Category	Tool	Description	Location	Tool Usage Standard Rate $/Hour	Tool Usage Reduced Rate $/Hour	Minimum Usage Charge $
Lithography	JEOL E-beam JBX 6300-FS	Directly pattern a variety of substrate materials with feature sizes as small as 10 nm. 2 nm spot size, 50 MHZ write speed, 200 mm loadable.	E	400	216	216
	JEOL E-beam JBX 6300-FS	Directly pattern a variety of substrate materials with feature sizes as small as 10 nm. 2 nm spot size, 50 MHZ write speed, 200 mm loadable.	C	422	228	228
	ASML Stepper PAS 5500/275	High throughput 5x projection I-Line lithography; < 300 nm resolution; 3D backside alignment, 200 mm loadable, 22 mm x 27 mm field size.	C	324	175	88
	ASML Stepper PAS 5500/275 Design Station	Provides ability to load jobs outside of cleanroom.	C	130	70	18
	Nanonex NX-2000 Nano-imprinter	UV and thermal large area imprint, features down to 10 nm.	C	180	97	49
	Heidelberg DWL-2000 Laser Writer	Less than 1 um resolution, greyscale writing modes,backside alignment capable, direct substrate write or mask exposure.	C	126	68	34
	Heidelberg MLA-150 Maskless Aligner	Maskless aligner, 1 um resolution, up to 200 mm substrate.	C	83	45	12
	Suss MA6 Contact Lithography	I or G line contact exposure with front and back side alignment, 1 um resolution, up to 150 mm substrate.	C	80	43	11
	Suss MA8 Contact Lithography	I or G line contact exposure, 1 um resolution, up to 200 mm substrate.	C	80	43	11
	Suss Microtec Delta12AQ Resist Developer	Automated photoresist developer station which supports temperature controlled spray photoresist development on substrates up to 200 mm.	C	93	50	13
	Suss Microtec ACS200 Resist Coater	Automated photoresist coat and bake station with cassette-to-cassette operation on substrates up to 200 mm. Supports spray coating and spin coating processes.	C	93	50	13
	CEE Apogee Spinner; A102, A103, A104	Uniformly apply and bake photoresist on substrates ranging from 200 mm diameter wafers down to small pieces.	C	43	23	6
Physical Vapor Deposition	4Wave Cluster Sputter System	Physical deposition capability using the ion beam deposition or biased target deposition techniques resulting in the densest available thin films deposited at room temperature on substrates up to 200 mm.	C	180	97	49
	Denton Discovery 550 Loadlock	RF and DC sputtering of over 30 metal and dielectric targets provided, magnetically enhanced gun, up to 600 W, heated stage to 350 °C, co-sputtering available, wafer pre-sputter, oxygen and nitrogen available for reactive sputtering. Loadlock for fast cycling.	C	163	88	22
	Denton Infinity 22	Thermal and E-beam evaporation of over 30 metal and dielectric sources provided, co-evaporation available, ion assist, ion wafer clean, fast cycle under 30 minute pumpdown.	C	128	69	35
	Denton Bench Top Turbo	The compact thermal evaporator system is used to coat electron-beam resists with thin conductive, charge dissipation, Aluminum layer on substrates ranging from small pieces up to 100 mm.	C	128	69	35
	Speciality Coatings PDC-2012 Parylene Deposition	Parylene N or C only, thickness to tens of microns.	C	130	70	35
Chemical Vapor Deposition	Oxford FlexALRPT Atomic Layer Deposition	Thermal and plasma ALD Processes for platinum, silicon oxide, aluminum oxide, titanium oxide, and halfnium oxide, up to 200 mm substrates.	C	143	77	39
	Plasma-Therm Versaline High Density PECVD	Low temperature deposition of oxide, nitride and amorphous silicon thin films, up to 200 mm substrates.	C	135	73	37
Dry Etch	SPTS Omega c2L Deep Silicon Etcher	High aspect ratio deep silicon etching on wafers up to 200 mm. "Bosch" process capability with higher etch rates and smoother feature sidewalls.	C	159	86	43
	Unaxis Shuttleline Deep Si Etcher	Bosch process capability 1 um per minute to 15 um per minute with high selectivity (> 100:1 silicon oxide, > 40:1 photoresist).	C	122	66	33
	Unaxis Shuttleline ICP Etcher	Inductively coupled plasma (ICP) chlorine and fluoring etching on substrates up to 150 mm.	C	130	70	35
	Oxford PlasmaLab 100	Chlorine or fluorine etching especially suited to III-V, metals, and anisotropic silicon etching, cryogenic and high temperature etch capability -150 °C to 400 °C, up to 200 mm wafer capable.	C	130	70	35
	Unaxis 790 RIE	Three general fluorine reactive ion etching systems for dielectrics and metals.	C	106	57	29
	4Wave Ion Mill	Argon ion milling of metals and dielectrics (150 mm wafer maximum), large 22 cm ion source provides < 1% non-uniformity, low base pressure, fast cycle, SIMS endpoint detection, reactive ion beam etch capable with oxygen and fluorocarbons.	C	126	68	34
	XeF2 Silicon Etcher	High rate silicon removal for mems release etch.	C	359	194	97
	SPTS µEtch HF Vapor Etcher	A combination of liquid hydrofluoric acid and alcohol isotropically etches silicon dioxide while not etching silicon. Substrates up to 200 mm.	C	94	51	13
	Microwave Asher	Polymer removal and surface clean.	C	81	44	11
Imaging and Analysis	FEI Titan Analytical TEM	Information Limit 0.10 nm, STEM resolution 0.14 nm, 80 kV to 300 kV, Gatan Orius 2k x 2k digital camera, Fischione HAADF STEM detector, Gatan GIF for EELS and EFTEM, EDAX EDS for elemental detection and mapping. Tomography acquisition, reconstruction, and analysis software.	E	167	90	90
	Zeiss Ultra 60 Field Emission SEM	1.5 nm resolution, 1 keV to 30 keV, Oxford EDS for detection and mapping of elements beryllium and heavier, in lens and Everhart Thornley secondary detectors, and in lens energy selective and four quad backscatter detectors, up to 150 mm wafers.	C	122	66	33
	Gemini 500 Field Emission SEM	0.5 nm resolution, 20 V to 30 kV, high efficiency in lens and Everhart Thornley secondary electron detector, and energy selective back scatter (EsB) detector for backscatter electron imaging at low voltages samples ranging from small pieces up to 100 mm wafers.	C	122	66	33
	Fischione 1040 NanoMill Low Energy Ion Mill	Low energy ion mill for final thinning of TEM specimens.	E	61	33	9
	Leica EM GP	Preparation of samples for cryo-TEM.	E	46	25	7
	Bruker Fast Scan AFM	Wafer scale AFM capability on wafers up to 200 mm for fast scanning of multiple sites on a wafer. Contact, tapping, and phase imaging modes, up to 200 mm substrates, electrostatic force microscopy, magnetic force microscopy.	C	133	72	18
	Asylum Cypher High Resolution AFM	High resolution AFM capability on wafers up to 20 mm for multipurpose research applications. Contact, tapping, and phase imaging modes, electrostatic force microscopy, magnetic force microscopy.	E	130	70	18
	Veeco Dimension 3100 Atomic Force Microscope	Contact, tapping, and phase imaging modes, up to 200 mm substrates, electrostatic force microscopy, magnetic force microscopy.	C	120	65	17
Focused Ion Beams	FEI Helios 660 Dual Beam FIB/SEM	SEM Imaging resolution < 1 nm from 1 kV to 30 kV, FIB resolution 2.5 nm at 30 kV, STEM detector, beam deceleration for insulating samples, Kleindiek in-situ probe system for nanopositioning and electrical measurement, MultiChem gas injection system supports platinum, tungsten, gold, carbon, insulator deposition and selective carbon and insulator enhanced etch, slice and view 3D reconstruction, TEM lamella prep, circuit editing, wafers up to 150 mm.	E	306	165	83
	FEI Helios 660 Dual Beam FIB/SEM	SEM Imaging resolution < 1 nm from 1 kV to 30 kV, FIB resolution 2.5 nm at 30 kV, STEM detector, integrated Oxford EDS and EBSD for detection and mapping of elements and crystallography, beam deceleration for insulating samples, gas injection system supports platinum, carbon, insulator deposition and selective carbon and insulator enhanced etch, Slice and View 3D reconstruction, TEM lamella prep, circuit edit, wafers up to 150 mm.	E	306	165	83

Category	Tool	Description	Location	Tool Usage Standard Rate $/Hour	Tool Usage Reduced Rate $/Hour	Minimum Usage Charge $
Metrology	Wyatt Dawn Heleos II DLS	Nanoparticle characterization system integrates several methods of field flow fractionation and light scattering to separate and measure nanoparticles in solution.	E	46	25	7
	Rigaku SmartLab 9kW X-Ray Diffraction	High resolution multipurpose x-ray diffractometer, 9 kW rotating anode x-ray generator, high temperature measurements up to 1100 °C in air, vacuum, and inert gas; measurements including film thickness, roughness, density, crystallographic texture, and film and crystal quality measurements.	E	141	76	38
	Sensofar Optical Profilometer	Measure height variations including step heights and roughness across a surface using light on substrates ranging from small pieces up to 200 mm.	C	134	72	18
Speciality Tools	Suss Microtec SB6e Wafer Bonder	Thermal, pressure and anodic bonding with vacuum or over-pressure condition.	E	217	117	59
	Tousimis Critical Point Dryer	Drying of high aspect ratio fragile structures on pieces up to 150 mm wafers.	C	130	70	18
	Tousimis Critical Point Dryer	Drying of high aspect ratio fragile structures on small piece samples.	C	98	53	14
	IPEC 472 CMP	Chemical Mechanical Polisher for SiO_2, Si, Au, Si_3N_4 on whole wafers 100 mm, 150 mm, and 200 mm.	E	210	105	53
	GnP 412S Wafer Cleaner	Post Chemical Mechanical Polish clean on 100 mm, 150 mm, and 200 mm substrates	E	100	50	25
Soft Lithography	Yield Engineering Silanization Oven	Silanization tool provides users the capability to automatically clean and silanize substrates for PDMS processes.	E	65	35	9
	CorSolutions Microfluidic Test Station	Integrated microfluidic station provides capability to test microfluidic devices with constant flow rate and pressure.	E	65	35	9
Furnaces	Sandvik Wet/Dry Oxidation Furnace	Pyrogenic and oxygen oxidation of silicon up to 1200 °C.	C	196	106	53
	Sandvik Anneal Furnace	Forming gas sinter, and anneal in N_2, O_2 and Ar up to 1200 °C.	C	98	53	27
	Sandvik Silicon Nitride Low Pressure CVD	Low stress and stoichometric silicon nitride deposition.	C	128	69	35
	Sandvik Polysilicon Low Pressure CVD	N-Doped and undoped polysilicon deposition.	C	141	76	38
	Sandvik Oxide Low Pressure CVD	TEOS and Low temperature oxide deposition.	C	133	72	36
	AnnealSys RTA	200 °C/s ramp rate up to 1500 °C in N_2, O_2, Ar, forming gas, 760 Torr to 5 mTorr.	C	151	81	41
Wet Chemistry	SSEC Single wafer acid spray clean tools	CMOS and general tools for RCA and Piranha clean of single substrates ranging from 200 mm diameter wafers down to small pieces.	C	50	27	5
	Microprocess Avenger Solvent Liftoff	Heated spray solvent liftoff, dry in dry out processing, substrates up to 150 mm.	C	141	76	13
Packaging	Disco 341 Dicing Saw	Wafer dicing (200 mm wafer maximum).	E	94	51	26
	K&S 4526 Wire Bonder	Manual wire bonder for electrical interconnect. Two dedicated systems for gold and aluminum wire usage.	E	126	68	34
	Tresky T-3000-FC3-HF Flip Chip Bonder	Eutectic, ultrasonic, thermal, and epoxy bonding, 1 um positioning accuracy, substrates up to 40 mm thick and 150 mm diameter.	E	139	75	38
	Dynatex GSX Scribe and Break	The GSX performs high precision diamond scribe and break dry dicing for materials such as Indium Phosphide, Gallium Arsenide, Gallium Nitride, and silicon in partial wafer pieces and substrate sizes up to 100 mm. It can be operated in an interactive or semi-automatic mode for operator controlled processing.	E	78	40	20
Access	Cleanroom Occupancy Rate	Clean room entrance fee includes gowning, most wet chemistry, and metrology including: Toho Tech FLX-2320 Laser Film Stress Measurement Firsttenangstroms FTA32 Contact Angle Goniometer Woollam XLS-100 Spectroscopic Ellipsometer Filmetrics reflectometer Bruker Dektak XT surface profilometer Four Dimensions four point probe Microscopic and Macroscopic Optical imaging and inspection Keithley 4200 Parametric test with capacitance, pulse, and high current modes.		67	36	
	Soft Lithography Lab	Dedicated tool set for soft lithography processing.		46	25	
	Processing Services Engineer	NanoFab Engineers can perform process development and run complex processes on your behalf in the NanoFab including mask layout with or without you present.		150	150	

Note: Location 'C' indicates that the tool is located inside of the cleanroom and incurs the clean room occupancy fee in addtion to the tool rate.
Location 'E' indicates that the tool is located outside of the cleanroom.

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CNST Center for Nanoscale Science & Technology

NANOFAB TOOL TRAINING RATES

Category	Tool	Typical Training Time	Individual Training Rate	Group Training Rate
		Hours	$/Hour	$/Hour
Lithography	JEOL E-beam JBX 6300-FS	6	$366.00	$183.00
	JEOL E-beam JBX 6300-FS	6	$378.00	$189.00
	ASML Stepper PAS 5500/275	6	$325.00	$163.00
	ASML Stepper PAS 5500/275 Design Station	6	$220.00	$110.00
	Nanonex NX-2000 Nano-imprinter	3	$247.00	$124.00
	Heidelberg DWL-2000 Laser Writer	4	$218.00	$109.00
	Heidelberg MLA-150 Maskless Aligner	4	$195.00	$98.00
	Suss MA6 Contact Lithography	4	$193.00	$97.00
	Suss MA8 Contact Lithography	4	$193.00	$97.00
	Suss Microtec Delta12AQ Resist Developer	2	$200.00	$100.00
	Suss Microtec ACS200 Resist Coater	2	$200.00	$100.00
	CEE Apogee Spinner; A102, A103, A104	1	$173.00	$87.00
Physical Vapor Deposition	4Wave Cluster Sputter System	4	$247.00	$124.00
	Denton Discovery 550 Loadlock	2	$238.00	$119.00
	Denton Infinity 22	2	$219.00	$110.00
	Denton Bench Top Turbo	1	$219.00	$110.00
	Speciality Coatings PDC-2012 Parylene Deposition	1	$220.00	$110.00
Chemical Vapor Deposition	Oxford FlexALRPT Atomic Layer Deposition	2	$227.00	$114.00
	Plasma-Therm Versaline High Density PECVD	1	$223.00	$112.00
Dry Etch	SPTS Omega c2L Deep Silicon Etcher	2	$236.00	$118.00
	Unaxis Shuttleline Deep Si Etcher	2	$216.00	$108.00
	Unaxis Shuttleline ICP Etcher	2	$220.00	$110.00
	Oxford PlasmaLab 100	2	$220.00	$110.00
	Unaxis 790 RIE	2	$207.00	$104.00
	4Wave Ion Mill	2	$218.00	$109.00
	XeF2 Silicon Etcher	1	$344.00	$172.00
	SPTS µEtch HF Vapor Etcher	1	$201.00	$101.00
	Microwave Asher	0.5	$178.00	$89.00
Imaging and Analysis	FEI Titan Analytical TEM	40	$240.00	$120.00
	Zeiss Ultra 60 Field Emission SEM	4	$216.00	$108.00
	Gemini 500 Field Emission SEM	4	$216.00	$108.00
	Fischione 1040 NanoMill Low Energy Ion Mill	2	$183.00	$92.00
	Leica EM GP	2	$175.00	$88.00
	Bruker Fast Scan AFM	2	$222.00	$111.00
	Asylum Cypher High Resolution AFM	2	$220.00	$110.00
	Veeco Dimension 3100 Atomic Force Microscope	2	$215.00	$108.00
Focused Ion Beams	FEI Helios 660 Dual Beam FIB/SEM	5	$315.00	$158.00
	FEI Helios 660 Dual Beam FIB/SEM	5	$315.00	$158.00
Metrology	Wyatt Dawn Heleos II DLS	6	$175.00	$88.00
	Rigaku SmartLab 9kW X-Ray Diffraction	4	$226.00	$113.00
	Sensofar Optical Profilometer	1	$222.00	$111.00
Speciality Tools	Suss Microtec SB6e Wafer Bonder	4	$267.00	$134.00
	Tousimis Critical Point Dryer	1	$220.00	$110.00
	Tousimis Critical Point Dryer	1	$203.00	$102.00
	IPEC 472 CMP	3	$255.00	$128.00
	GnP 412S Wafer Cleaner	3	$200.00	$100.00
Soft Lithography	Yield Engineering Silanization Oven	2	$185.00	$93.00
	CorSolutions Microfluidic Test Station	2	$185.00	$93.00
Furnaces	Sandvik Wet/Dry Oxidation Furnace	1	$256.00	$128.00
	Sandvik Anneal Furnace	1	$203.00	$102.00
	Sandvik Silicon Nitride Low Pressure CVD	1.5	$219.00	$110.00
	Sandvik Polysilicon Low Pressure CVD	1.5	$226.00	$113.00
	Sandvik Oxide Low Pressure CVD	1.5	$222.00	$111.00
	AnnealSys RTA	1.5	$236.00	$118.00
Wet Chemistry	SSEC Single wafer acid spray clean tools	1	$177.00	$94.00
	Microprocess Avenger Solvent Liftoff	1	$226.00	$113.00
Packaging	Disco 341 Dicing Saw	3	$201.00	$101.00
	K&S 4526 Wire Bonder	1	$218.00	$109.00
	Tresky T-3000-FC3-HF Flip Chip Bonder	2	$225.00	$113.00
	Dynatex GSX Scribe and Break	1	$190.00	$95.00
All Other Tools		Varies	$150.00	$75.00

Typical training times cover general tool operation and can vary depending on previous experience and aptitude. Application specific training beyond general tool usage will require additional training time and should be discussed with process engineer prior to training.