Facilities – Key features:

• User facilities mode of operation: training + self-use + staff support.
• Highly qualified staff responsible for the various techniques.
• 24/7 access for trained users.
• Typical usage: ~800 users; ~88,000 hours of instrument time per year.
• Funding by UIUC, MRL/DOE clusters, fees.
• Complete suite of materials characterization instrumentation.
• Deposition, crystal growth, nanofabrication and device processing facilities.
• User basis: UIUC, other universities and research centers, industry.

www.mrl.illinois.edu, http://mrl.illinois.edu/facilities.html
• Sources Mg, Al
• Al monochromatic x-ray
• Ar⁺ gun depth profile
• UV source: He I, He II

**Phi 5400 XPS**
- Elemental mapping
- High spatial resolution
- Large AMU range (10,000)
- 1μm lateral resolution
- Dual ion source (Cs and O) for depth profiling
- CMA detector
- Detection limits ~ at%

**Phi 660AES**
- Elemental or molecular analysis
- Large AMU range
- Detection limits ~ ppm - ppb
- Detection limits ~ ppm - ppb

**Cameca 5f-ims SIMS**
- Magnetic sector SIMS
- Primary ion beam: Cs⁺ or O₂⁺
- Depth resolution 3-15 nm
- 1μm lateral resolution
- E-gun for charge neutralization (insulators)
- AMU range: up to 280

**Kratos Axis ULTRA XPS**
- XPS w/ 5μm imaging resolution capabilities
- 5-10 nm depth resolution
- Sources Mg, Al
- Al monochromatic x-ray
- 1-5 keV Ar⁺ surface cleaning
- In-situ deposition capabilities
- No depth profiling

**Malvern Zetasizer Nano-ZS particle analyzer**
- Zeta potential
- Molecular weight
- Size distribution 0.6nm-6μm
- He-Ne 633 nm laser

**Additional facility:**
1st Floor, MRL 125
- Standard bio prep: tissues, virus, bacteria.
- Embedding and sectioning of particles.
- Research combining bio and materials science.

**Bio Sample Preparation Lab**
- Standard bio prep: tissues, virus, bacteria.
- Embedding and sectioning of particles.
- Research combining bio and materials science.
Hitachi S-4800 HR SEM
• 1 nm res @ 15kV
• Field Emission

FEI Helios Nanolab 600i
Dual Beam FIB
• Schottky field emission SEM:
  0.35-30kV
• Low kV FIB: 0.5-30kV, < 65 nA
• Resolution: 0.9-1.4 nm (e-), 2.5 – 4.5 nm (ion)

JEOL 2200FS (S)TEM
• 200 kV field emission gun
• Probe Cs-corrector
• In-column energy (omega) filter aberration corrector
• Chemical and elemental analysis
• Z contrast high-angle annular dark field
• High-res EELS + mapping
• 0.1 nm res
• Only used in STEM mode.

Philips CM12 TEM
• Conventional TEM: 0.22 nm resolution
• Double tilt holder, +/- 60°; EDS mapping
• Optimized for BF/DF imaging / diffraction
• Heat (1000°C) + LN2 stages
• STEM mode, 10 nm probe

Hysitron TI 950 TriboIndenter
• Nanomechanical tests / Nano-indentation
• Nano-scratch test / Nano-wear test
• 400°C heat option
• Hardness, Elastic constants

Sloan Dektak Profilometer
• Surface height / edge / crater depth measurements down to a few nm

Varian Cary 5G-UV-Vis-NIR spectrometer
• 200-3300 nm laser / T ~ -20-100°C

MRL Basement
Sw corner
Secondary targets: Gd, Sn, Ag, Ge, Fe, Ti.

Filter: d (6 mil), n (4 mil), Ag (2 mil).

Detector collimators: Ag, Ta.

Siemens/Bruker D5000 XRD
- Horizontal stage powder XRD
- Phase, composition and structure determination
- Polycrystalline bulk, nanoparticles
- Cu K-α radiation
- Theta/2theta Bragg Brentano
- 0.1° 2theta resolution

Rigaku D/Max-b XRD
- Vertical stage XRD
- Phase, composition and structure determination
- Polycrystalline bulk, nanoparticles
- Cu K-α radiation
- Theta/2theta Bragg Brentano
- 0.1° 2theta resolution

X’pert # 1 MRD XRD
- 4-circle Eulerian stage XRD
- Line focus
- Parallel beam high resolution configuration
- High-speed line detector
- Ultra-fast Bragg Brentano available
- Rocking curve analysis
- Reciprocal lattice mapping
- Reflectometry
- Single crystal orientation
- Epitaxial thin film
- Cu K-α1 radiation
- 0.003° 2theta resolution

X’pert # 2 MRD XRD
- 4-circle Eulerian stage XRD
- Point or line focus
- Parallel beam configuration
- Phase, composition
- Thin film analysis
- Polycrystalline bulk materials
- Glancing angle XRD
- Texture, stress
- Dome-shaped hot stage (900°C)
- Cu K-α radiation
- 0.1-0.4° 2theta resolution

Kevex Analyst 770 XRF
- Elemental analysis
- Solid, liquids, powders
- 165 eV energy resolution
- Rh tube, Si(Li) detector
- Secondary targets Gd, Sn, Ag, Ge, Fe, Ti
- Filter Gd, Sn, Ag
- Detector collimators Ag, Ta

Computer room
- ICDD PDF database
- ICSD database
- Search/Match
- Structure determination
- Rietveld, etc.

Diagram not to scale
**Microfab**

**E-beam 1**
- 6 pockets
- Ag, Ti, SiO$_2$, TiO$_2$, Si, HfO$_2$, Al$_2$O$_3$...

**E-beam 2**
- 6 pockets
- Au, Cr, Pd, Ti, Ni, Fe, Ta, Nb...

**E-beam 3**
- 4 pockets
- Au, Ti, Cr, ITO, Ni, Ge, Cr...

**AJA 4 Gun Co-sputtering**
- Targets: Au, Nb, ITO, Ti, ...
- Gas Ar, N$_2$, O$_2$

**Ion Miller / Evaporator**
- Ar$^+$ ion mill
- Thermal evaporation
- Pb, In, Cu

**March Polymer RIE**
- for photoresist / polymer only (O$_2$/CF$_4$)

**PECVD**
- Deposition of amorphous Si, SiO$_2$, Si$_3$N$_4$
  - (SiH$_4$, N$_2$, N$_2$O, NH$_3$, purge with CF$_4$)

**Plasma-Therm RIE**
- Si, SiO$_2$, Si$_3$N$_4$ dry etching
  - (O$_2$/CF$_4$/SF$_6$/CHF$_3$)

**PECVD**
- (SiH$_4$, N$_2$, N$_2$O, NH$_3$, CF$_4$+O$_2$)

**E-beam 2**
- 6 pockets
- Au, Cr, Pd, Ti, Ni, Fe, Ta, Nb...

**Wire bonding**

**PECVD**
- Deposition of amorphous Si, SiO$_2$, Si$_3$N$_4$
  - (SiH$_4$, N$_2$, N$_2$O, NH$_3$, purge with CF$_4$)

**Raith e-line**
- Electron beam lithography
- Sub 10 nm lines.

**Diagram not to scale**
**Cryo Low T (LN$_2$)**

**Probe station**

ALD (Pt, HfO$_2$)

**Furnace room**

CM Furnace
Ar, max 1400°C

Lindberg Tube (2)
Furnace
Ar, N$_2$, O$_2$, max 1200°C

Omega Muffle Furnace

Vacuum Oven

Rapid Thermal Annealing
max 1000°C

**Fume hood**

**Pb furnace**

**Clean room**

1400 sqft

Mask aligners

Spinners

Wet etching, surface patterning

Optical lithography

Device fabrication

**E-beam 4**

(6 pockets)

(Au, Cr, Ti, SiO$_2$, Mo, Al, ...)

**Cryo Low T (LN$_2$)**

**Probe station**

(I/V curves, C-V measurements)

**Glove Boxes**

**ALD (TiO$_2$, Al$_2$O$_3$, HfO$_2$)**

**Diagram not to scale**