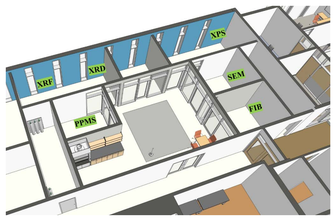
Yale West Campus Materials Characterization Core

Introduction

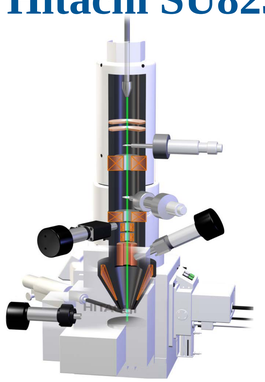


The MCC is a university-wide shared user facility in partnership with the existing materials characterization resources at Yale and with the existing Analytical Services Group at West Campus.

The Core supports the characterizations of surface electronic structures, surface structures and morphologies, crystal structures, transport properties and extended capabilities to surface modification such as nano patterning for device fabrication.

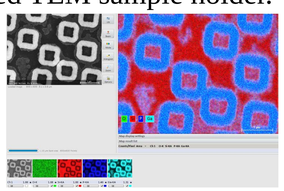
We provides the user training support to research groups in west campus including Energy Sciences Institute and all other institutes, the main campus School of Engineering and Applied Science, School of Arts and Sciences, and School of Medicine.

Hitachi SU8230 CFE SEM

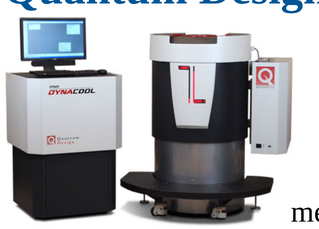


Features:

- High image resolution: 0.8 nm.
- External photodiode backscattered electron (PD-BSE) detector
- Deceleration mode: low accelerating voltages provide enhanced surface details and allow direct imaging on insulating materials
- STEM: dedicated TEM sample holder.
- EDS (side entry detector): extremely fast mapping at high spatial resolution in tens and hundreds of nanometers. Sensitive to light elements detection.

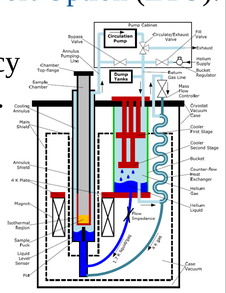


Quantum Design PPMS® DynaCool™



Features:

- Temperature range: 0.3 K – 400 K
- Magnetic field: ±14 Tesla.
- Electrical Transport Option (ETO): AC Resistance measurements (frequency range: 0.1 – 200 Hz), Hall Effect, I-V sweeps. Measurement sensitivity: a few nV; resistance range: a few μΩ to GΩ.



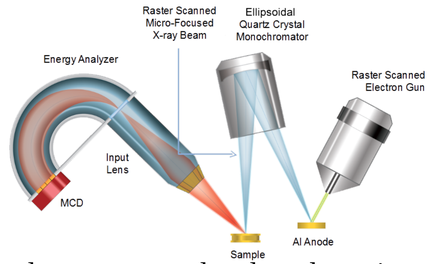
- Horizontal Sample Rotator: rotate the sample 0-180 degrees with respect to the direction of the field (angular step size: 0.053 degrees).
- Multi-function Probe: allows customized experiments involving optics, microwaves or extra electrical leads.

PHI *VersaProbe* II XPS Microprobe

Monochromatic, micro-focused, scanning x-ray source provides excellent large area and superior micro-area spectroscopy performance.

Features:

- Multi-point mode**: s**pectrum collected on multiple positions/samples in a queue.
- Single-point mode micro area analysis: spectrum collected at any specified single point on x-ray induced secondary electron image (SXI) of sample surface at a high spatial resolution (<10 μm), crucial for heterogeneous surfaces.
- Elemental and chemical state imaging: elemental and chemical state spectra extracted at each pixel of SXI image and processed using PHI MultiPak software
- Thin film profile analysis (destructive): using Ar^+ (inorganic films) or C60 cluster gun (organic films) with minimized chemical state damage.
- Angle resolved thin film analysis (non-destructive): angle dependent spectral analysis provides thickness and composition of ultra-thin films without materials damage.

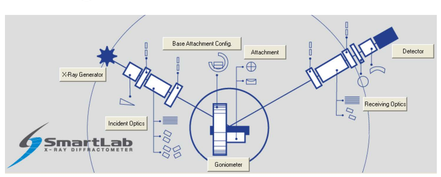


- UPS analysis: detailed valence band structure, molecular adsorption and work function measurement using low energy UV source (He I: 21.2 eV and He II: 40.8 eV).

Rigaku SmartLab X-ray Diffractometer

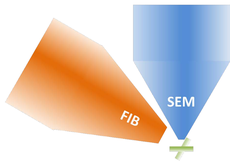
Features:

- Full automated alignment under computer control
- High spatial resolution 2D detector: large active area ~ 3000 mm² with a small pixel size of 100 μm².
- Cross Beam Optics (CBO): easy switching between focusing (BB) and parallel beam (PB) geometries.
- In-plane diffraction: greatly enhanced signals from ultra-thin films with incident and diffracted beam parallel to sample surface.
- High temperature mode: temperature (<1500 ºC) dependent measurements in air, vacuum and helium.

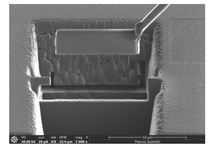


FEI FIB-SEM Helios G4 UX

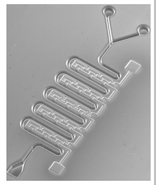
Features:



- High quality ultra-thin TEM sample preparation: automated sample preparation using AutoTEM allows multiple lamella preparation for final polishing.



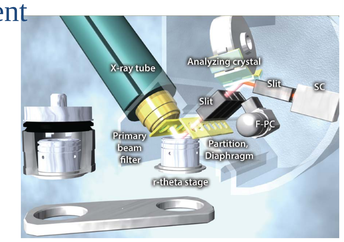
- Low-energy (>500 eV) final polishing: minimizes sample damage for high quality TEM lamellas.
- Slice and view: automated sequential mill and view to collect series of slices images. Allow sample 3D reconstruction for further analysis such as 3D segmentation.
- EDS: allows simultaneous EDS mapping for 3D reconstruction
- EBSD: provides grain orientation maps, grain boundary maps, phase maps and pole figures.
- FIB patterning: creates small structures with feature size down to tens of nanometers via 3D ion milling and deposition.
- E-beam lithography: e-beam writing on resist coated surface for device fabrication with feature size smaller than 10 nm.



Rigaku ZSX Primus II XRF Spectrometer

Features:

- Wavelength Dispersive X-ray Fluorescence (WDXRF): high spectral resolution (typically 5 – 20 eV) and minimal spectral overlaps.
- Measurement range: from Be to U.



- Tube above optics: minimizes contamination issues.
- Micro analysis: analyze samples as small as 500 μm.
- Mapping: obtain elemental topography/distribution.

Core Contact:

https://ywcmatsci.yale.edu

Min Li, Ph.D.
min.li@yale.edu
203-737-8270

Lei Wang, Ph.D.
lei.z.wang@yale.edu
203-737-6579