NEBRASKA NANOSCALE FACILITY
CHARACTERIZATION FACILITIES

Jeff Shield
Department of Mechanical & Materials Engineering
Nebraska Center for Materials and Nanoscience

National Nanotechnology Coordinated Infrastructure
University of Nebraska

March 22-23, 2016

NNF WORKSHOP

NNF WORKSHOP

NNF Core Facilities

- Nanoengineering Research
- Scanning Probe & Materials Characterization
- X-ray Structural Characterization
- Electron Microscopy

CSI: Lincoln

Utilize materials characterization capabilities to uncover the secrets of a material's behavior

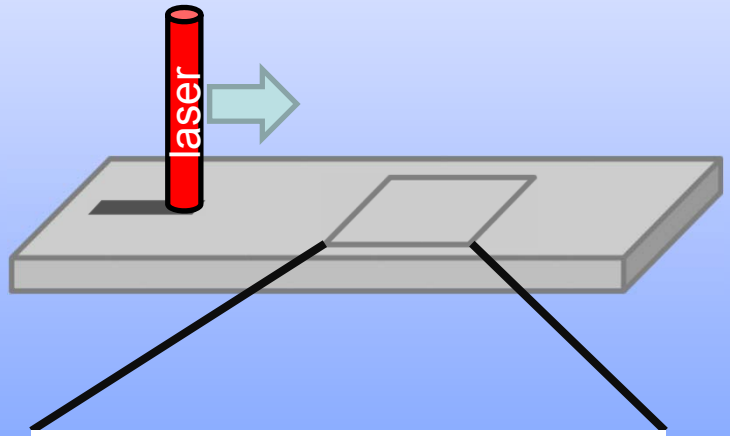
- Probe microstructure ➡ properties/behavior

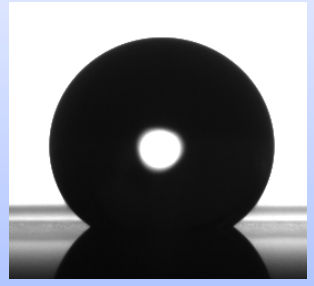
Within the Nebraska Nanoscale Facility, we have many tools to probe microstructures at our disposal

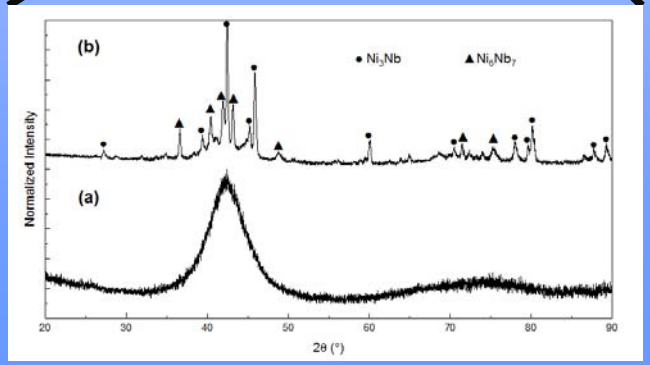
Functionalized Surfaces

Scanning a femtosecond laser over a smooth surface creates various features that can alter behavior

- Hydrophobic/hydrophyllic





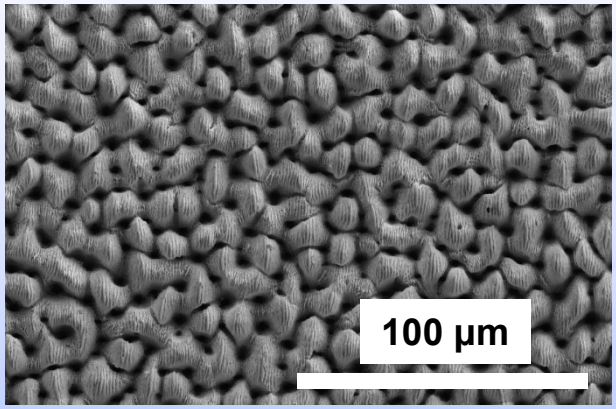


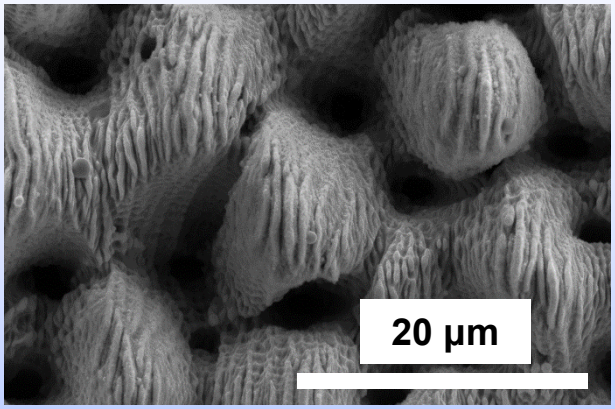
X-ray diffraction can be used to characterize the base material

- *The NNF has a number of x-ray diffractometers capable of a wide range of measurement techniques*

Functionalized Surfaces

Surface structure characterization



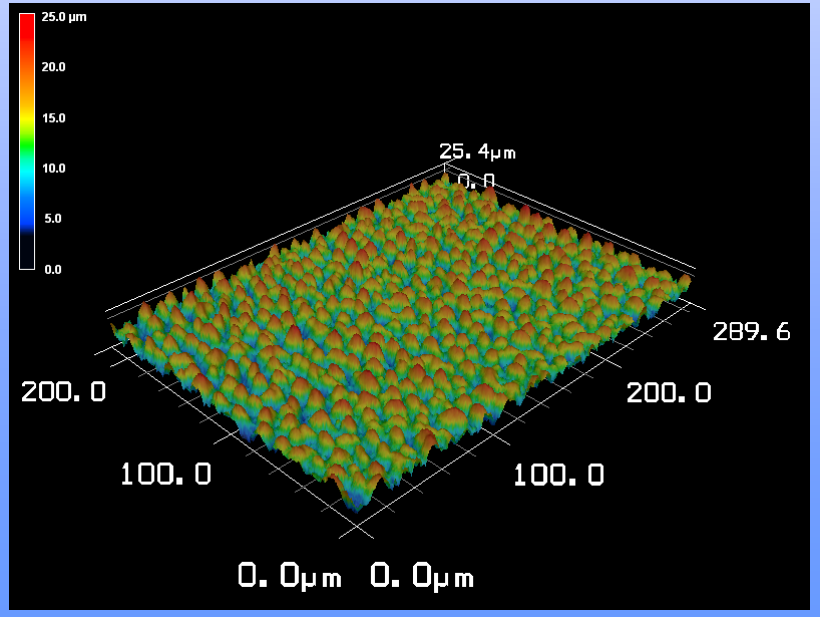


Scanning electron microscopy (SEM) reveals surface morphology

- *The NNF has a number of SEM instruments, most with chemical analysis capabilities*

Laser scanning confocal microscope (Keyence VK-X) provides quantification of surface

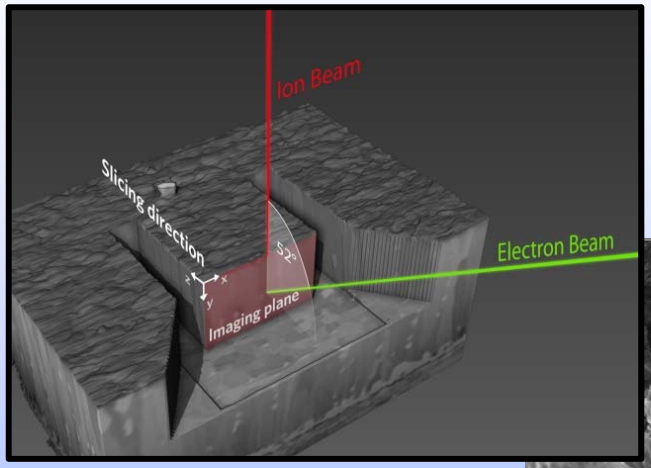
- *Surface morphology parameters such as relative surface area, peak-to-valley height, peak-to-peak distance*



Functionalized Surfaces

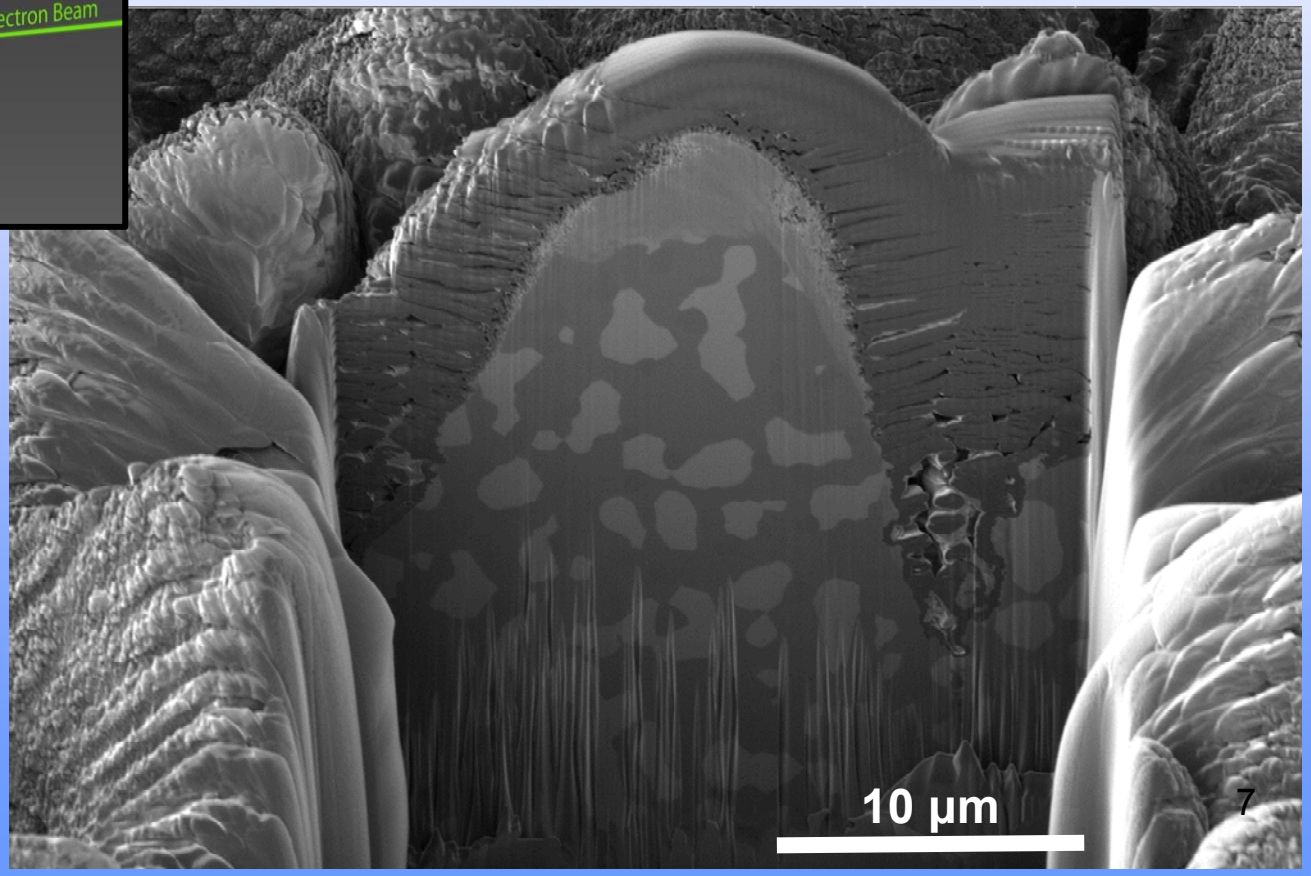
NNF

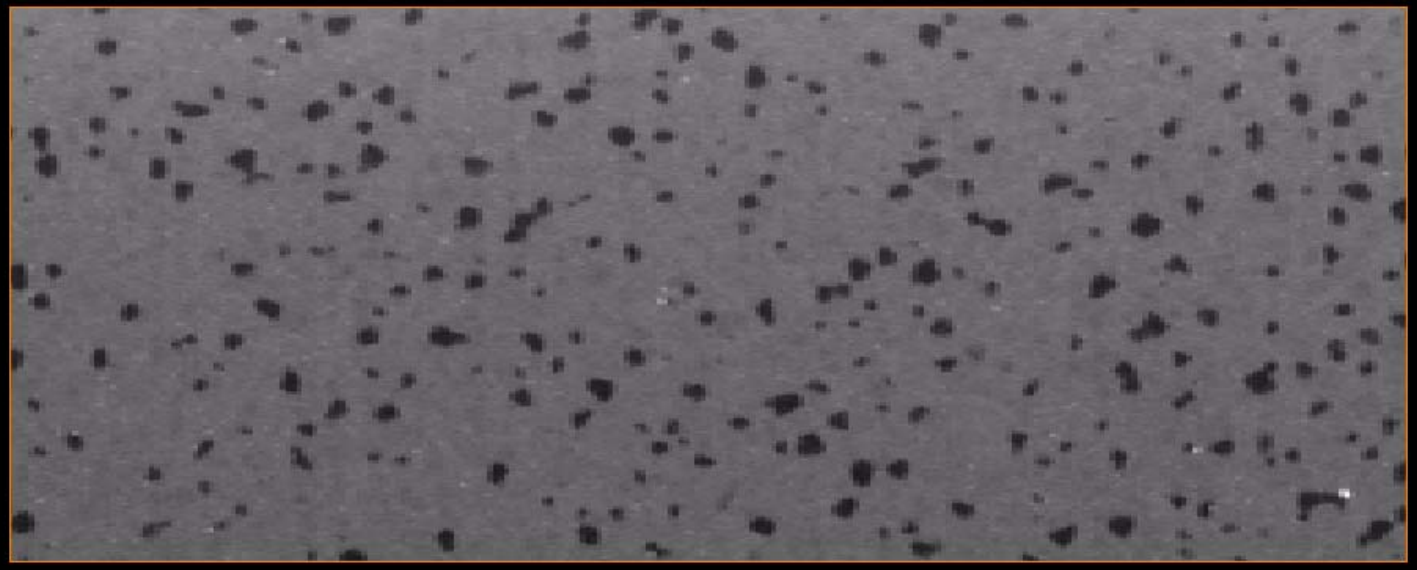
Sub-surface characterization



Dual-beam FIB/SEM (FEI Helios 660)

- *The focused ion beam (FIB) removes material, allowing cross-sectional imaging and a view of the effects of processing on the material*



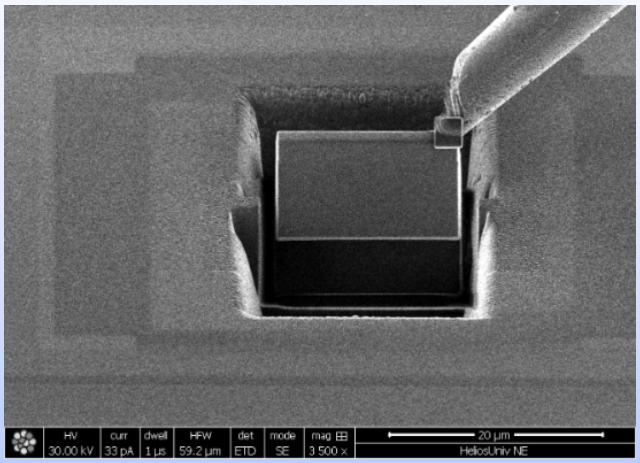


Avizo

FEI™

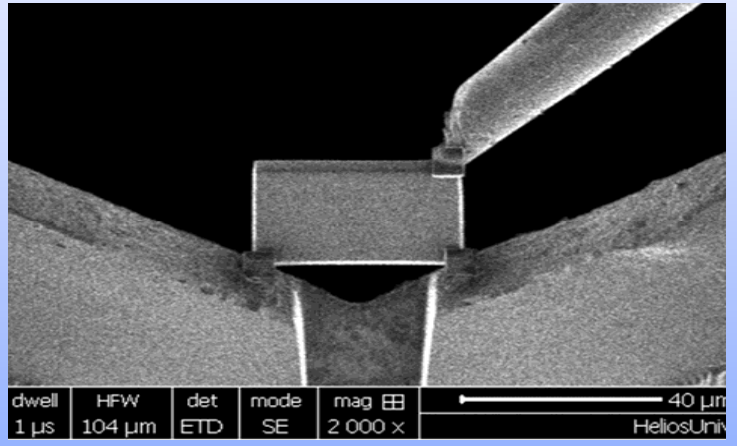
Scanning/Transmission Electron Microscopy

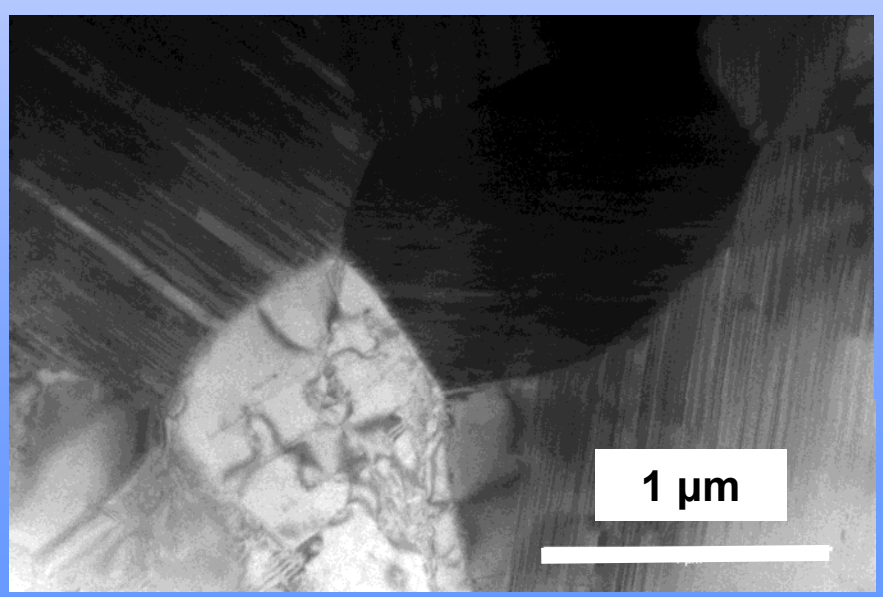
NNF



Dual-beam FIB/SEM (FEI Helios 660)

- *The focused ion beam (FIB) can be used to selectively make transmission electron microscope samples, too*



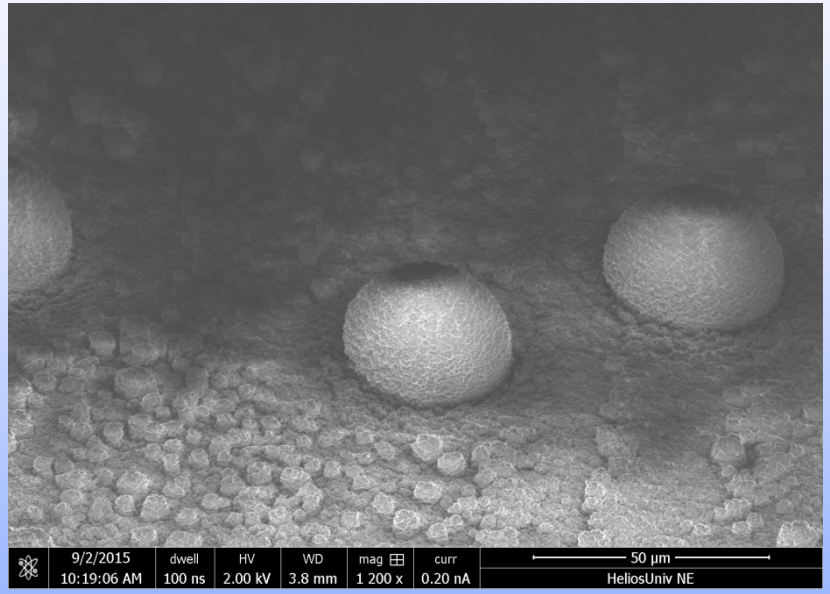


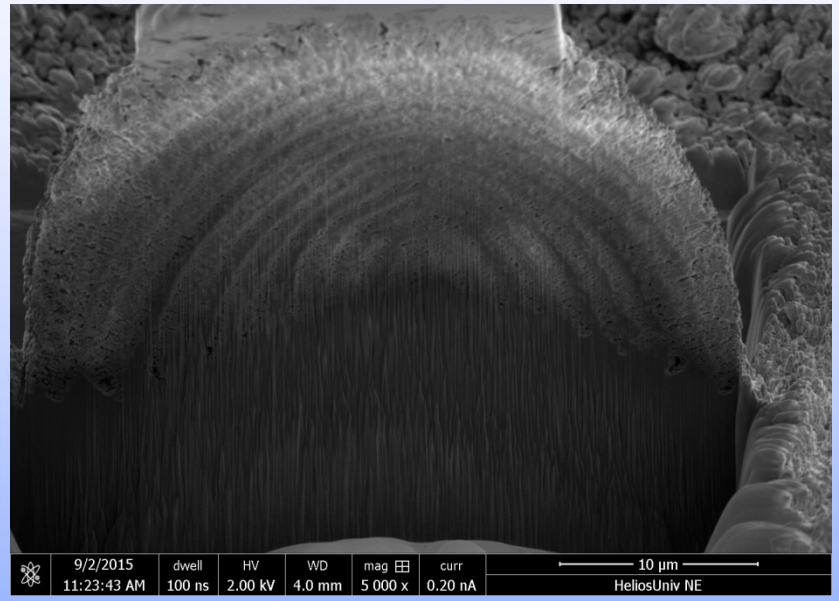
S/TEM (FEI Osiris, JEOL 2010)

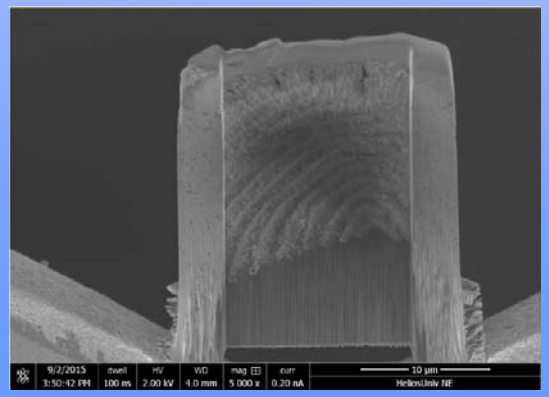
- *Probe microstructure at a high magnification (grain structure, structural defects, chemistry)*

NNF

What's inside these?

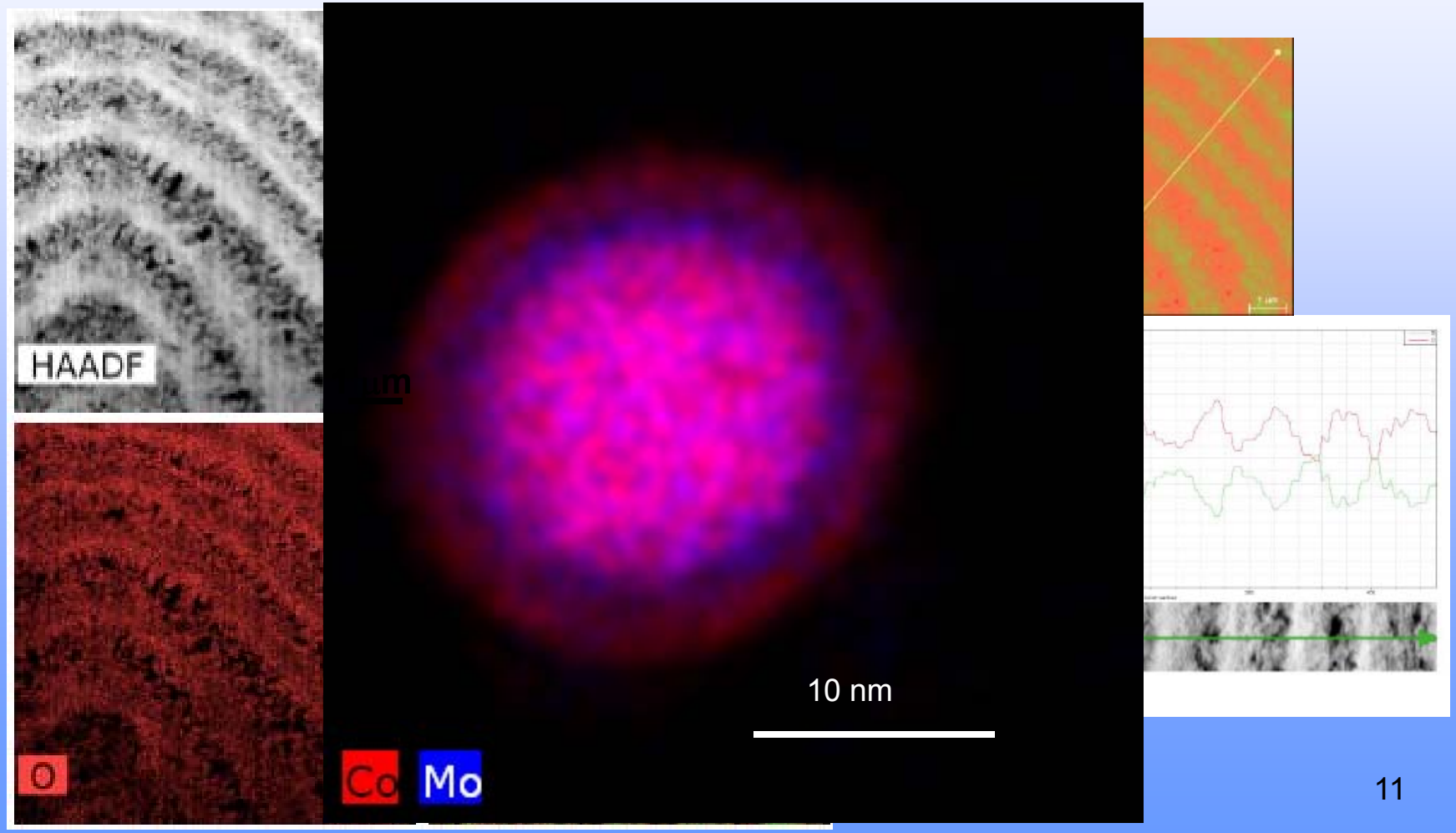




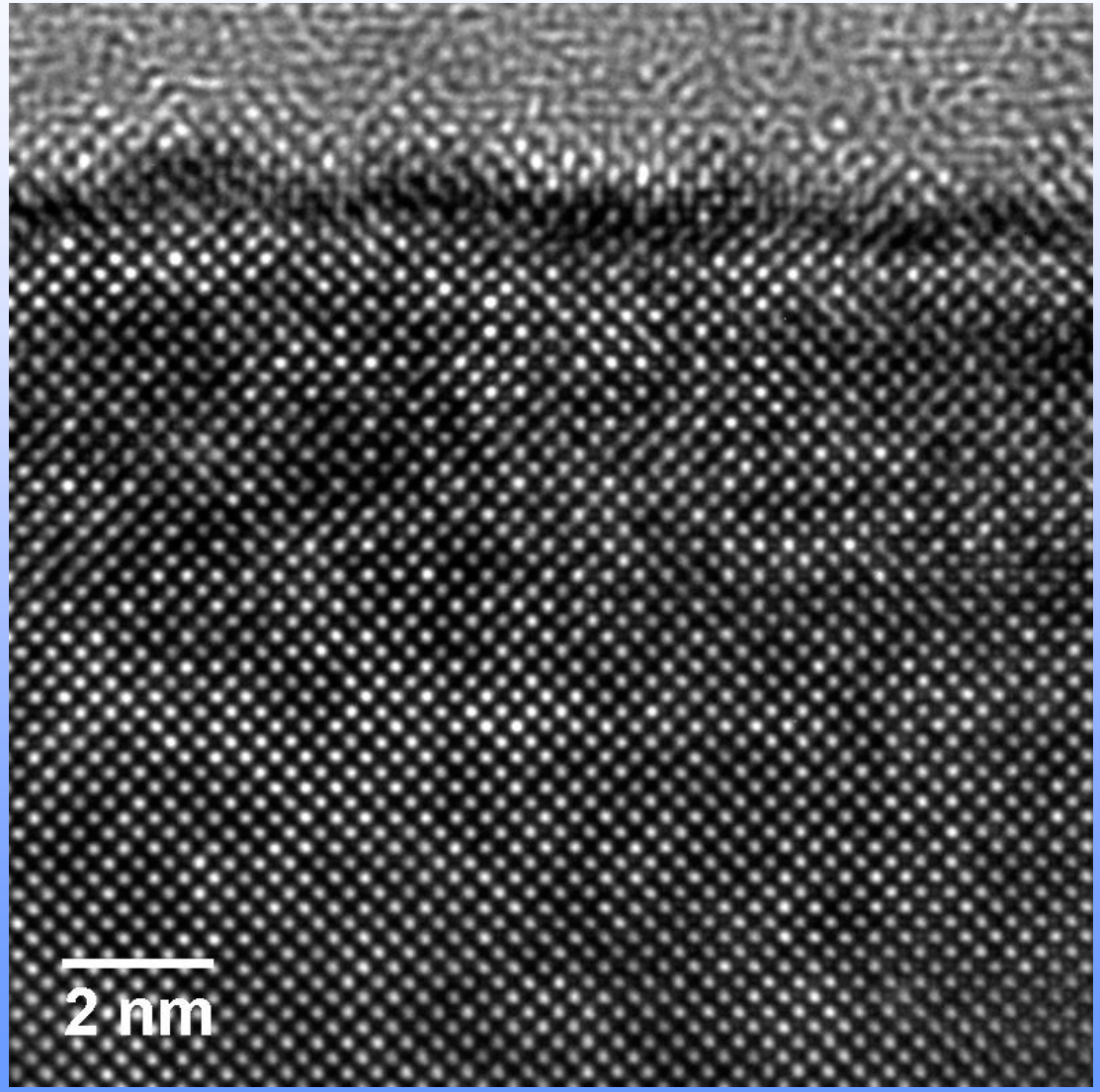


What's inside these?

ChemiSTEM—collect x-rays from small regions to determine (very) local chemistry



And structural imaging

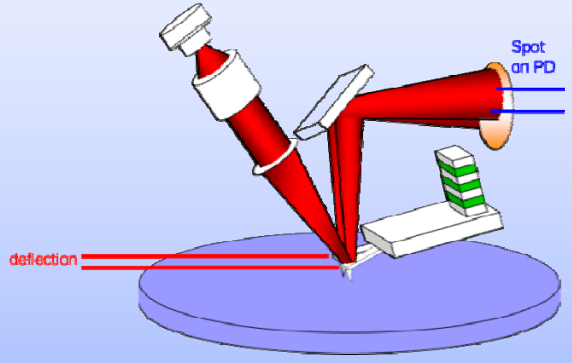


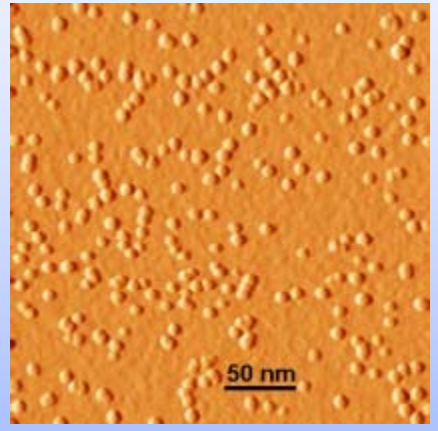
Other Capabilities

Stratasys Objet 500 Connex3 3D printer (polymers)

. . . and coming soon: Metal 3D printing!

Atomic force microscopy (AFM)

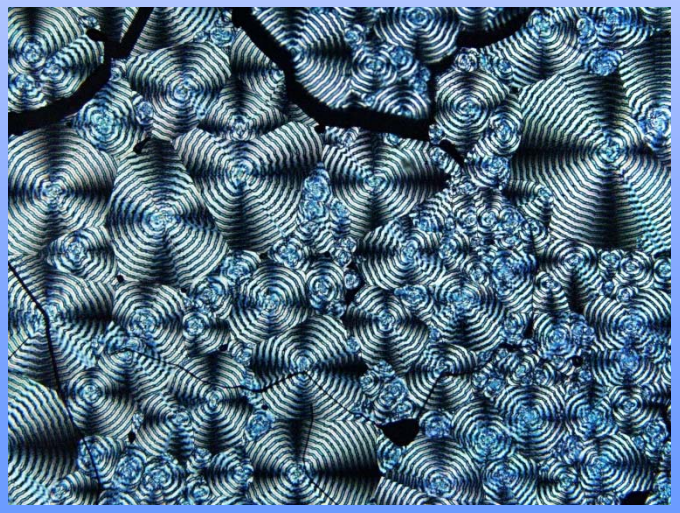


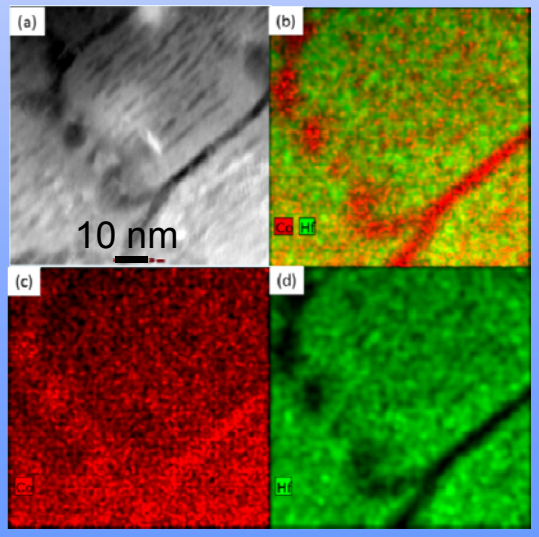


Microhardness
Optical Microscopy
Differential Scanning Calorimetry (DSC)
Thermal Gravimetric Analysis (TGA)
Thin film processing (RF/DC magnetron sputtering)

NNF WORKSHOP

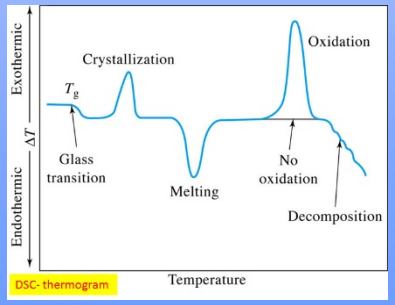
We have a wide variety of state-of-the-art capabilities to both fabricate and characterize materials at many length scales



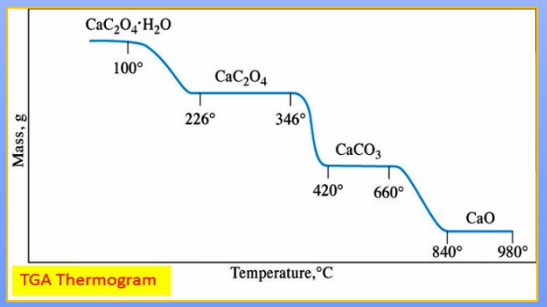


NNF Facility for Scanning Probe & Materials Characterization

Thermal Analysis- DSC



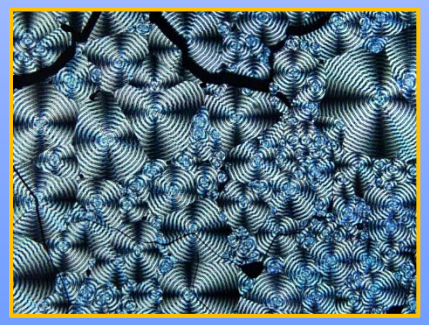
Thermal Analysis- TGA



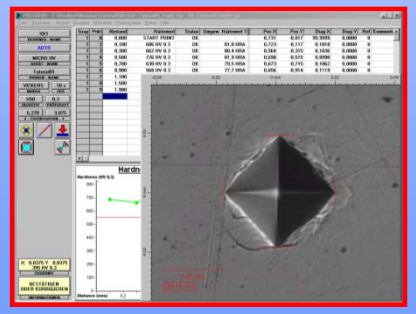
NNF Facility for Scanning Probe & Materials Characterization

Optical Microscopy

Tukon 2500 Hardness Tester

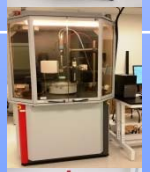


Polyhydroxyaalkanoate (PHA)



Knoop and Vickers Hardness

NNF Facility for X-ray Characterization

Rigaku D/Max B Bragg-Brentano (BB), 0D, **Co-radiation**		Powder XRD: Phase ID & Quantification, **Residual stress analysis, Ideal for Ferrous samples**, vertical sample mount
PANalytical Empyrean Bragg-Brentano (0 – 2D) , Cu-radiation		Powder XRD: **Fast data collection**, sample spinner, **Automatic sample batch processing**, Horizontal sample mount
Bruker D8 Discover Parallel Beam (PB), 2D Large Area Detector & 0D, Hi-res Optics, Cu-radiation		Powder and Hi-Res XRD, **Fast data collection, High Temperature XRD**, XRR, Pole-Figure, vertical sample mount, **capillary diffraction**
Rigaku SmartLab BB & PB, Ultra Hi-Res optics 0D & 1D detector, Cu-radiation		Powder and **Ultra Hi-Res XRD,** XRR**, Grazing incidence In-plane XRD, In-plane pole figure, Small Angle X-ray Scattering (SAXS), reciprocal space mapping**
Bruker Photon Parallel beam, CMOS detector (2D), **Mo-radiation**		**Small Molecular Crystallography with Temperature range T ~ 100 – 500 K**
Rigaku Multiflex Bragg-Brentano (0D), Cu-radiation		Powder XRD: Phase ID & Quantification, Horizontal sample mount

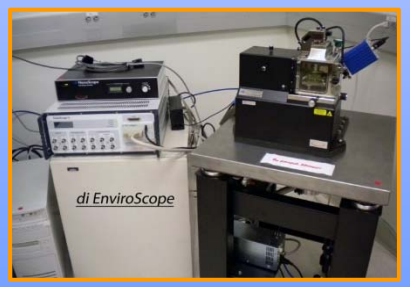
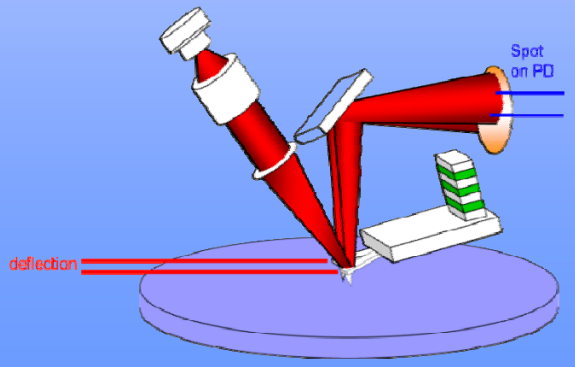
NNF

NNF Facility for Scanning Probe & Materials Characterization

- Quantitatively nanomechanical properties (modulus: 1MPa--50GPa; adhesion: 10pN--10μN.)
- Conductivity mapping : charge distribution, surface potential distribution, etc.
- Nanomanipulation (indentation and lithography)
- Heating and Cooling: –30°C to +250°C

Bruker Dimension ICON SPM

EnviroScope Atomic Force Microscope



Dimension 3100 SPM System