



UTAH NANO FAB Tool List



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 PI89
- ♦ 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
- ♦ SAS JMP statistical design of experiments (CADE)
- ♦ ANSYS & COMSOL finite element analysis

LITHOGRAPHY (Class 100) *Pattern Generation & Transfer*

- ♦ Heidelberg DWL66+ Laser Pattern Generator submicron 0.3μm (300nm) min lines and spaces, gray-scale patterning
- ♦ Heidelberg μPG 101 Laser Pattern Generator (x2) 0.9μm, 2.5μm write heads, gray scale lithography
- ♦ Nanofrazor 30nm-200nm nanolithography tool
- ♦ EVG EV-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 10B, 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, AlN, 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



UTAH NANOFAB Tool List



PECVD

- ♦ Oxford Plasmalab 80+: α -Si, low-stress Si_3N_4 , SiON_x , SiO_2

CVD

- ♦ SCS PDS 2010 Parylene-C

MOCVD

- ♦ Agnitron Agilis-IH: Gallium Oxide

ALD

- ♦ Cambridge Fiji F200 w/ thermal & plasma dep modes, H_2O plasma (Pt, HfO_2 , ZnO, Al_2O_3 , SiO_2 , TiO_2 , MgO, ZrO_2)

FURNACES and DIFFUSION (Class 1000) LPCVD

- ♦ Expertech TEOS / LTO / PSG / low-stress silicon rich and stoichiometric Si_3N_4 , α & phosphorous-doped polySi

Atmospheric and Rapid Annealing

- ♦ Allwin 610 RTP/RTA with O_2 , N_2 , Ar, H_2 forming gas, 200-1250 °C
- ♦ ProTemp wet/dry thermal silicon oxidation with DCE
- ♦ Blue-M box furnace with N_2 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 SF_6 , CF_4 , CHF_3 , O_2 , Ar, N_2
- ♦ Oxford Plasmalab 80+ multipurpose (SF_6 , CF_4 , O_2 , Ar)
- ♦ Technics PEII H_2O vapor, O_2 descum & resist strip
- ♦ Xactix Xetch XeF_2 silicon isotropic etch
- ♦ Plasmatherm 790 (2X, oxide and metal etch, Cl_2 , BCl_3)

Wet Chemical

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

MICROMACHINING / MESO-SCALE PROTOTYPING

- ♦ Nanoscribe Professional GT-2 3D nano/micro printer: 200nm-mm scale printing on silicon and glass. IP-DIP, IP-S, IP-Q, IP-Visio, IP-PDMS, GP-Silica, IP-n162 Resins
- ♦ Custom KOH bulk Si etch station
- ♦ LaserStar 1900 micro laser welder (1064nm, 150J)
- ♦ ULS CO_2 flatbed laser (dual laser cartridge, 25W + 75W, 1090nm)

BACKEND PROCESSES & PACKAGING

- ♦ Strasbaugh 6EC 100 mm CMP (Si, SiO_2 polishing & planarizing)
- ♦ EVG 520IS wafer bonder (hot embossing, thermal & anodic)
- ♦ Disco DAD 641 & Disco 3220 dicing saws (std or UV tape)
- ♦ MEI wedge wirebonder with Au and Al wire
- ♦ TUI 9101 wire bond pull tester

CLEAN (Class 10,000) MICROFLUIDICS

- ♦ Sylgard 184 PDMS
- ♦ SU-8 soft lithography
- ♦ Omnicure 1000 UV curing (320-500nm)
- ♦ Lamination press, spinner, vacuum oven, hotplate
- ♦ Corona discharge UV/ O_3 plasma treatment

CLEANROOM (Class 1000) METROLOGY

- ♦ Keyence VHX-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
- ♦ Magnetron Instruments 4-point probe
- ♦ Polyvar Met with DIC + many optical microscopes
- ♦ 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 with 4 SMUs
- ♦ Micromanipulator light-tight micro probe station



UTAH NANOFAB Tool List



STAFF SERVICES

- ◆ Equipment Installation, Diagnostics, and Repair
 - FLIR
- ◆ Professional Technical Support
 - Design of Experiments (DOE)
 - R&D Process Development
- ◆ Thin Film Deposition and Patterning
- ◆ Photomasks, microfluidics, microsensors, micro-optics
- ◆ Center for Engineering Innovation www.cei.utah.edu
 - Engineering design services
 - (Bio)MEMS design and fabrication
 - Advanced package development

AFFILIATED CHARACTERIZATION LABS

- ◆ SMBB Co-located HSC Core Facility www.cores.utah.edu/
 - 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>