Shared Use MaSC Equipment in the Owen Cleanroom and Owen Characterization Labs (Spring 2023)

Upon approved lab access and equipment training the equipment listed below is available for use within defined process and operating parameters. To get started, please contact:

- *Chris Tasker, Facility Manager*
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* = standard recipe available or "plug and play"
** = extra charge or purchase on own

Vacuum Deposition

- **AJA International Orion 5 sputter system for metal oxides**
  - Current materials: ITO* and IGZO, also Ti (for getter layer), TiO_2, ZnO, In_2O_3, other materials must be approved, e.g. non-toxic)
  - Targets: Ti, ZnO,IGZO,ITO
  - Substrates up to 100 mm
  - Substrate heating, rotation and RF bias
  - Five confocal 2" sputter sources with good thickness uniformity
  - Load locked
- **OSU constructed (TANG) sputter system for metals and amorphous metals**
  - Current materials: AlNi, MoW, Ru, TaHfSi, TiAl, ZrCu
  - Previous materials: TaWSi, TaNSi, Ta, W, other metals, etc.
  - Substrates up to 150mm
  - Substrate linear translation
  - Two 3" and three 2" sputter sources
  - Load locked
- **OSU constructed chalcogenide deposition system (CDS) with sputter, e-beam, and thermal sources**
  - Current materials: metals such as e-beam Pt** and Au**, Al, W
  - Chalcogenides (not recently used for this): CuSbS, CaTaS
  - Substrates up to 150mm
  - Substrate heating, rotation and RF bias
  - Two 2" confocal sputter sources and six pocket ebeam with good thickness uniformity
  - Load locked
- **Circuits Processing Apparatus (CPA) sputter system**
  - Exploratory materials system, anything (almost) goes (metal, oxide, nitride), may schedule for non-toxic, new materials must be approved, may schedule enough time to develop your process
  - Current materials: indium tin oxide, silver
  - Substrates up to 2" square
  - Two 3" or 2" sputter sources

- **OSU constructed sputter system for nitrides and metals**
  - Nitride only system (no oxides)
  - Current materials: Al, AlN*, Ti, TiN, Si_3N_4*, Ta, TaN*
  - Targets: Al, Ti, Ta, Si_3N_4
  - Substrates up to 100mm
  - Substrate heating, rotation and RF bias
  - Four 2” confocal sputter sources with good thickness uniformity
  - Load locked
- **AJA International Orion 8 dual chamber sputter system for magnetic materials**
  - Current magnetic materials: cobalt zirconium tantalum
  - Substrate in situ transverse magnetic field
  - Substrates up to 100mm
  - Substrate heating, rotation and RF bias
  - Four 2” confocal sputter sources with good thickness uniformity
  - Load locked
  - Current materials in metal/metal oxide chamber: titanium
  - Substrates up to 100mm
  - Substrate heating, rotation and RF bias
  - One 2” sputter source with good thickness uniformity
  - Load locked
- **Veeco 7760 Thermal Evaporator**
  - Metal deposition*: Al, Au**, Ti, Cu, Zn
  - Any non-toxic metal
  - Two 250 amp thermal sources: Ti is highest melting point available
- **Cooke Vacuum products CVE-301-T-FR thermal evaporator**
  - Al contacts, mainly for undergrad teaching lab but open to all

Plasma Etch, Ash, and Surface Treatment

- **Oxford Instruments PlasmaPro System 100/1 Cobra 380 ICP/RIE**
  - Al, Cr, IGZO, Ru, Si, SiO2, Ti, TiN, AlN, TiAl3, W
  - Other materials upon approval (not Au)
  - Temperature controlled chuck: -150 °C (using LN2) to 400 °C
  - Gasses: Cl_2, BCl_3, HBr, $SiCl_4$, CHF_3, Ar, O_2
- **PlasmaTherm Batchtop System VII RIE**
  - SiO_2, Si_3N_4
  - More of an open / dirty system, other materials upon approval
  - Also for O_2 or other plasma exposure
  - Gasses: CHF_3, O_2, Ar
  - Needs characterization of processes
- **Plasma Etch PE50 oxygen plasma asher**
  - 50W plasma process
  - Medium vacuum so oxygen rich plasma
  - Open / dirty system
  - Cleaning of "dirty" substrates
- **Plasma Etch PE200 oxygen plasma system for surface treatment (clean substrates only)**
  - 50W plasma process
  - Medium vacuum so oxygen rich environment
  - Clean system
  - Cleaning of bare glass, bare Si wafers, etc.

Photolithography

- Heidelberg Instruments DWL66fs laser lithography system
  - Mask generation to 1 micron critical dimension
  - Direct write capability
- Karl Suss MJB3 mask aligners (x2)
  - S1818/S1813 exposure process
  - Lithography to 5 micron critical dimension
- Cee 100CB programmable spinner with integrated hotplate
  - S1818/S1813, 80/20 primer and LOR
  - Open tool
- Laurell WS-650HZ-23NPPB programmable spinners
  - PR only
- Laurell WS-650HZ-23NPPB programmable spinners
  - For process development
- Cee 100CB programmable spinner with integrated hotplate
  - Inorganics only (may change in future)
- Headway Research 1-EC101 spinner for doping
  - Undergrad lab for spin on glass
- Tractrix spin coating system
  - Programmable coater for spin-bake-chill-repeat, up to three alternating materials, up to 20 layers
  - Requires restarting

Electrical Test

- **Signatone CM200 probe station with Temptronics heated chuck**
  - Agilent 4156C Semiconductor Parameter Analyzer
  - Agilent 8114A Pulse Generator
- **Alessi REL 4800 probe station with Temptronics heated chuck**
  - Agilent Technologies 4155C Semiconductor Parameter Analyzer
  - Agilent Technologies E4980A Precision LCR Meter
- **Karl Suss PA 200 Semiautomatic Probe Station**
  - Agilent Technologies B1500 Semiconductor Device Analyzer
  - Agilent Technologies 4284A Precision LCR Meter
- **Micromanipulator 6400 probe station**
  - Agilent Technologies 4156C Semiconductor Parameter Analyzer
- **Signatone S-1003 Dielectric Characterization Station**
  - Primarily for undergrad lab
- **Micromanipulator 1800 probe station**
  - Hewlett Packard 4140B pA meter/DC voltage source
  - Hewlett Packard 4275A multi-frequency LCR meter

Film Characterization and Metrology

- Film Sense FS-1 multiwavelength mapping ellipsometer
- KLA Tencor Alpha Step 500 Surface Profiler
- KP Technologies Kelvin Probe
- Nanometrics Nanospec/AFT 4000 Visible Film Thickness System

- Jandel RM2 four point probe
- Gaertner L116A ellipsometer (old)
- Leeds Northrup hot point probe (old) (for 518)

Microscopes
- Zeiss Axiotron microscope with camera
- Leica INM 200 microscope with camera

Cutting and Dicing
- DISCO DAD 3220 six inch automatic dicing saw
- South Bay Technology Model 650 low speed diamond wheel saw (old)

Thermal Processing
- Allwin21 610M tabletop atmospheric RTA
    - Clean system, 150 mm
    - Controlled atmosphere: H_2/N_2, N_2, O_2, Ar
    - 400 °C up to 1200 °C for 60 sec
- Allwin21 610M tabletop atmospheric RTA
    - Flexible system, 150 mm
    - Controlled atmosphere: H_2/N_2, N_2, O_2, Ar
    - 300 °C up to 800 °C for 120 sec
- Carbolite three zone furnace with two inch tube
- Lindbergh six inch oxidation/diffusion furnace
- Neytech QEX furnace
- Thermolyne 62700 furnace
- Thermolyne 47900 furnaces (x2)
- BLUE M OV-8A ovens (x3)
- Numerous Cimarec hotplates

Substrate cleaning
- Branson 5510 ultrasonic cleaner
- Branson 1510 ultrasonic cleaner
- Branson 1200 ultrasonic cleaner

Solution processing
- Cee 100 programmable spinner
- Sonoplot GIX Microplotter II

Other
- MBRAUN labmaster 130 glovebox with VOH-600 vacuum oven
- (5) Fume hoods
- Wet etch bench
- Mettler H80 precision scale
- Sun EC1A environmental chamber

Some Other Facilities on Campus

- Electron Microscopy Facility (https://emfacility.science.oregonstate.edu/)
- XPS Facility or Ambient Pressure Surface Characterization Laboratory (http://nnci.oregonstate.edu/apscl)
- X-ray diffraction (XRD) facility (https://xrd.science.oregonstate.edu/)
- Spectroscopic Ellipsometry and AFM ()
- Atomic Layer Deposition (https://web.engr.oregonstate.edu/~jconley/facilities.html)
- Internal photoemission spectroscopy (https://web.engr.oregonstate.edu/~jconley/facilities.html)

Additional details for Oxford RIE

ICP-mode

Material	Gases	Etch rate	Uniformity	Selectivity	Profile
Al, AlSi, AlSiCu	HBr[1]-Cl_2-BCl_3	>250nm/min	<±5%	>2:1 to PR >5:1 to SiO_2	>88°
Cr	Cl_2-O_2	>15nm/min	<±5%	>0.5:1 to PR >20:1 to SiO_2	>80°
Ti, TiN	Cl_2-(optional $SiCl_4$)	>200nm/min	<±5%	>1:1 to PR >2:1 to SiO_2	>88°
W, TiW	SF_6-CHF_3	>100nm/min	<±5%	>2:1 to PR >4:1 to SiO_2	>85°
Au*, Cu*	Ar-Cl_2	>150nm/min	<±5%	>0.8:1 to PR mask >1.5:1 to SiO_2 mask	>70°
Pt*, Pd*, Ag*	Ar-Cl_2	>100nm/min	<±5%	>0.5:1 to PR mask >1:1 to SiO_2 mask	>70°
Ni*, NiFe*, NiCr*, Ru* [2]	Ar-Cl_2	>40nm/min	<±5%	>0:3 to PR mask >0.5:1 to SiO_2 mask	>65°
Co*, CoFe*, FeGa*, IrMn*	Ar-Cl_2	>20nm/min	<±5%	>0:2 to PR mask >0.4:1 to SiO_2 mask	>60°
YIG	Ar-CHF_3	>10nm/min	<±5%	>0.8:1 to Cr mask	>60°

[1]HBr is not strictly essential but helps improve selectivities and sometimes profile
[2]We have no experience of ICP etching of Ru at OIPT. However literature reports suggest it can be chemically etched with an O_2-Cl_2 chemistry (e.g. "Anisotropic etching of RuO_2 and Ru with high aspect ratio for gigabit DRAM", Yunogami and Nojori, JVST B 18(4), pp1911-14, Jul/Aug 2000).
[3]MRAM stacks of metals are also possible

RIE-mode (ICP power set to zero)

Material	Gases	Etch rate	Uniformity	Selectivity	Profile
Al, AlSiCu	$SiCl_4$	>50nm/min	<±5%	>1.5:1 to PR >4:1 to SiO_2	>85°
Cr	Cl_2-O_2	>10nm/min	<±5%	>0.5:1 to PR >20:1 to SiO_2	>80°
Ti, TiN	Cl_2	>40nm/min	<±5%	>1:1 to PR >2:1 to SiO_2	>85°
TiW, W	SF_6-CHF_3	>100nm/min	<±5%	>2:1 to PR >4:1 to SiO_2	>80°
Au*, Cu*	Ar-Cl_2	>30nm/min	<±5%	>0.8:1 to PR mask >1.5:1 to SiO_2 mask	>70°
Pt*, Pd*, Ag*	Ar-Cl_2	>5nm/min	<±5%	>0.5:1 to PR mask >1:1 to SiO_2 mask	>70°
Ni*, NiFe*, NiCr, Ru* [2]	Ar-Cl_2	>2nm/min	<±5%	>0:3 to PR mask >0.5:1 to SiO_2 mask	>65°
Co*, CoFe*, FeGa *, IrMn*	Ar-Cl_2	>1nm/min	<±5%	>0:2 to PR mask >0.4:1 to SiO_2 mask	>60°
YIG	Ar-CHF_3	>0.5nm/min	<±5%	>0.5:1 to Cr mask	>50°

*Metal features etched with a sputter based processes (such as Ag, Au, Cu, Ni, Pt and Ru) cannot be guaranteed to be free of redeposition or profile trenching.