User-Facility Capabilities

Center for Optoelectronics and Optical Communications

Prof. Glenn Boreman
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STS Advanced Silicon Etch (ASE) ICP

Contact: Robert Hudgins

- Process achieves high microns/minute rate anisotropic etching using the Bosch process
- Vertical etch depths of >0.5 mm
- Aspect ratios approaching 20:1
- Gases: $\text{C}_4\text{F}_8$, $\text{O}_2$, $\text{SF}_6$, $\text{Ar}$, $\text{He}$
STS III-V Multiplex Pro ICP Etch System

- Inductively Coupled Plasma system uses chlorine based chemistry to etch compound semiconductor materials such as GaAs, GaN, InP, GaP, SiC, and Al₂O₃
- Uniform anisotropic etching of thin film materials
- Power RF generators
- Gases: Ar, O₂, SF₆, SiCl₄, He, N₂, Cl₂, BCl₃

Contact: Robert Hudgins
STS Advanced Oxide Etcher (AOE)

Contact: Robert Hudgins

- Employs fluorine plasma chemistries to etch dielectrics, including SiO2 and Si3N4
- Available Gases: SF6, O2, C4F8, H2, CHF3, He
- RF Power:
  - Coil - 3 Kw at 13.56 MHz
  - Platen – 600 w at 13.56 MHz
STS PECVD Multiplex Pro

- High quality SiO₂, Si₃N₄
- Uses 100 mm substrates
- Low frequency and high frequency generation
- Gases: C₄F₈O₂, NH₃, N₂, N₂O, SiH₄

Contact: Robert Hudgins
SSI Solaris 150 Rapid Thermal Processor

Process up to 150mm-dia substrates at a temperature range from RT-1000°C
Temperature Ramp-Up 25°C/sec
PID process controller ensures accurate temperature stability and uniformity
Designed for silicon implant annealing and monitoring, compound semiconductor implant activation and ohmic contact alloying
Gases: N₂, Ar, O₂

Contact: Robert Hudgins
AJA ATC 1800-F Sputter Deposition System

Contact: Robert Hudgins

- ATC 1800-F sputter deposition system
- Wafers up to 150 mm in diameter
- Single layer, sequential, or co-sputtered processes
- Platen can be rotated for enhanced thickness uniformity
- Gas: Ar
AJA ATC 1500-F Ion Mill System

Contact: Robert Hudgins

- 250 mm diameter ion source
- Process substrates up to 150 mm in diameter
- Two mass flow controllers
- Removes thin film materials that cannot be plasma etched
- Gases: Ar
Lesker PVD 75 Thin Film Evaporation System

Contact: Lou Deguzman

- Electron-beam and thermal evaporation system
- $10^{-8}$ Torr Vacuum
- Capacity of processing three 100 mm wafers or a single 150, 200, or 300 mm wafer
- Runs in manual or automatic mode
- Up to 4 deposition materials
- Beneficial for lift-off metallization
Imprio100 Nanoimprint System

Contact: Lou Deguzman

- **Step and Flash Imprint Lithography Technology**
  - Resolution: sub-50 nm
  - Alignment: < 500 nm
  - Wafer handling: up to 8-inch diameter wafers
  - 6", 4" and 3" diameter wafer chucks available
  - Field size: 25 mm maximum
  - Mini-environment: Class 3
Raith 150 E-Beam Lithography System

Ultra high resolution patterning
Minimum feature size < 20 nm
Overlay capability: < 60 nm
Stitching capability: < 60 nm
Magnification: 20x - 1,000,000x
Ultra high resolution imaging

Contact: Lou Deguzman
Quintel Mask Alignment System

For 100mm and 150mm wafers, and piece parts
Vacuum, pressure, and proximity mask exposure
Sub-um lithography in vacuum contact mode
Split Field Alignment Microscope
Overlay accuracy:
- Frontside alignment: ~ 0.5 um
- Backside alignment: ~ 1 to 2 um
GCA 5X Stepper

5X reduction projection lithography tool
G-Line 436 nm wavelength
4” 1mm thick wafers, silicone and fused silica
Single wafer chuck

Contact: Robert Hudgins

Lithography
K & S 4524 Digital Ball Wire Bonder

- Ball-Wedge bonding wire capability
- Olympus microscope and spotlight targeting
- Deep access capability
- Flat substrate holder with built-in temperature controller
- Motorized Y axis and programmable auto-stepback function for precise wire length and loop formation
- Auto-2nd bond mode for complete single wire programmed sequence
- Digital readout of all parameters etc

Contact: Robert Hudgins
Scribe and Break Tool, Loomis LSD-100

- Precise (~10mm) Scribing and Breaking
- Roller-Style Breaker
- Motorized Rotation Control
- 4" (100mm) Wafer Capability
- Color Camera
- Machine Control Software

Contact: Robert Hudgins

Cleaved laser diode chips

Packaging
Programmable, Microprocessor-controlled, automatic saw for cutting semiconductor wafers and other hard material

Split field video system for aligning wafers before cutting, for program and data display, and for monitoring

Cuts maximum 150mm substrates up to 500mils thickness

Spindle speed from 15000-40000 rpm
FineTech Flip Chip Bonder

Flip-Chip bonding capability
- Substrates up to 50x50 mm²
- Placement accuracy is ± 1.0 µm
- PC-controlled heating plate (up to 400°C)
- Bonding force range: 0.1 N - 500 N

Contact: Robert Hudgins
K&S Digital Wedge Bonding System

Gold ribbon (≤250mm-wide) wiring for high-speed and high-current application

- Nikon microscope and spotlight targeting
- Deep access capability
- Flat substrate holder with built-in temperature controller
- Motorized Y axis and programmable auto-stepback function for precise wire length and loop formation
- Digital readout of all parameters

Contact: Robert Hudgins
**PANalytical X-Ray Diffractometer (XRD)**

Advanced materials science and nanotechnology diffraction
Metrologic characterization in semiconductor process development
It can handle a wide range of applications, and is especially suitable for thin film analysis applications such as:
- Rocking curve analysis and reciprocal space mapping
- Reflectometry and thin film phase analysis
- Residual stress and texture analysis

Contact: Lou Deguzman

Imaging/Characterization
JEOL SEM w/EDAX

Maximum Magnification: 300,000
Resolution: 3 nm
Capable of both high and low vacuum operation
Acceleration Voltages: 0.3 Kv to 30 Kv
System includes EDAX x-ray analysis for material characterization

Contact: Lou Deguzman

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Imaging/Characterization
Dimension 3100 SPM System with NanoScope IV Controller AFM

Surface imaging technique for analyzing nanoscale and atomic structures
- Sub-nm Resolution
- Multiple scanning modes, including:
  - Contact
  - Tapping
  - Magnetic

Contact: Robert Hudgins
3D Measuring Laser Microscope

Seven Measurement Modes:
- Step Measurement
- Surface Roughness Measurement
- Area/Volume Measurement
- Particle Measurement
- Film Thickness Measurement
- Under Geometric Measurement
- Auto Edge Detection Measurement

Five Key Laser Technologies:
- Under short-wavelength laser source
- Confocal Optical System
- XY Scan
- Real Color Image Acquisition
- Linear Scale Z-scanning

Contact: Robert Hudgins
VASE Spectroscopic Ellipsometer

- Spectral Range: 193 to 1700 nm
- WVASE32® data analysis software
- Measures:
  - Thin film thickness
  - Optical constants (n and k)
  - Spectral transmittance and reflection
- Focusing optics for 200 um spot size

Contact: Lou Deguzman
Nd YAG Laser and Optical Parametric Oscillator OPO

Continuum Pulsed Q-switched Nd YAG 8000 series Laser
- Warms up to full energy in less than 5 minutes
- Excellent beam quality and pointing stability

Panther OPO (Optical Parametric Oscillator)
- Linewidth of down to less than 1.5 cm-1
- Signal energies to > 150 mJ per pulse
- Complete tunability with no degeneracy gap (205 – 2550 nm)
Contact Information

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UNCC’s Optoelectronics Center has capabilities complementary to CPM in the area of **optical metrology**.

These include precise measurement of dimensional metrology for films and optical elements, measurement of optical properties of materials, and scattered light instrumentation for surface-finish assessment.

All instruments listed are available in UNCCs user facility.

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Dr. Angela Davies, Professor – Optical Metrology
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Optic characterization (mm-scale) 633 nm wavelength
Form metrology of near flat and spherical optical-quality components (2mm – 10mm aperture)
Radius of curvature (1mm – 30mm)
Optical system alignment
633 nm wavelength
Form metrology of near flat and spherical optical-quality components
Radius of curvature (1cm-1m)
Optical system alignment
4” – 0.6” aperture (flat measurements)
Wavelength Scanning Interferometer

- 1550 nm wavelength
- Absolute thickness as low as 1mm
- 4”-1” aperture
- Homogeneity
- Window dimensional metrology
  - Wedge and flatness (thickness variation)

Contact: Angela Davies

Wavelength scanning interferometry is a technique used to measure the thickness and homogeneity of window samples. It provides precise measurements at specific wavelengths, such as 1550 nm, with an absolute thickness as low as 1mm. The technique is applicable to various aperture sizes, including 4”-1”. Different interference patterns are observed at different wavelengths, such as 830 nm and 1064 nm, to assess homogeneity and thickness variations. A Nd:YAG crystal with 34 ppm PV at 1064 nm is shown as an example. The gauge block L is used for dimensional metrology, ensuring accurate window characterization.
Micro-optic Reflection and Transmission Interferometer

633 nm wavelength
Sub-mm Aperture Lenses
- Form Error
- Radius
- Focal Length
- Wave front Aberration

Contact: Angela Davies
10 micron Twyman-Green Interferometer

- **Detector Array**
- **Reference Flat**
- **Pellicle Beam Splitter**
- **Sample**
- **Telescope**
- **CO₂ Laser**

Contact: Glenn Boreman

- **10.6 um wavelength**
- **Testing LWIR Optics**
Tunable THz Laser

Line tunable: 300 GHz to 7 THz (1 mm to 42 um).

This unique source enables materials characterization, sensor characterization, component development.
Material characterization in the THz region:
  Reflection, transmission, material dispersion.
  Can also characterize smoke & dust.

Contact: Glenn Boreman
Ellipsometers

Measure refractive index, attenuation, conductivity from 400 nm (blue end of VIS) to 40 um in the far IR (continuous coverage)

Contact: Glenn Boreman
FTIR Microscope

Measure reflection, transmission, absorption in SWIR, MWIR & LWIR
100 um spatial resolution

Contact: Glenn Boreman
Measure surface emissivity in MWIR & LWIR
Near-plane imaging and far-field imaging available

Contact: Glenn Boreman
Measure surface roughness & subsurface damage using scattered light VIS and LWIR laser, as well as spectrally resolved MWIR/LWIR

Contact: Glenn Boreman
Measure vector electric field in 3D with 20 nm spatial resolution

Contact: Glenn Boreman
Optical Communication Infrastructure Facility

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Scott Williams, Research Operations Manager
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Fiber Optic Connector Assembly

Capabilities

- Connector assembly of most major connectors and manufacturers including FC, FC/Angle, SC, SC/Angle, ST, LC, MU, MTRJ, FDDI, ESCON, DIN, Biconic, SMA

- Assemblies done on most size fiber including 250um coated, 900um coated, 1.6mm Jacketed, 2.0mm Jacketed, 3.0mm Jacketed

- Assemblies on large count cables, large core, loose tube, breakout, distribution
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Capabilities
• Connector end face inspection at 400x for most connector styles
• Connector testing for most connector style.
  • (IL) Insertion Loss
  • (RL) Return Loss
• End Face Geometry checked with Norland Connect-Check 6000
  • Apex Offset
  • Fiber Protrusion/Undercut
  • Radius of Curvature
  • Angle
• Full reporting Capabilities

Fiber Optic Connector Testing
Domaille Engineering
Optical Fiber Polishing Machine
Model: HDC-4000

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Technical Data
Current Connector Types MT
Connector types that can be added FC, LC, LC/Angle, LX.5, MT/Angle, MTRJ, MTRJ/Angle, MU, SC, SC/Angle, SMA, Ferrule Only
Pressure Type Pneumatic
Platen Size 5in.
Seiko Instruments
Optical Fiber Polishing Machine
Model: OFL-12

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Technical Data
Current Connector Types
- FC, FC/Angle
- LC, LC/Angle, MU, MU/Angle, ST, SC, SC/Angle, E2000, E2000/Angle, Ferrule Only, Ferrule only/Angle

Connector types that can be added

Pressure Type
- Spring

Platen Size
- 4in.
Technical Data

End Shapes: Cone, Chisel, Bevels
Angle Range: 20 to 180 degrees
Angular Accuracy: 0.1 degrees
Fiber Diameter: 80 & 125um
Platen Size: 5in.

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Ultra Tec
Ultrapol Fiber Lens Polisher
Model: 6380.1
Technical Data

Fibers
- Single-mode, multimode, dispersion-shifted,
- Polarization maintaining, erbium

Typical splice losses
- 0.02 dB SM fibers

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Ericsson Fusion Splicer
Model: FSU 975 PM-A
Technical Data

Fibers
- Single-mode, multimode, dispersion-shifted, Polarization maintaining,

Typical splice losses
- 0.07dB PM fibers
- 0.03dB SM fibers
- 0.02dB MM fibers

Typical Extinction ratio >30dB

Fujikura Fusion Splicer
Model: FSM-20PMII

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Technical Data

Fibers: Single-mode, Multimode, Dispersion-shifted, Non-zero dispersion shifted, Cut-off shifted, Erbium doped

Typical splice losses: 0.02dB SM fibers, 0.01dB MM fibers, 0.04dB NZDS fibers

Typical return loss: >60dB

Fujikura Fusion Splicer
Model: FSM-40S

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Luna Technologies
Optical Backscatter Reflectometer
Model: OBR

Measurement Highlights:

- High resolution OFDR - Resolve individual features with spatial resolution down to 10 microns.
- High sensitivity - 70 dB of dynamic range and -130 dB sensitivity.
- Long range - Measure up to 2000 meters in length with a single connection, single scan.
- Single Connection IL and RL - Measure insertion and return loss in a single scan.
- Locate loss events - Monitor backscatter levels to isolate losses due to bends, crimps, bad splices.
- “Look inside” devices - High resolution and sensitivity enable inspection of individual components within a subsystem.
- Polarization Tracking - Track changes in the state-of-polarization as light propagates through an optical network.
- Intuitive graphical interface - All key data and graphs in a simple, easy to use interface.
- Distributed sensing - Use standard optical fiber to monitor the changes in temperature and strain.

Wavelength Range 1530nm to 1620nm

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Measurement Highlights:
The OVA simultaneously performs these optical component characterizations every second:

- Insertion Loss (IL)
- Return Loss (RL)
- Polarization Dependent Loss (PDL)
- Phase Response
- Group Delay (GD)
- Chromatic Dispersion (CD)
- Polarization Mode Dispersion (PMD) / Second Order PMD
- Min/Max Loss due to Polarization
- Impulse Response
- Jones Matrix Elements
- Phase Ripple - Linear and Quadratic

Wavelength Range 1530nm to 1620nm
Agilent
All Parameter Analyzer
Model: 81910A

Measurement Highlights:
The Agilent 81910A enables exhaustive analysis of advanced photonic devices, covering all physical properties relevant to DWDM components in a single solution:

Simultaneous all-optical measurement of:
- (IL) Insertion loss
- (RL) Return Loss
- (PDL) Polarization Dependent Loss
- (GD) Group Delay
- (DGD) Differential Group Delay
- (CD) Chromatic Dispersion
- (PMD) Polarization Mode Dispersion

Direct access to Mueller Matrix and Jones Matrix for deepest insight into a device's transmission and reflection properties

Wavelength Range 1530nm to 1620nm
Exfo/Burleigh
Nano Robot System
Model: FR3000

EFOS
UV Curing System
Model: Novacure

Features and Benefits

Nano Robot System
• Ultrahigh performance in six degrees of freedom for the most demanding photonics applications
• Robust design suitable for the manufacturing floor as well as labs and clean rooms
• High stiffness and stability minimize drift during bonding and reduce effects of environmental vibration and temperature
• Independent axis control with full range of motion in six degrees of freedom eliminates detrimental translation and cross-coupling effects
• Incorporates patented INCHWORM® motor technology to deliver high 0.1-nm resolution and long travel

Novacure
Typical power output with a standard filter at 320-500nm: 23,400 mW/cm²

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Features and Benefits
• Modular 2 bay design.
• Touch screen for ease of use.
• Full color display
• Large internal storage with USB ports to retrieve data.

Current Module:
OTDR 1310nm and 1550nm

Expansion Modules Available
• Over 25 OTDR models covering all network testing applications, from core to access.
• Over 11 OLTS models for testing optical return loss (ORL) and insertion loss (IL).
• CD and PMD analyzer.
• OSA.
• SONET/SDH analyzers (up to 10 Gbit/s)
• Next-generation SONET/SDH analyzers.
• DSn/PDH analyzers.
• Ethernet analyzers (up to 10 Gbit/s).
• Fiber Channel analyzers.
• Switch module.
• Modular pulse-suppressor boxes (single mode and multimode)
Capabilities

- Multiple Tunable Lasers covering from the S-Band through the C & L Bands.
- Wavelength Meters
- Power Meters
- Optical Spectrum Analyzers
- Optical Stages
- Motion Controllers
- Polarization Controllers
- Laser Drivers
- Free space optical meters and heads
- Optical Switches
- Erbium Doped Fiber Amplifiers
- Microscopes

Bench Top Equipment and Custom Designed Test Arrangements

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Capabilities
• Tunable wavelengths from 205nm to 2550nm
• A line width of down to less than 1.5 cm

Continuum
Optical Parametric Oscillator
Model: Panther

Continuum
Nd:Yag Laser
Model: Precision II 8000
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Capabilities
- 1-15Hz adjustable repetition rates
- Up to 100mJ at 15Hz
- 1064, 532, 355, and 266nm

Continuum
Nd:Yag Laser
Model: MiniLite II