COLUMBIA UNIVERSITY

IN THE CITY OF NEW YORK

COLUMBIA NANO INITIATIVE / CENTER FOR INTEGRATED SCIENCE AND ENGINEERING

CNI Shared Labs Equipment List (detailed version)

For more information please contact:
Dr. Nava Ariel-Sternberg, *na2661@columbia.edu*
or cnilabs@columbia.edu

Last updated: March 8, 2023

Thin Film Deposition, Anneal, and Growth:

Equipment name	Description	Image	Location
Edwards BOC/Auto 306 Thermal Evaporator	Thermal deposition of various materials. Now open for various materials including: Ti, Al, Cr, In, Pd, and more. The evaporator vacuum is obtained using a direct drive mechanical pump and turbomolecular pump; ultimate vacuums attained are in the mid 10-8 torr range. The deposition rate is monitored by a calibrated frequency thickness monitor; the power supply to apply current for evaporation is manually controlled. The system was upgraded early 2018 to an automatic deposition control and graphic user interface.		CNI Clean room, CU
Cressington 108 Manual Sputter Coater	The 108 Manual Sputter Coater is a simple system for coating non-conducting samples with Au-Pd for standard SEM imaging. A fine-grain layer can be achieved with a very efficient low voltage DC magnetron head with negligible sample heating. The coater has fully variable current control, digital process timer with "pause", variable height specimen table, hinged top plate and O-ring sealed vacuum chamber.		CNI Clean room, CU

Oxford PlasmaPro NPG80 PECVD	The PlasmaPro®NGP80 is a modular plasma processing system, configured to carry out plasma enhanced chemical vapor deposition (PECVD). Process gases are then supplied to the aluminum chamber from a gas pod and radio frequency (RF) power is used to create a plasma. The deposition can be controlled by altering the plasma power and (high/low) frequency conditions, the source gas for the plasma, the vacuum pressure, the substrate temperature, and other parameters. The system can be used to deposit amorphous silicon, SiO_2 or Si_3N_4.		CNI Clean room, CU
Angstrom EvoVac Multi Deposition System	Angstrom Engineering's EvoVac system allows substrate coating several deposition techniques within the same machine: Thermal Resistive Evaporation with two resistively heated evaporation sources which can deposit simultaneously or along with the electron beam source, Electron Beam Evaporation with 6 pockets for 12cc crucibles metal deposition including high melting point materials and ceramics. Sputter deposition with two 3in circular sources sharing a 600W RF power supply for metals and ceramic deposition. Sputtering of magnetic materials is possible. Substrate capability of up to 6in or chips and can be temperature control of ambient to 400ºC. System contains a Load Lock and plasma pre clean is optional. 6"		CNI Clean room, CU

	wafer coating dome is available to use upon request.		
Angstrom Nexdep UHV e-Beam evaporator	E-beam evaporator with a 16”x16”x28” size stainless streel chamber. Base pressure is as low as < 3×10^{-9} Torr achieved with a cryo pump. The system is equipped with a load lock with high vacuum (turbo) pumping. Telemark series 6kW (10kV-600mA) power supply with 6x15cc crucibles. In situ QCM film thickness measurement. The 4” substrate compatible chuck can be heated with a quartz lamp to 600 °C.		CNI Clean room, CU
AJA Orion 8 Dielectric Sputtering system	This system consists of two 2” magnetron sputtering guns, 300W RF generator, auto matching network and additional pulsed DC power supply. Substrates of up to 4” in size can be coated. The 4” substrate compatible chuck can be heated with a quartz lamp and the substrate can be biased for pre-clean or reactive sputtering. System contains a load lock and is dedicated to dielectric film sputtering. Materials available: Al_3Nx, TiN, Si, ZiO, Al_2O_3, SiOx. Other materials may be possible upon request.		CNI Clean room, CU

AJA Orion 3 Metallic Sputtering system	This system consists of 1 4” magnetron sputtering guns. Substrates of up to 4” in size can be coated. The 4” substrate compatible chuck can be heated with a quartz lamp and the substrate can be biased for pre-clean or reactive sputtering. System contains a load lock and is dedicated to metal film sputtering. Materials available: Undoped Si, W, Ti, Cr, Al. Other materials may be possible upon request.		CNI Clean room, CU
ALD, Cambridge Nano Tech Inc. Savannah 200	The Atomic Layer Deposition (ALD) creates alternate, saturated, chemical reactions on the surface, resulting in unique self-limiting growth with high level of conformity, uniformity, repeatability and accurate thickness control. Precursors, in the liquid phase, are pulsed sequentially in an N_2 carrier gas through a heated substrate, with a purge time between the pulses to prevent vapor phase reactions. Typical growth rate is less than one molecule layer / deposition cycle. Materials available: TiO_2, Al_2O_3 and HfO_2.		CNI Clean room, CU

Expertech LPCVD CTR-125 thermal reactor	A diffusion 4 tube furnace allowing for the highly control growth of thermal wet/dry oxidation, LPCVD Si3N4, LPCVD SiO_2 as well as forming gas anneal. Quartz and SiC process tube and boats available for 100mm substrates with three heating zones water cooled and 50 wafer capacity. Gases available are N_2, H_2, O_2, NH_3, N_2O, and C_2H_4. The furnace is a metal free tool other than the annealing tube which is open for metal (metal free anneal can be done in the oxidation tube).		CNI Clean room, CU
Solaris 100 Rapid Thermal Anneal (RTA)	The Rapid Thermal Anneal (RTA), Solaris 100 system performs short thermal treatments at temperatures of up to 1,100C for periods of up to 2 min. Heating is performed by a quartz lamp at a rate of up to 50C per second. Nitrogen or oxygen environment are available.		CNI Clean room, CU

Photo and e-beam lithography:

Süss MicroTec MA6 Mask Aligner	The MA6 is designed for standard lithography applications with full field exposure. Proximity, soft/hard and vacuum contact exposure modes are available, giving down to sub-micron resolution in vacuum contact mode. A wafer leveling and gap calibration system offers precise parallelism to the mask. Motorized Top Side Alignment (TSA) provides alignment accuracy of ±0.5 µm. The light source is a 300 W Hg arc lamp (280-350 nm) and is controlled by a Suss CIC 1200 unit, which monitors lamp intensity and life. The system can process wafers and pieces up to 6”.		CNI Clean room, CU
Süss MicroTec DUV MA6 Mask Aligner	The DUV MA6 is designed for all standard lithography applications and is equipped with Suss micro-optics lenses to minimize aberrations. A 1000W Hg lamp (controlled with a CIC 1200 unit) and bandpass filters allow DUV exposures at 248 nm in addition to standard i- and g-line lithography. The system exposes samples from small pieces to 6” wafers and is equipped with motorized top- and backside alignment as well as a video camera-based microscope.		CNI Clean room, CU

Heidelberg DWL 66+ Laser Writer – 600 nm	The fully automated 405 nm laser mask writer uses a laminar-flow environmental chamber for high writing precision. The system is equipped with a 2 and 5 mm write head with writing resolution of 0.6 and 1.0 micron resolution, respectively and has an interferometer-controlled stage. The DWL 66+ accepts design formats of DXF, CIF, GDSII, and Berber files.		CNI Clean room, CU
Heidelberg µPG 101 Laser Writer – 3 micron	Table top simple to use laser writer for micropattern mask generation of 3 µm resolution. ~30mm^2/min writing speed, address grid of 100 nm, and edge roughness of ~200 nm. Max write area is 100x100 mm^2.		CNI Clean room, CU
Reynoldstech litho/solvents hoods	Three solvent hoods provide lithography and other wet-chemical processing capability (e.g. lift-off, development). Hoods contain three programmable spin coaters. Three programmable Electronic Micro Systems vacuum hotplates give enhanced wafer thermal uniformity during photoresist baking. The hoods contain built-in heated water baths and ultrasonicators.		CNI Clean room, CU

Laurell Spin Coater	Spin coater made of natural Polypropylene (NPP). Various sizes chucks can be purchased in the clean room office. Real-time display of all program functions. This system is now designated for non-standard ("dirty") materials which are not allowed in the litho hoods (e.g. PDMS etc.).		CNI Clean room, CU
Nanobeam nB4 Electron Beam Lithography	The Nanobeam nB4 is Gaussian round-beam vector-scan electron beam lithography system that uses a step-and-repeat method for nanopatterning. The system operates at accelerating voltage of 80 kV, and has a 10-chuck cassette. The various chucks accept small chips to 180-mm wafers. The beam current can be changed to achieve optimal writing resolution (~15 nm) or faster writing speed.		North West Corner, 705 suit, CU

Yield Engineering Systems (YES) Vapor Priming System (HMDS).	The YES (Yield Engineering Systems) Vapor Priming System is used to prepare substrates for optimal photoresist/electron beam resist coating. The instrument de-hydrates surfaces and deposits an ultra-thin coating of hexamethyldisilazane (HMDS) molecules from the vapor phase, which bond strongly to silicon oxide surfaces. The methyl groups in the tail portion of the molecule produce a stable hydrophobic surface that is ideal for uniformly applying photoresist.		CNI Clean room, CU

Blue M Oven	The oven is available to use in the litho area with mostly nitrogen atmosphere. The max temperature available is 150C.		CNI Clean room, CU
Thermo Fisher Vacuum oven	The oven is available to use in the litho area with nitrogen atmosphere or vacuum. The max temperature available is 300C.		CNI Clean room, CU

Dry and Wet Etching, Cleaning:

Oxford PlasmaPro 80+ (ICP)	Inductively Coupled Plasma (ICP) with a low frequency and a high frequency supply allowing high density plasmas to process substrates at low bias which yields high throughput and low damage to the substrate. The etch process can be tuned by gas flow rates, chamber pressure, coil power etc. Biasing of the substrate is used to tailor ion bombardment energies and tune the degree of anisotropy of the etch features. Process recipes can be written while system is in the operate mode and can be run automatically. Typical materials etched by this system include: SiN, SiO2, Si, and metal masked materials. This machine is a new (replaced April 2022) version of the ICP PlasmaLab80 with a new PLC and turbo, as well as closed coupled MFC allowing for Bosch silicon etch. Other materials etched that can be etched using this machine include: SiN, SiO2, Si, metal masked materials, and more. Available gases are: SF6, C4F8, CHF3, O2, and Ar.		CNI Clean room, CU

Anatech Plasma Asher	The Anatech plasma asher is capable of providing O2 and/or Ar plasma for removal of organic materials from substrate. The tube chamber internal dimensions are: 10” x 18”. Powerful RF generator of 1000 W, 13.56 MHz with automatic RF tuning network for RF load impedance matching. Common uses include de-scumming of resist from exposed surfaces before etching or metallization, or the cleaning of substrates to remove stubborn resist deposits.		CNI Clean room, CU
Diener Plasma Etch System	This system uses two types of plasma: O2 plasma and forming gas. It can be used for plasma etching, ashing (descum), or cleaning, as well as H_2 saturation. The etching process can be controlled by pressure, power, process time, gas flow and gas composition.		CNI Clean room, CU

Oxford Plasma Pro System100 Cobra III-V ICP-RIE (Cl-RIE)	Designed for III-V etching this new ICP-RIE system utilizes Cl2 and BCl3 chemistries as well as O2, CF4, CH4, and H2 in an aluminum chamber. 300kW, 13.56MHz RF generator for lower electrode, with a 300mm diameter ICP source coupled with 3kW 2 MHz RF generator. System can etch substrates up to 4" in diameter, as well as pieces (mounted on a carrier).		CNI Clean room, CU
Oxford Plasma Pro System 100 Cobra (F-RIE)	This system used Fluorine based chemistry to etch silicon, SiO_2, and Si_3N_4, in high aspect ratios and etch rates. Process gases include: C_2F_6, CH_2F_2, CF_4, CHF_3, C_4F_8, SF_6 and O_2. 300kW, 13.56MHz RF generator for lower electrode, with a 300mm diameter ICP source coupled with 3kW 2 MHz RF generator. Software add-ons and a close coupled SF6 and C4F8 MFC pair allow for a licensed Bosch anisotropic silicon etch processes. The system is kept clean from contaminants such as: Au, Ag, and Cu. The system can etch substrates up to 4" in diameter as well as pieces (mounted on a carrier).		CNI Clean room, CU

RCA Hood	RCA hood is a designated wet chemical processing station to perform the cleaning process developed by Werner Kern in 1965 at the Radio corporation of America (RCA). It is intended to remove light organic contamination, metal ions, to prevent contamination and short threat to devices. It includes an SC1 Clean with Ammonium Hydroxide, Hydrogen Peroxide and water, SC2 Clean with a mixture of Hydrochloric acid, Hydrogen Peroxide and water, and hydrofluoric (HF) acid dip to remove the oxide grown by the hydrogen peroxide and native oxide on silicon wafers. It is generally used before thermal oxidation and LPCVD processes.		CNI Clean room, CU
General Acid/Bases Hoods	The general acid/base hoods are equipped with temperature controlled baths for wafer assisted heating of chemicals for specific etch processes.		CNI Clean room, CU

Spin Rinse Dry Station (SRD)	This station is for cleaning, rinsing and drying wafers after wet processing using DI water and clean nitrogen. The SRD station can process 4” wafers.		CNI Clean room, CU

Metrology and Characterization:

P17 KLA profiler	2D & 3D profiling, roughness, and stress map. The system offers a programmable scan stage, low noise, and sub-angstrom electronic resolution throughout the vertical range, enabling high resolution scans across the entire sample surface. The stage is 200mm allowing for 200mm wafer scans without stitching. Top and side view optics enable easy site teaching, pattern recognition, and visualization of the stylus during a measurement. Constant force control from 0.3 to 50 mg. Vertical range up to 1 mm, 200 mm scanning stage, 5 megapixel video camera with top and side viewing.		CNI Clean room, CU
UVOzon Clean	Used for cleaning or surface activation. A UV lamp irradiates light at 185 and 254 nm. In the case of organic materials, chain scission of molecules happens and organic contaminants are gently removed from the substrates as volatile byproduct such as CO_2, H_2O and O_2.		CNI Clean room, CU

Optical profilometer, Wyko NT9100	The Wyko NT9100 Optical Profile employs coherence scanning interferometry, also known as white-light interferometry, white-light confocal, or vertical scanning interferometry to produce high quality three-dimensional topography and film thickness surface maps of the object under test without any contact.		CNI Clean room, CU
Optical Microscope	Nikon Eclipse LV100ND Microscope with objectives of up to x100. Bright field and dark field (transmission) and a Nikon DSRi2 Color Digital Camera. Differential interference contrast (DIC) imaging provides enhanced image contrast for topographically-varied samples.		CNI Clean room, CU
Filmetrics	Microscope-based thin film measurement system for C-Mount UV with int. video, UV source, 100um and 250um apertures.		CNI Clean room, CU

Agilent 8453 UV/Vis Spectrophotometer	Measures optical absorbance in the 190-1100 nm wavelength range. Samples are typically loaded as aqueous/organic solutions in 1cm quartz or plastic cuvettes, but other configurations are possible. A sample thermostat is also available for temperature range of 10-100°C.		Havemeyer 224, SMCL, CU
Agilent SuperNova SCXRD	A single crystal X-ray diffractometer to determine full crystal structures of organic and inorganic solids. Dual (Cu/Mo) microfocus X-ray sources are usable for crystals down to ~10-20 um size. Absolute configuration can be determined even for light atom structures. Nitrogen cryostream for temperature control between 90-400 K. Assistance with crystallography is available.		Havemeyer 544, SMCL, CU

Bruker Dimension FastScan AFM	This is a highly automated, multimode system for high resolution scanning of large samples. Scan areas up to 40 um are typical with in-plane resolution of 2-10 nm and height resolution < 1 nm. Topography imaging is typically performed in tapping mode using Bruker's ScanAsyst technology. Numerous advanced modes are also available. Electrical characterization can be performed in Kelvin probe and conductive modes; phase contrast and nanomechanical measurements are also possible.		Havemeyer, SMCL, CU
Malvern Zetasizer Nano-ZS	This system is measuring particle size, molecular weight, and zeta potential for organic and aqueous colloids, nanoparticles, and proteins. Dynamic light scattering (DLS) measurements are possible for samples as small as 12 uL; the optimal size range is 10-1000 nm particles. Zeta potential measurements require approximately 0.5 mL.		Havemeyer 224, SMCL, CU

PANalytical XPert3 Powder XRD	This powder diffractometer is typically used in the Bragg-Brentano geometry for Phase identification, particle size/strain analysis, preferred orientation measurements, and Rietveld refinements. The system consists of a 3 kW Cu X-ray source, vertical goniometer (theta-theta) and a PIXcel 1d position-sensitive detector for rapid measurements. An Antron-Paar TTK 450 stage allows for measurements in the -173 to 400°C range. Typical samples are approximately 50 mg, but small and/or air-sensitive samples can also be measured.		Havemeyer 54, SMCL, CU
Phi 5500, XPS	This XPS system is used for thin film surface analysis. Al and Mg x-ray sources are available. An ion gun (Ar, Xe, He) is used for in-situ sputtering, for pre-cleaning the surface and for depth profiling (typical rate is 2-5 nm/min). SIMS measurement is also available on this system.		Havemeyer 544, SMCL, CU

Renishaw inVia micro-Raman spectrometer	In this system samples are excited by 405, 532, 633 or 785 nm lasers. Laser spot size is ~1 µm and spectral resolution is about 1 cm^{-1}. Signals can be measured within 100 cm^{-1} of the laser wavelength. Linearly and circularly polarized excitation are possible for the green (532 nm) and red (633 nm) incident beams. Confocal measurements and 2-dimensional mapping (single wavelength or full spectrum) are also possible.		Havemeyer, 542, SMCL, CU
TA Instruments Q500 TGA	The Q500 is a research-grade thermogravimetric analyzer. The system consists of a low mass furnace with a rapid, precise temperature and rate programming. Analysis is performed on samples from 10 mg to 1 g at temperatures between ambient and 1000 °C. Air, oxygen, nitrogen and CO_2 atmospheres are available.		Havemeyer, 544, SMCL, CU
Woollam Alpha-SE Ellipsometer	Ellipsometry is used to determine a film's thickness and optical constants by measuring changes in polarization. An easy to use, white-light, single-angle system for simultaneous measurements of thin film thickness and refractive index. Film thickness between 1 nm – 5 µm can be measured.		Havemeyer 224, SMCL, CU

Variable Angle Woollam Ellipsometer	Ellipsometery measures changes in light polarization to determine a film's thickness and optical constants. The VASE system allows continuous adjustment of the angle of incidence. The system is equipped with a Si/InGaAs detector as well as an extended IR detector.		Havemeyer 224, SMCL, CU
Glove box 2D materials processing	A glove box for device assembly and characterization in an inert environment containing less than 3 ppm oxygen and 1 ppm water. Two autofinders (microscope equipped micromanipulator stations) for locating and transferring flakes of 2D materials. A Horiba XploRA Micro-Raman with 532 nm laser and computer-controlled stage is available for insitu characterization of the created stack.		Havemeyer 544, SMCL, CU
Brunauer–Emmett–Teller (BET), Micromeritics ASAP 2020 plus	The ASAP 2020 Plus is a high-performance adsorption analyzer for measuring surface area, pore size, and pore volume of powders and porous materials. Standard methods or user customized protocols can be used to characterize adsorbents, catalysts, zeolites, MOFs, APIs, excipients, and a wide variety of porous and non-porous materials. The ASAP 2020 Plus is ideally suited for gas adsorption analysis of microporous (0.35 to 2nm) and mesoporous (2 to 50nm) materials and delivers superior accuracy, resolution and data reduction.		Havemeyer, 224, SMCL, CU

	The system is equipped with an ISO Sub-ambient temperature controller which utilizes thermoelectric cooling based on the Peltier principle. The unit is designed to maintain a constant temperature between -5 °C and 80 °C when using CO2, N2, and other gases for adsorption analysis. The device rapidly cools and efficiently maintains temperature with minimal electrical current required.		
Agilent 1260 Infinity GPC	The Agilent 1260 Infinity is used for gel permeation chromatography analysis of polymers. Typical sample concentration is 0.1-10 mg/mL, and 50 uL of solution is required. A fraction collector is included for the isolation of sub-mg quantities of fractionated polymer. The typical solvent is THF or chloroform, but others are available upon request. The columns are maintained at 40 C. Molecular weights from 100 Da to 500kDa can be analyzed.		Havemeyer 544, SMCL, CU

EcoSEC RI-UV GPC	The EcoSEC RI-UV GPC is used for gel permeation chromatography analysis of polar organic-soluble polymers. The EcoSEC is operated in DMF containing 0.01 M of LiBr. Refractive-index and single-wavelength UV/visible absorption detectors are available. Typical sample concentration is 0.1-10 mg/mL, and 0.5 mL of solution is required. A mixed-bed column permits the analysis of molecular weights from 100 Da to 1.5 MDa.		Havemeyer 544, SMCL, CU

Backend and Packaging:

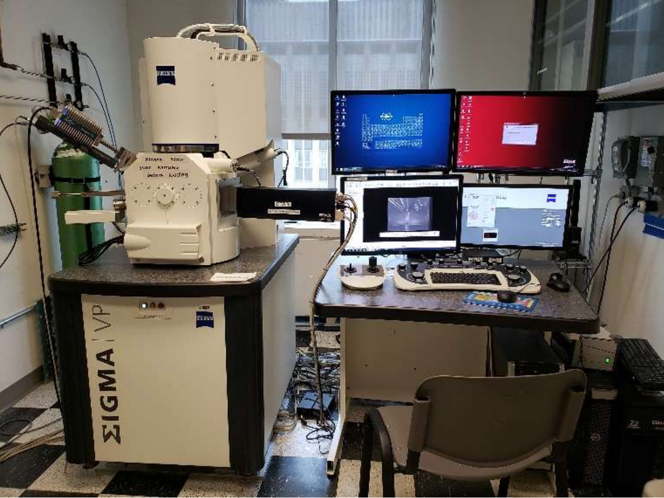
Bal-Tec Critical Point Dryer 030	Critical point drying is a method to dry samples (used mostly in MEMS/NEMS or biological applications). The water is replaced by liquid CO_2 which is then released from the sample at the critical point of liquid/gas temperature and pressure. The result is a safe drying procedure without any residual surface tension. The pressure chamber is made of stainless steel. Sample chamber is 40 mm in diameter and 36 mm in height. The solvent content is ~70 ml. The system is designed to cool the pressure chamber in the range from +2°C to +12°C. The cool down time is ~ 2C/min.		CNI Clean room, CU
Semi-automatic wire bonder	This new semi-auto wire bonder is capable of Ball (15-50um), Wedge (17-75um), Bump, and Ribbon (max 25x250um) Bonding. It has the options of Au, Al, Cu, and Ag wires. The Z-axis is motorized. X-Y are manual.		CNI Clean room, CU

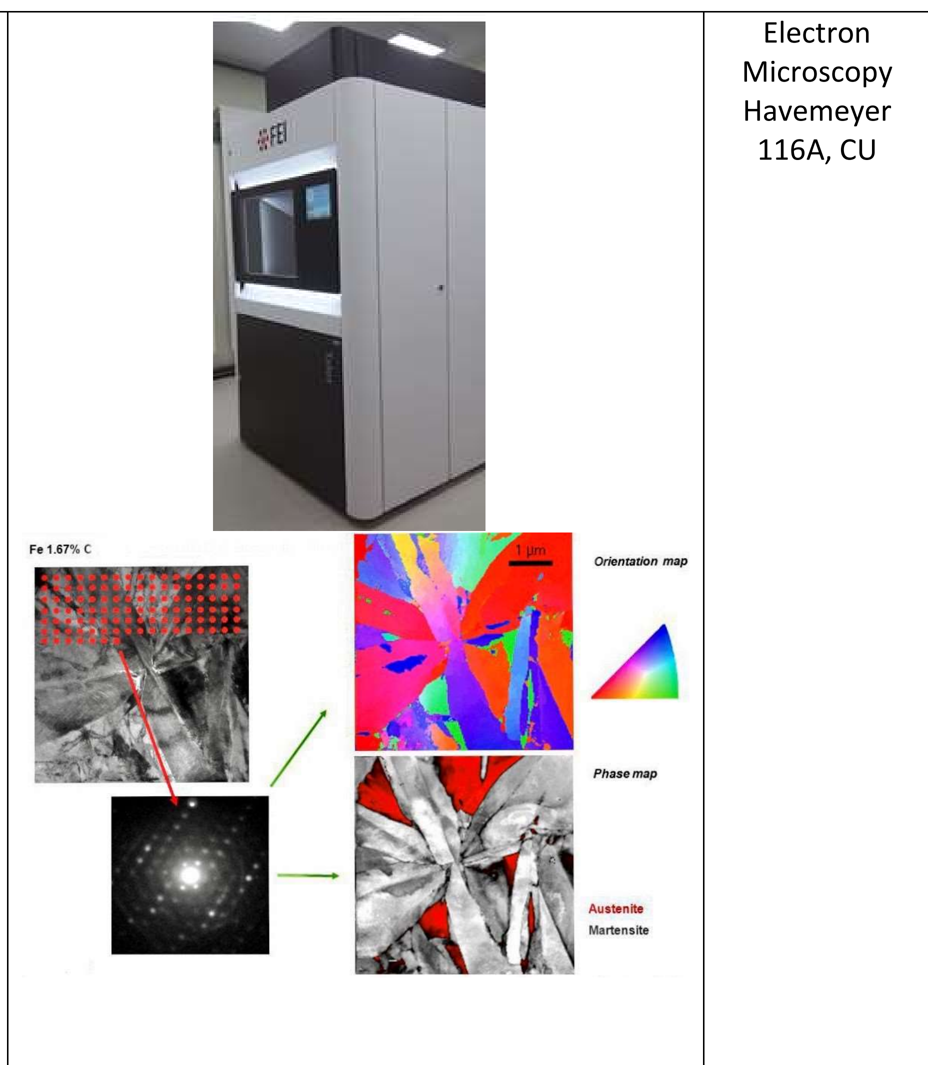
Dicing Saw - Disco DAD3220	The DAD3220 is a single spindle dicing saw capable of handling wafers and pieces up to a maximum of ø6" or 6" square workpiece with a user-programmable specified recipes. The cutting range is 160 mm over 162 mm, cutting speed is 0.1-500 mm/sec. The Spindle output is 1.5 kW. Standard blade (supplied by the clean room) can be used for silicon. Other blades can be purchased upon request.		CNI Clean room, CU
Chemical Mechanical Polishing – POLI 400L G&P.	Nikon Eclipse LV100ND Microscope with objectives of up to x100. Bright field and dark field (transmission) and a Nikon DSRi2 Color Digital Camera. Differential interference contrast (DIC) imaging provides enhanced image contrast for topographically-varied samples.		CNI Clean room, CU

SCS Parylene coater, PDS 2010	Parylene polymer deposition takes place at the molecular level where the dimer, is heated under vacuum and vaporized into a dimeric gas then transferred to its monomeric form and deposited on the substrate. The process is performed at room temperature. Parylene coating provides complete and uniform encapsulation. Typical thickness is in the microns range.		CNI Clean room, CU

Electron Microscopy and sample preparation:

Nova Nano FE SEM 450 with Nabity Nano Pattern Generation System (NPGS) e-beam lithography	HR FEG ultra high brightness field emission source. Two mode lens with immersion (high resolution by increasing NA>1) and free operation (undistorted low mag imaging). Directional Back Scatter (DBS) detector included for both topographic and phase information, 5-axes motorized x-y-z-tilt=rotate stage with X=y=110 mm, Z=25 mm, tilt= +75deg to -15 deg, and eucentric tilt. High vacuum imaging resolution at 30kV is 0.8 nm. Environmental mode of imaging (for isolating or biological samples) is available. Nanometer Pattern Generation System for Electron Beam Lithography is installed allowing for e-beam writing and imaging.		CNI Clean room, CU

Carl Zeiss Zigma VP FE SEM	The Zeiss Zigma is a high performance variable pressure scanning electron microscope, featuring the GEMINI column with electromagnetic/ electrostatic objective lens system (80º conical final-lens) and water cooling for best thermal stability and reproducibility, designed for analytical applications. Resolution of 1.3 nm at 20 kV, acceleration voltage of 0.1-30 kV, magnification of 12x-1Mx. Motorized 5 axis stage. The microscope is equipped with a Quantax 200 EDS system with a Bruker XFlash® 6|30 detector and silicon drift detector (SDD) with solid angle of 30 mm^2. Elements detectable are Beryllium to Americium (Z = 4 to 95). ESPIRIT 2 software package in this system provides spectrum quantification, line scan and elemental mapping. In addition since 2019 the microscope is also equipped with an EDAX TEAM™ EBSD Hikari Plus detector, OIM Analysis™ v8 software for phase and crystallographic orientation at high resolution, high data collection rate (1000 indexed points per second) and high precision (0.1deg). Another remotely connected analytical computer is added to the setup for processing EBSD data, remotely.		CEPSR 1016, CU

FEI Talos F200X Transmission/Scanning Transmission Electron Microscope (S/TEM)	FEI Talos combines high-resolution S-TEM (scanning) and TEM imaging with energy dispersive x-ray spectroscopy (EDS) signal detection and chemical characterization with compositional mapping. Max (default) accelerating voltage is 200 kV, with additional configuration of 80 kV which is available for studying softer or biological materials. X-FEG field emission source provides high brightness with total beam current of >50 nA; Al 200 kV, TEM point resolution is 0.25 nm and the magnification range is 25 x – 1.5 Mx. S-TEM mode combines with the Bruker Esprit software for drift corrected EDS elemental analysis (i.e. elemental maps quantification). In this instrument, STEM high angle annular dark field (HAADF) resolution is 0.16 nm, EDS solid angle (srad) is 0.9. This instrument can be fully operated remotely. The microscope is equipped with the NanoMEGAS ASTAR mapping technique that is able to characterize materials (by recording their diffraction patterns) with 2 nm resolution (with precession off) and 4 nm resolution (with procession on) for phase and crystallographic orientation. An additional computer is available for data processing remotely.		Electron Microscopy Havemeyer 116A, CU

Light Zeiss Axioscope A1	High performance optical microscope with 5 objective lenses from 5x-100x, integrated imaging system (software and camera), variable stage movements. LED transmitted light and fluorescence light sources located on the top (reflective) and the bottom (transmissive).		Electron Microscopy Havemeyer 116A, CU
Zeiss stemi DV4 light microscope	Optical microscope with backside lighting to assist with TEM sample preparation (allows to assess the thickness of silicon sample by the brightness of red appearance of the samples below 25 µm).		Electron Microscopy Havemeyer 116A, CU
Buehler Diamond Saw model 11-1280-160	Slices samples for further thinning as part of the sample preparation for TEM. Diamond blade and ceramic blades are available for cutting very hard/brittle and semi-hard materials.		Electron Microscopy Havemeyer 116A, CU

Gatan Dimple Grinder 656	Creates a dimple in the thinned sample for a thinner central area and mechanical stability. Grinding wheels and polishing wheels are 10, 15, and 20 mm in size. Grinding can be set by dimple depth or by final specimen thickness. After thinning, the sample can be further polished by ion-polishing system.		Electron Microscopy Havemeyer 116A, CU
South Bay Technology Polisher 910	Polishing TEM samples with several levels of grit pads. Clear sample mounting stubs and SiC abrasive grinding/polishing papers with various grading are available.		Electron Microscopy Havemeyer 116A, CU
Gatan PIPS II 695	Precise Ion Polishing System uses a focused Ar ion beam to precisely mill TEM samples close to or until a hole is created in their thinned area. The voltage can be tuned between 100 V-8kV to prevent damage to the sample. This instrument uses two ion-guns located at 120° from each other and can polish a 0.5 mm area.		Electron Microscopy Havemeyer 116A, CU

Gatan Solarus Plasma Cleaner 950	The plasma cleaner is using Ar, O_2 and H_2 plasma to clean TEM samples prior to inserting them into the microscope. The system is coupled with a H_2 generator.		Electron Microscopy Havemeyer 116A, CU
Sorvall Dupont Ultra Microtome MT-2B	The microtome is used in combination with diamond knife to cut sections of resin embedded samples between 80nm and 1000nm thick to prepare bio TEM samples for imaging. Both diamond and glass knives are available.		Electron Microscopy Havemeyer 116A, CU