Nano-scale Imaging & Surface Analysis
(co-located MRSEC shared facilities)

ELECTRON MICROSCOPES
• STEM: JEOL JEM-2800 with ultrafast EDS (3D tomo)
  Protochips liq & gas phase ETEM / electrochemistry
• dbFIB: FEI Helios Nanolab 650i hi-res, Nabity EBL
  Pt, W, C dep; XeF₂, I₂, H₂O enhanced etch, EDS, EBSD
• SEM: FEI Quanta 600 FE-ESEM w/ EDS, EBSD, particle
  ID, MAPS
• SEM: FEI Teneo FE-SEM w/ EDS, EBSD, Trinity™
  imaging detectors

MATERIALS CHARACTERIZATION: (COMPOSITION,
STRUCTURE, MECHANICAL, OPTICAL, MAGNETIC,
ELECTRICAL)
• SAXS/WAXS/GISAXS: Anton Paar SAXSPoint 5.0 with
  in situ heating/cooling/mechanical loading/humidity
  capabilities
• DLS: Anton Paar Litesizer 500 with Zeta potential
• XRF: EDAX Eagle III Microspot (µprobe & mapping)
• Nanoindenter: Hysitron TI Premier with heating stage
• Picoindenter: stage for SEM: Hysitron P189
• Ellipsometer: Woollam V-VASE spectroscopic
• Magnetometer: Microsense vibrating sample
  magnetometer (EZ-7 VSM)
• Potentiostat: Gamry Reference 600+

SURFACE ANALYSIS
• XPS/AES/ISS/UPS: Kratos AxisUltra
• AFM: Bruker ICON-PT with PF-QNM, wet cell, MFM,
  KPFM

OPTICAL MICROSCOPES AND PROFILERS
• Olympus OLS5000 LEXT 3D measuring microscope
• Vertex 220 microVu Digital Comparator
• Optical Microscope: Reichert MeF3 with BF, DF, DIC

SAMPLE PREPARATION (COATING, POLISHING, ION-
POLISHING, PLASMA CLEANING)
• Micro fiducial laser cutter for correlative multiscale
  microscopy: 355, 532, 1064 nm: 1.2-15mJ
• Sample Coating for SEM imaging (Au/Pd, C, Cr):
  Gatan PECS I, Leica ACE600
• Mechanical polishing: SEM/TEM prep tool suite
• Ion polishing: Fischione 1060, Gatan PECS I and II
• Plasma Cleaner for TEM samples: Fischione 1020

Cleanroom

DESIGN & SIMULATION SOFTWARE
• L-Edit, Cadence, AutoCAD, SolidWorks
• Link-CAD DXF/GDSII/CIF/BMP conversion tools
• SASS JMP statistical design of experiments (CADE)
• ANSYS & COMSOL finite element analysis

LITHOGRAPHY (Class 100)
Pattern Generation & Direct Write
• Nanoscribe Professional GT-2 micro/nano 3D printer:
  200nm-mm scale printing on silicon and glass. IP-DIP, IP-
  S, IP-Q, IP-Visio, IP-PDMS, GP-Silica, IP-n162 Resins
• Heidelberg DWL66+ Laser Pattern Generator submicron
  0.3µm (300nm) min lines and spaces, gray-scale patterning,
  direct write up to 200nm substrates and 9° photomasks.
• Heidelberg µPG 101 Laser Pattern Generator (x2)
  0.9µm, 2.5µm write heads, gray scale lithography
• Nanofrazor 30nm-200nm nanolithography tool
• EVG-420, Suss MA1006 front & backside mask aligner
• OAI Models 200 & 810 (with BSA) contact aligners
• SSEC 3305 Auto spin/bake HMDS/PR/EBR track
• Spinners, ovens, hot plates, fume hoods, SRDs, ultrasonic
  lift-off
• LOR 108, AZ 9620, Shipley 1813, nLOF 2020, AZ 40XT, SU8,
  ma-P 1275, AZ Barlii II ARC, AZ MiR 701
• YES HMDS vapor prime vacuum oven

THIN FILM DEPOSITION (Class 1000)

Sputtering:
• TMV SS-40C: 8 dedicated cathodes, dual cryo-pumped
• Denton Discovery 18: 3 user config 3" cathodes, RF/DC
• Denton 635LL: 4-cathodes, RGA, OES-feedback reactive
  oxygen or nitrogen sputter, heated/cooled chuck to 500C,
  co-sputtering, coats up to 200mm diameter substrates
Metals/Alloys: Ag, Al, Al/Si, Au, BN, C, Chromel, Co, Cr, Cu,
  Cu/Ag, Ir, Ge, Fe, Ni, NiCr, NiCrFe, Nb, Pd, Pt, Ru, Si (p-type),
  Ta, Ti, TiW, V, W, Cr₂Si, Zr, Hf
Oxides / Ceramics: Al₂O₃, AIN, SiO₂, IrOₓ, ITO, BN, CeSm(ox),
  LaSrFe(ox), NaMnO₃, NdMgO, SiC, Si₃N₄, TaO₂, TiO₂,
  YNiZrO, YSZ, ZnO, MgO
Evaporation: Al, Ag, Au, Au/Ge, Cr, Cu, In, Mg, Mo, NiCr, Ni, Ta, Ti
- Denton e-beam DV-SJ/20C with 4 hearths, user configurable

PECVD
- Oxford Plasmalab 80+: α-Si, low-stress Si₃N₄, SiONₓ, SiO₂

CVD
- SCS PDS 2010 Parylene-C

MOCVD
- Agnitron Agilis-IH: Gallium Oxide

ALD
- Cambridge Fiji F200 w/ thermal & plasma dep modes, H₂O plasma (Pt, HfO₂, ZnO, Al₂O₃, SiO₂, TiO₂, MgO, ZrO₂)

FURNACES and DIFFUSION (Class 1000) LPCVD
- Expertech TEOS / LTO / PSG / low-stress silicon rich and stoichiometric Si₃N₄, α & phosphorous-doped polySi

Atmospheric and Rapid Annealing
- Allwin 610 RTP/RTA with O₂, N₂, Ar, H₂ forming gas, 200-1250 °C
- ProTemp wet/dry thermal silicon oxidation with DCE
- Blue-M box furnace with N₂ purge
- Vacuum oven (250 °C)

ETCH (Class 1000)
RIE and DRIE
- STS Aspect ICP DRIE: time-multiplex Si etch (anti-footing)
- Oxford Plasmalab 100+ ICP time-multiplex & cryo DRIE
  - SF₆, CF₄, CHF₃, O₂, Ar, N₂
- Oxford Plasmalab 80+ multipurpose (SF₆, CF₄, O₂, Ar)
- Technics PELI H₂O vapor, O₂ descum & resist strip
- Xactix Xetch XeF₂ silicon isotropic etch
- Plasmatherm 790 metal etch (Cl₂, BCl₃, SF₆, CF₄, O₂, Ar)

Wet Chemical
- Bold & WAFAB wet benches (x6) acids, bases, organics
- Gold wet-etch station

MICROMACHINING / MESO-SCALE PROTOTYPING
- Custom KOH bulk Si etch station
- LaserStar 1900 micro laser welder (1064nm, 150J)
- ULS CO₂ flatbed laser (dual laser cartridge, 25W + 75W, 1090nm)
- DPSS Samurai UV laser (355nm, 10um spot size, 3 W)

BACKEND PROCESSES & PACKAGING
- Strasbaugh 6EC 100 mm CMP (Si, SiO₂ polishing & planarizing)
- EVG 520IS wafer bonder (anodic, eutectic, polymer, fusion)
- Disco DAD 641 & Disco 3220 dicing saws (std or UV tape)
- MEI wedge wirebonder with Au and Al wire

CLEAN (Class 10,000) MICROFLUIDICS
- Sylgard 184 PDMS
- SU-8 soft lithography and PDMS bonding
- Omnicon 1000 UV curing (320-500nm)
- Lamination press, spinner, vacuum oven, hotplate
- Corona discharge UV/O₃ plasma treatment

CLEANROOM (Class 1000) METROLOGY
- JEOL JSM-IT200 SEM
- Keyence VH-5000 3D microscope
- n&k NKT 1500 thin film analyzer with wafer mapping
- Nanometrics NanoSpec 3000 film thickness
- Filmetrics F20 & F40 small spot film thickness and refractive index
- Tencor P-10 and P-20 stylus profilometers
- Tencor Flexus 2320 film stress analyzer

ELECTRICAL / MAGNETIC TESTING
- Verigy 9300 SOC IC tester
- Keysight 404A Mixed Signal O-scope
- Keysight E5061B Network Analyzer
- Keithley 4200A semiconductor parameter analyzer(4 SMUs)
- Micromanipulator light-tight micro probe station
Tool List

STAFF SERVICES

- Professional Technical Support
  - 3D microprinting on Nanoscribe GT2 Pro
  - Photomask design and generation
  - Wafer/chip design and fabrication
    - Microfluidics
    - Microoptis (lenses, diffractive optical elements)
    - MEMS and microactuators
    - Microsensors
    - Multi-electrode arrays
- R&D Process Development
- Thin Film Deposition and Patterning
- Equipment Installation, Diagnostics, and Repair
  - FLIR

AFFILIATED CHARACTERIZATION LABS

- SMBB Co-located HSC Core Facility
  - JEM 1400 TEM (120 keV)
  - FEI Technai T-12 TEM (120 keV), T-20 (200 keV cryo)
  - ThermoFisher Titan Krios G3 Cryo TEM
  - Olympus FV-1000 Scanning laser confocal sources: 405, 457, 488, 514, 568, 633, 748nm
- Dixon Laser Institute
  - www.physics.utah.edu/laser/
  - Witec Alpha 300 SNOM, Raman, and Confocal
  - FEI NovaNano 630 FE-SEM w/ EDS, CL and Nabity EBL
- X-ray CT Lab – Michael Czabaj
  - m.czabaj@utah.edu
  - Varian BIR/150/130; GE eXplore Locus SP
- Fast-capture camera
  - o.kingstedt@utah.edu
  - +10M fps Shimadzu Hypervision HPVX2 camera
- Nanomaterials Lab
  - http://nanomaterials.utah.edu
  - Hitachi S-4800 HR-SEM / Oxford EDS (nuclear materials)
  - Micrometrics ASAP 2020 Surface Area (BET) Porosity
  - Shimadzu GCMS-QP2010; UFLC HPLC; UV-3600 UV-Vis-NIR
  - Benchtop powder XRD
- BYU: www.chem.byu.edu/faculty/matthew-r-linford/
  - TOF-SIMS IV
- Materials Science
  - http://characterizationlab.mse.utah.edu
  - Philips X’Pert XRD (also DSC, dilatometer)
  - Hitachi S3000-N SEM w/ EDS & EBSD
  - FT-IR (Varian 3100) & PE Lambda 950 UV/VIS
  - Volatile, non-toxic deposition (ebeam and sputt)
- College of Earth Sciences (Geology & Metallurgy)
  - QEMScan 4300 (erich.petersen@utah.edu)
  - WDS microprobe (http://probelab.utah.edu)
  - ICP-MS (diego.fernandez@utah.edu)
  - Bruker D8 thin film XRD
  - s.guruswamy@utah.edu
- Energy and Geosciences Institute (http://egi.utah.edu)
  - QEMScan EVO 50
  - XRD mineral quantitation
  - Wet laboratories (GeoChem Lab)
- Chemistry Department www.chem.utah.edu/facilities/
  - NMR: Unity-300, Inova-400, and VXR-500
  - Single Xyl XRD; MS: TOF, Quad GC, UPLC, FTIR
  - UV-VIS-NIR, Polarimeter, scintillation, lumi, fluor

MRSEC AFFILIATED LABS
nanofab.utah.edu/index/about-us/affiliatedlabs

- Organic spintronics deposition system
- Sagnac Interferometer
- Magnetic Resonance X-band cw-EPR, ENDOR, ELDOR
- (3+3)-Pass Tandem Fabry-Perot Interferometer
- THz Time-Domain Spectrometer
- UV Time-Resolved Spectroscopy

AFFILIATED PROTOTYPE MANUFACTURING LABS

- Mechanical Engineering Shops
  - www.mech.utah.edu
  - 3D printing / rapid prototyping
  - Waterjet machining
  - All traditional machine shop tools
- Interference Lithography
  - photonics.ece.utah.edu
- Center for Biomedical Microfluidics
  - www.mems.utah.edu
  - PDMS and soft lithography
  - CO2 laser micromachining
  - Knife plotter
- BioInnovationsGateway (BIG)
  - bioinnovationsgateway.org
- Center for Medical Innovation
  - http://healthsciences.utah.edu/center-for-medical-innovation/
- USTAR North Innovation Center
  - https://ustar.org/find-us-statewide/ustar-innovation-center