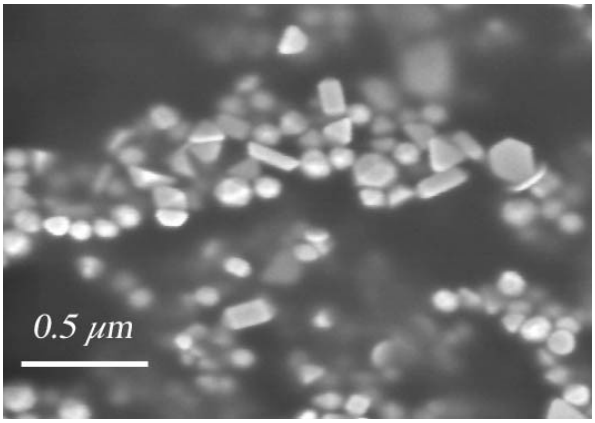

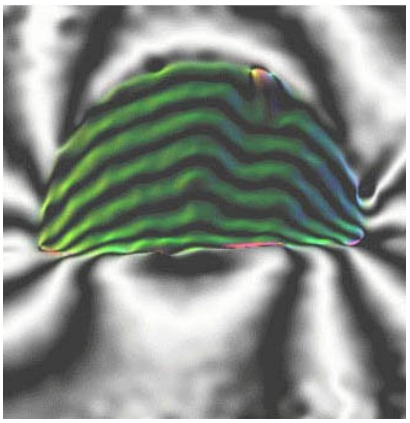

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AEM Instrumentation Profiles and Access

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

Instrument	Operating Modes	Specimen Holders	Resolution
Tecnai F20ST (S)TEM 80 – 200 kV Schottky FEG FEI	CTEM, STEM (BF/ADF, HAADF), CBED, SAED, CCD camera (16 Mpixel), light element EDS, PEELS, spectrum imaging, energy-filtered imaging (EFI), Lorentz magnetic imaging (LMI), electron holographic imaging (EHI).	Compustage. DT holders for EDXS: ambient temperature and cooled (93K). Cooling holders: N_2-cooled (DT) & He-cooled (< 20K, TR). Magnetic field coils holder (ST) Heating holder (1270K, DT) *DT = Double Tilt* (±40˚ α, ±30˚ β) *ST = Single Tilt* (±40˚ α) *TR = Tilt/rotate* (±40˚ α, 360˚)	~0.24 nm point ~0.1 nm line Cs obj. ≈ 1.2 mm Cc obj. ≈ 1.2 mm probe ≈ 0.2–1 nm
CM30T TEM ≤50 – 300 kV LaB_6 Philips (FEI)	CTEM, CBED, SAED, fast CCD camera (1 Mpixel, 15 fps), hollow-cone DF, light element EDS, PEELS, electron dosimetry.	Double Tilt (±60˚ α, ±30˚ β): Be cup for EDXS; N_2-cooled (93 K) with Be cup; heating (1270 K). Tilt/rotate (±60˚, 360˚) and single tilt holders.	~0.25 nm pt-pt ~0.14 nm lattice probe size ≥ 9 nm
S-4700-II SEM 0.5 – 30 kV Cold FEG Hitachi	SEI, BEI, light element EDS (mapping & spectrum imaging).	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 *in situ* manipulators, SEI, BEI, STEM, light element EDS (mapping & spectrum imaging.)	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 & Be window), specimen chamber pressures $2x10^{-5}$–2660 Pa (air & water vapor standard)	5-axis motorized stage. Maximum sample size: 100 x 100 mm. Heating stages (≤ 1770 K). Peltier-cooled stage (248–328 K).	SEI resolutions at 30 kV: ≤ 3 nm at 1330 Pa ≤ 10 nm at 2660 Pa

Table 2
Typical Investigations Using AEMs in the EM Center

Instrument	Typical Investigations
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.
FEI/Philips CM30T TEM	Nanomaterials investigations. Quantitative EDS & EELS. Morphological and diffraction contrast studies of defects. *In situ* 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.

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, electopolishers, a precision lapping machine, dimplers, ion mills, and an ultramicrotome.