Open-User Facilities and Services

Available to academic, industry, and government researchers, the Institute for Electronics and Nanotechnology (IEN) labs and cleanrooms on Georgia Tech's campus offer a wide variety of processing tools and expert IEN staff support.

Partial List of Technology Areas Enabled by IEN Labs and Services			
BioMEMS Systems	Solid-State Sensors	Electronic Devices	MEMS & NEMS
Organic Electronics	Bio-Medical Devices	Simulation	Optical MEMS
IC Design	Microfluidics	Graphene & CNT	Solar Cell System
Electronic Device Packaging	Silicon Semiconductor Device Fabrication	Compound Semiconductors (III/V) Device Fabrication	

Shared User Equipment and Processing Capabilities

- Design
- Material Characterization
- Fabrication
- Process Flow Design
- Testing
- Performance Modeling
- Imaging
- Process Optimization

User Tool & Process Capabilities

Device Fabrication and Processing

- **Thin Film –** ALD, RF/DC Magnetic Materials and Co-Sputtering, Graphene, SiGe, Oxide, Dielectric, Filament, E-beam Metal Evaporation, Ink Jet
- **Coatings –** Wet and Dry, Conformal, Isotropic, & Anisotropic, thicknesses from 5µm to 50µm
- **Lithography –** Optical .5µm, E-beam 20nm, Imprint 20-40nm up to 150mm substrates/wafers
- **Wet and Dry Etch –** Semiconductor, Dielectric, III-V, Metal, Organic Materials
- **Diffusion & High Temp. Processes –** Wet/Dry Oxidation, N/P Doping, Annealing, TOS SiO_2, Low Stress Nitride, Poly-Si, a-Si, Doped a-Si, Deposition, etc.
- **Plating –** Electro & Electro-less Cu, Ni, Au, Pt, Solder, up to 150mm Substrates/Wafers

Package Assembly

- **Flip Chip –** 30µm pitch on 10mm substrates, Eutectic, Thermosonic, Thermo Compression
- **Wire Bond –** Al Wedge, Au Ball
- **Wafer-Wafer –** up to 150mm

Measurement, Test, and Characterization

- **Imaging –** SEM, TEM, AFM
- **Surface Analysis –** IONToF-SIMS, XPS
- **Failure Analysis –** FIB
- **Interface/Analysis –** CSAM, XRay, Die/Ball Shear
- **Metrology –** Profilometry, Ellipsometry
- **Reliability Testing –** -55°C to 155°C
- **Electrical Testing –** DC to 110GHz
- **Warpage Measurement –** 2µm on 150mm

Unique and High End Capabilities

- **Deep Trench; TSV DRIE Etching**
- **Graphene/CNT Growth**
- **Conformal Spray Coating**
- **Conformal Si Chemical Dry Etching**
- **Electron Beam Lithography**
- **Nano-imprinter**
- **110GHz Testing**

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Materials Processed

> **Dielectrics:** SiO_2, Si_3N_4,SiC, HfO_2, ZnO, ZrO_2, AlN, TiN, TiO_2, Al_2O_3, additional dielectrics on request

> **Metals:** Al, Cr, Ti, W, Ni, Mo, Pt, Fe, Cu, Ir, Pd, Ag, additional metals by request

> **Semiconductor:** Silicon/polysilicon (Bosch process), Silicon/polysilicon (Cl_2-based RIE, SF_6/O_2 RIE, Cl_2-based ICP) Silicon/polysilicon (cryogenic ICP), ITO

> **Nanostructures:** SW-CNT, MW-CNT, Graphene, MoS_2, SiGe Nanowires

Typical Processing Capabilities

> **Dry Etching: Semiconductor:** Silicon/Polysilicon (Bosch process), Silicon/Polysilicon (cryogenic ICP), Silicon/Polysilicon (Cl_2-based RIE, SF_6/O_2 RIE, Cl_2-based ICP), ITO; **Dielectric:** SiO_2 (quartz, fused silica), Si_3N_4 (CxFy-based ICP); **III-V:** Cl_2, BCl_3, $SiCl_4$ RIE & ICP; CH_4, H_2 RIE; HBr-based ICP; **Metals –** Al, Cr, Ti, W, Ag

> **Wet Etching:** SiO_2, Si_3N_4 Metals, Organic materials, Others upon request

> **High Temperature Processes:** Oxidation (wet & dry), Annealing, Polymer curing, Diffusion (solid-source), Drive-in, Sintering

> **Thin Films Deposition:** RF/DC Sputtering, Evaporation, ALD, PECVD, CVD, LPCVD

> **Polymer Deposition:** Parylene, Spin-coating, Spray-coating

> **Lithography:** UV Photo, Deep UV (248nm) Photo, Nanoimprint, Electron beam, Surface modification, UV laser-based, Inkjet printing

> **Plating: Electro-plating –** Cu, Ni, Au, Pt, PbSn **Electroless –** Ni, Au

> **Characterization: Microscopy:** SEM/EDX, TEM, FIB-SEM, ToF-SIMS, XPS/ESCA, UPS, XRD/XRR; Optical - Ellipsometry Reflectometry, FTIR, UV-Vis photospectrometry, Non-contact 3D profilometry, Thin film thickness, Particle sizing (DLS), Particle zeta potential, Contact angle measurement; **Other** – Surface Plasmon Resonance, Quartz Crystal Microbalance with Dissipation, Thin-film stress mapping, Elastic modulus (Nano-indentation), Atomic force microscopy

> **Packaging:** Wire bonding, Wafer bonding: Anodic Bonding/Glass Bonding, Chemical Mechanical Polishing, Flip-chip bonding Lapping, Lamination, Thermal Compressive Bonding

Key Equipment

> **High Temperature Furnaces:** Tystar; oxidation, solid-source dopant, and anneal furnaces; Lindberg oxidation, anneal, sintering furnaces; Tystar mini-oxidation & diffusion, MRL oxidation & anneal

> **Etching: RIE –** Unaxis, Vision, Oxford, Oxide, Plasma-therm, Plasma-therm SLR; **Deep RIE –** STS HRM, Oxford Cryogenic ICP, Trion ICP, Plasma-therm ICP, STS AOE ICP, STS Multiplex ASE ICP, STS Pegasus ICP, STS SOE ICP; **Plasma Etcher –** Gasonics Asher, Yes Plasma Cleaner, **Chemical Dry –** Xactix XeF2: **Other –** AMMT HF Vapor; **Stripper:** Samco UV Ozone

> **Rapid Thermal Processing:** Jetfirst, SSI, AET

> **Chemical Vapor Deposition: PECVD –** Oxford ICP, Black Magic CNT, Surrey CNT PECVD, FirstNano Graphene Furnace, FirstNano SiGe Nanowire Furnace, FirstNano Sulfurization Furnace, FirstNano CNT system, Plasma-therm, STS, Unaxis; **LPCVD –** Tystar TEOS, Tystar silicon nitride, Tystar doped polysilicon (N&P); **ALD –** Cambridge Fiji

> **Physical Vapor Deposition: Sputtering –** Denton Discovery RF/DC, Denton Discovery II, Kurt Lesker PVD-75 RF, Unifilm, CVC DC; **Evaporation –** CHA Metal, CHA Dielectric, Denton Explorer I Metal, Denton Infinity Metal, PVD75 Filament, CVC E-beam

> **Polymer Deposition: Spin/Spray Coat –** Suss Altaspray, RC-8 track coater, RC-8; BLE, SCS G3P8, EVG 101, Laurel, CEE; **Passivation:** SCS Parylene Coater

> **Lithography: Optical Mask Align –** Suss: TSA MA-6, MA-6, MA-6/BA-6us, EVG 620, OAI, **E-beam –** JEOL JBX, **Laser Writer –** Microtech LW405, **Nano-Imprint –** Jetlab inkjet, Obducat, Bioforce Nanoenabler

> **Characterization: Profilometers –** Dektak 150, Tencor P15, Veeco Dimension 3100 AFM, Wyko NT3300 Optical; **Electron Microscopy – SEM –** Zeiss Ultra 60, Hitachi 8230, Hitachi 4700, LEO 1530, Hitachi 3500, Hitachi 3700 VP; **TEM –** Hitachi 7700 TEM; **Ellipsometry –** Woollam M-2000 VI, Woollam VASE; Nanospec Reflectometer; **Optical Microscopy –** Olympus LEXT OLS-4000 laser confocal, Olympus IR, Keyence Digital; **Spectroscopy –** Fisher UV-Vis, GE SPR, Thermo Almega Raman, DAGE XD7600NT X-ray tomography; **Surface Analysis –** Kratos Axis Ultra XPS, Thermo K-Alpha XPS, IonTOF 5 ToF-SIMS; **Focused Ion Beam –** FEI Nova Nanolab 200 FIB/SEM; **Cyrstallopgraphy –** Panalytical MRD XRD, **Other Techniques –** Malvern Zetasizer, SCA-2500 surface charge analyzer, FSM 900TC-VAC, Qsense QCM, Rame-Hart 250 Contact Angle, Hysitron Triboindenter, Dage Die Shear

> **Packaging: Wafer/Chip Bonding –** Karl Suss SB-6, SB-8e Logitech SS, Finetech Lambda; **Wire/Ball Bonding –** K&S 4523 Semi-automatic, K&S 4523 Wedge, K&S 4522, K&S 1472; BGA rework station

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