

CENTER FOR NANOSCALE MATERIALS TOOLS AND CAPABILITIES

*Indicates remote operation is available

Nanofabrication and Devices

Lithography

- Electron Beam Lithography JEOL 8100FS*
- Electron Beam Lithography: Raith 150*
- e3511 Plasma Asher
- FIB/SEM: FEI Nova 600 NanoLab*
- Heidelberg MLA150 Maskless Lithography*
- Interferometric Lithography System
- Laser Pattern Generator (Microtech LW405, Direct Write Optical Lithography)
- SUSS MA6/BA6: Contact aligner for front side and front-to-back side alignment
- Wafer Priming Oven: YES-TA Series
- Stepper: ASML PAS 5000 Wafer Stepper

Post-Processing

- ADT Dicing Saw*
- AS-One 150 Rapid Thermal Processor
- Cleaving Machine: LatticeGear Ax 420
- Critical Point Dryer (Leica CPD030)
- Hybond 626 Wire bonder
- SET FC-150 Flip-chip bonder

Wet Chemistry

- Electroplating (Au, Cu, Fe, Ni, Pt)
- Selective Wet Chemical Etching

Dry Etching

- Hydrofluoric Acid Vapor Etcher
- ONTOS Atmospheric System
- Oxford PlasmaPro 100 Cobra
- PlasmaTherm Deep Reactive Ion Etcher for Silicon (DRIE)
- RIE March CS-1701, Chlorine Chamber
- RIE March CS-1701, Fluorine Chamber
- RIE Oxford ICP Etcher (6-inch)
- RIE Oxford PlasmaLab 100, Chlorine and Fluorine Chambers
- SAMCO RIE-10NR
- SPTS uEtch HF Vapor Release Tool
- Xactix X4 Xenon Difluoride Etcher

Inspection and Metrology

- Bruker FastScan AFM*
- Filmetrics f40 Thin Film Analyzer*
- Four Point Probe
- K-space Stress Gauge
- Keyence 3D Laser Scanning Confocal Microscope, VK-X1000*
- KLA Tencor Profiler (2D & 3D)
- Laser Confocal Microscope OLS4100
- Optical Microscope: Olympus MX-61
- Potentiostat

- Scanning Electron Microscope VEGA 3
- Three-Dimensional Contact Profilometer: Dektak 8
- UVISEL Spectroscopic Ellipsometer: Horiba Jobin Yvon

Deposition

- AJA Oxide Sputtering, 3-inch targets*
- Temescal FC2000 Electron Beam Evaporator
- AJA Dielectric Sputtering System*
- AJA Metal Sputtering System*
- AJA Sputtering, 2-inch targets*
- Angstrom Sputter System
- Angstrom Engineering Thermal Evaporator
- Atomic Layer Deposition (Arradiance Gemstar)*
- Integrated UV-Ozone Cleaner and Molecular Vapor Coater
- Lambda Microwave Plasma CVD System: Nanocrystalline Diamond Deposition*
- Oxford Plasmalab 100 Inductively Coupled Plasma Enhanced Chemical Vapor Deposition
- Thermal/PECVD System for CNT and Graphene Synthesis

Piezoelectromechanical Spectrometer (POMS)

Adiabatic Demagnetization Refrigerator (ADR)*

Ultralow Temperature/Strong Magnetic Field Measurements*

- BlueFors LD400 Dilution Refrigerator System: (10mK base temp, free-space optical access, high-pressure fill lines, top-loading sample, low-noise amplifiers)
- AMI Superconducting Vector magnet: 5T in Z axis, 1T in Y axis, 10mG field stability, integrated persistent switches

Wear/Friction Measurements

- Multifunctional Tribometer with controlled environments*
- PicoIndenter, in situ TEM (PI-95)
- Sonotek Ultrasonic Spray Coating System

Theory and Modeling

CNM High-Performance Computing Cluster (Carbon)*

Computational Nanoscience Software and Modeling Expertise*

- BLAST (Bridging Length/Timescales via Atomistic Simulation Toolkit)
- Dacapo
- Density-Functional-Based Tight-Binding (DFTB)

- FANTASTX (Fully Automated Nanoscale to Atomistic Structure from Theory and eXperiment)
- Ingrained
- GPaw, a real space, grid-based DFT-PAW code
- MPI-Based Parallel Versions of Nanophotonics
- Time-Domain Nanophotonics Simulation Package
- VASP, Ab-Initio Molecular Dynamics Calculations
- Other specialized analysis software or modeling expertise

Nanophotonics and Biofunctional Structures

Bench-Top Spectroscopy

- UV-Visible Absorption
- Emission (uv-vis, NIR, MIR)
- FTIR Absorption
- Circular Dichroism
- Cryostat/Temperature Control

Magneto-optical Microscope (MOM)

Magneto-Electro-Optical Spectrometer (MEOS)

Raman Spectroscopy

- Temperature-Controlled Stage

Electron Paramagnetic Resonance Spectroscopy (EPR: CW and Pulsed)

enVISION Transient Absorption Spectrometer

FLS1000 Spectrofluorimeter

Time-Resolved Emission Spectroscopy

- Time-Correlated Single Photon Counting (TCSPC) Spectroscopy (uv-vis, NIR)
- TCSPC Microscopy (400 – 800 nm)
- Visible and Near-IR TCSPC with Streak Camera
- Near-IR TCSPC with Superconducting Nanowire Single Photon Detector

Transient Absorption Spectroscopy

- Visible Probe
- Near-IR/Mid-IR Probe
- THz Probe
- Cryostat

Visible and Near-IR Microscopy

- Lamp Illumination
- Laser Illumination
- Visible Detection
- Near-IR Detection
- Cryostat

Correlation/Antibunching Measurements

- Visible (350 – 800 nm) Detection with APD Detectors
- NIR (800 nm – 2 μm) Detection with Superconducting Nanowire Single-Photon Detectors (SNSPD)

Automated thin film solution processing robot

Autoclaves

Biological Safety Cabinets, Labconco Purifier Delta Series (Class II, B2)

Centrifuges

Drop Shape Analysis Tool

Electrochemical Workstation (BASi Epsilon)

Field Emission Scanning Electron Microscope, JEOL JSM-7500F

GC-MS (Agilent 5975C Series GC/MSD)

General Wet Lab Space for Sample Prep

Glove Box, MBraun LabMaster 130

HPLC (LabAlliance)

Isothermal Titration Calorimetry (ITC)

Laser Scanning Confocal Microscope, Zeiss LSM 510 Meta

Optical Microscope, Zeiss Axio Imager Z1 M Upright*

Integrated Glove Box System

Internal/External Quantum Efficiency Measurement System (Oriel IQE-200)

Lyophilizer

Ossila Slot-Die Coater

Peptide Synthesizer*

Rotary Evaporator

Schlenk Lines

Solar Simulator, Oriel

Solution-Shearing Station

Surface Preparation

- Harrick Plasma Cleaner
- UVO Surface Cleaner

Synthesis

- Surface Modification of Nanoparticles
- Functionalization
- Quantum Dots
- Metal Nanoparticles
- Metal Oxide Nanoparticles

Thin film transfer system

Post Processing

- External Field, Ultrasound, Dip-coating

ZetaSizer Nano, Malvern

Nanoscale Synthesis and Characterization

Agilent Inductively Coupled Plasma Optical Emission Spectroscopy ICP-OES

Asylum Cypher-S AFM

Electrical Characterization

- Associated High-Sensitivity Test Systems
- Keithley 4200-SCS/F Semiconductor Parameter Analyzer

FT-IR with Hyperion Microscope, Bruker Vertex 70

Langmuir-Blodgett, Kibron MicroTrough X Magnetometry

- Quantum Design MPMS-XL

- Quantum Design PPMS-9

- DynaCool 14T PPMS

Tube furnaces (1-inch)

Physical Vapor Deposition, common loadlock is shared*

- Lesker E-beam Evaporator (PVD250)
- Lesker Sputtering System (CMS18)

Rheometer, AntonPaar Physica MCR301

Rheo-XPCS at APS Sector 8

Scanning Probe Microscope, Veeco MultiMode 8

- PeakForce Quantitative Nanomechanical Mapping, Tapping
- Fluid Imaging
- Low Current STM
- Magnetic Force
- Variable Temperature Imaging

Spin Coater, Laurell WS-400, not for lithography resist work

Synthesis Lab – Inorganic Crystals

Thermal Analysis

- Differential Scanning Calorimetry, Mettler Toledo 823
- Thermogravimetric Analysis, Mettler Toledo 851

UV-Vis-NIR spectrometers, Perkin-Elmer Lambda 950 and Cary 5000

VT-UHV-Atomic Force Microscope/Scanning Tunneling Microscope (AFM/STM; Omicron VT-AFM XA)*

- Contact AFM
- Magnetic Force Microscopy
- Non-Contact AFM
- Scanning Tunneling Spectroscopy

Optical UHV VT STM/AFM*

- Lasers for Optical UHV VT STM/AFM
- Contact and non-contact AFM, MFM
- Scanning Tunneling Spectroscopy

UHV Cryo SFM with 6T Magnetic Field, Omicron

Low Temperature Scanning Tunneling Microscopy (LT-STM, Createc)*

Laser Scanning Interferometric Microscope

SPM Tip Etching

West-Bond Wire Bonder*

X-Ray Diffractometer Bruker D2 Phaser

X-Ray Diffractometer Bruker D8 Discover

Electron and X-Ray Microscopy

Hard X-Ray Nanoprobe, Sector 26*

- Multimodal Chemical and Structural Nanoimaging
- Scanning Nanodiffraction, Bragg Ptychography

UEM: Ultrafast Electron Microscopy*

- Temporal resolution ca. 1 ps
- Spatial resolution ca. 1 nm
- Energy resolution ca 1 eV
- Pump laser wavelengths: 515, 325-450, 650-900, 1030, and 1200-2000 nm
- Repetition rate: 10-500 kHz (fs laser), 1-100 kHz (ns laser)

Hitachi S-4700-II SEM*

- SEI & BSE Imaging (0.5 – 30 kV)
- XEDS Mapping or Spectrum Imaging

FEI Tecnai F20ST (S)TEM*

- TEM Imaging and Diffraction (80, 120, & 200 kV)
- STEM Imaging (HAADF & BF; 80, 120, & 200 kV)
- EFTEM Imaging and Diffraction (120 & 200 kV)
- EELS (120 & 200 kV)
- XEDS
- Spectrum Imaging (profiles and/or maps)
- Lorentz Imaging (200 kV)
- Tomography (200 kV)
- Special Specimen Holders:
 - Double-Tilt Liquid N2-Cooled (T >= 97 K)
 - Double-Tilt Heating
 - Tilt-Rotate Liquid He-Cooled

FEI Quanta 400F (E)SEM*

- SEI & BSE Imaging (2 – 30 kV)
- High-Vacuum Mode (P < 10⁻⁵ torr)
- Low-Vacuum Mode (P ~ 0.1 – 2 torr)
- ESEM Mode (P ~ 2 – 20 torr)
- ESEM Mode with a gas other than air or water vapor
- Peltier-Cooled Stage (T ~ 248 – 328 K)
- Heating Stages (T < 1273 K or T < 1773 K)

Field Emission Transmission Electron Microscope, JEOL JEM-2100F*

- TEM Imaging and Diffraction (200 kV)
- EFTEM Imaging (200 kV)
- EELS (200 kV)
- XEDS
- Tomography (200 kV)
- Special Specimen Holders
 - Liquid Flow Holder (room temp)
 - Gas Flow Holder (room temp or 100 – 500C)
 - Single-Tilt Heating Specimen Holder (T <= 900C)

JEOL IT800HL SEM*

Talos F200X (S)TEM*

- TEM Imaging and Diffraction (80, 120, & 200kV)
- STEM Imaging (HAADF & BF; DF2, DF4, DPC, 80, 120, & 200 kV)
- XEDS, Super-X, 4SDD EDX System
- EDS Mapping (profiles and/or maps)
- Lorentz Imaging (200 kV)
- Tomography (200 kV)

TFS Spectra 200*

Zeiss 1540XB FIB-SEM

- TEM Sample Preparation
- 3D FIB-SEM Serial Sectioning
- SEI & BSE Imaging, FIB cross-sectioning

Zeiss NVision FIB-SEM*

Specimen Preparation Resources (not FIB)

- Cutting from bulk, Grinding/Polishing, Dimpling, Ion-Milling*, Vacuum-Coating with gold or carbon

Data Analysis

- Image Processing
- HRTEM Image Simulation
- Diffraction Pattern Simulation
- XEDS Analysis (inc. spectrum images)
- EELS Analysis (inc. spectrum images or EFTEM spectrum images)

CENTER FOR NANOSCALE MATERIALS

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