ZEPLER INSTITUTE

UNIVERSITY OF Southampton

Nanofabrication facility

Equipment and technical capabilities

LITHOGRAPHY

SCANNER

NSR-S204B-Nikon Scanner

- Configured for 200 mm wafers
- Light source: KrF laser at 248 nm
- Resolution 180 nm, NA: 0.68
- Exposure field size: 25 x 33 mm
- Stepping precision of 20 nm
- Throughput of 120 wafers per hour

Accompanying tools for the Scanner:

Hitachi S8840 CD SEM:

- Post-development and -etching inspection SEM for Nikon Scanner
- Substrate size 150 and 200 mm
- Acceleration voltage 0.5 to 1.3 kV
- CD measurement range from 0.1 to 10 microns
- Magnification x1000 to x150,000 (SEM image), x110 (optical image)

KLA-Tencor 5200XP Overlay Metrology System:

- Overlay inspection (layers to layers alignment for the Scanner)

ELECTRON BEAM LITHOGRAPHY

- Jeol JBX 9300 e-beam writing system
- Substrate sizes from 3 mm up to 200 mm
- Loading options for 12 × "50 mm", 3 × "100 mm", 2 × "150 mm" and 1 × "200 mm" substrates in one pump-down
- 2 nm minimum spot size (@100 kV)
- Minimum resolution of 8 nm line width
- +/-30 nm overlay and +/-25 nm stitching accuracy
- See "Resist Processing" section below for pre-write capability

OPTICAL LITHOGRAPHY

- EVG 620T/TB (×3) and SUSS Microtec alignment systems
- UV range from 200 to 450 nm with i- and g-line filters
- Resolution 0.8 microns
- Front to backside alignment
- Bonding pre-alignment
- Substrates sizes from 10 × 10 mm up to 200 mm
- Multiple exposure modes (proximity, soft, hard, vacuum)
- Alignment accuracy of 1 micron
- See "Resist Processing" section below for pre-exposure capability

3D LASER LITHOGRAPHY

Nanoscribe Photonic Professional:

- Maskless 3D laser lithography tool
- Rapid fabrication of 3D nano-, micro-, and meso- structures
- Resolution higher than 150 nm
- Structure depth of up to 300 microns
- Area size up to 100 mm × 72 mm

RESIST PROCESSING

- Resist processing capability for a range of spin-on materials like negative, positive, lift-off resists and polymer and spin-on glass coatings for e-beam and optical lithography applications
- Coating range from nm range up to 100's of microns
- Dedicated resist spinners for e-beam and optical lithography applications
- 300°C maximum temperature hotplate for substrates up to 200 mm
- Dehydration and resist bake ovens
- Mask cleaner & lift-off station (SSE OPTIwet ST 30)
- Can handle up to 200 mm wafers or 230 mm masks
- Fully programmable
- Heated NMP (up to 80°C) option
- Spin rinse and dry function

Contact us
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ETCHING

DEEP REACTIVE-ION ETCH (DRIE)

Plasma-Therm Versaline DSE:

- Deep Si etching (Bosch process)
- Shallow oxide etch process for hardmask generation
- Accepts substrates up to 200mm wafer
- Gases available: SF_6, C_4F_8, Ar, N_2, O_2
- Etch rates for Si typically 2-7 micron/min
- Sidewall roughness (RMS) ~20 nm
- Selectivity: Si:PR is 100:1 and Si:SiO2 is 20:1
- Rotational and angular etching
- Capability to etch a significant range of materials including but not limited to Si, Ge, GaN, sapphire, and metals

REACTIVE ION ETCH (RIE)

- Accepts substrates from small chips up to 200 mm wafers

OPT Plasmalab 80Plus (×2):

- Gases available: CHF_3, CF_3, Ar, O_2
- Si, SiO_2, Si_3N_4 etch
- Remove photoresist, de-scum and clean substrates

INDUCTIVE COUPLED PLASMA ETCH (ICP)

OPT Sys100 ICP380 etcher (×2):

- High density plasma etching technique
- Higher etch rate, aspect ratio, anisotropic etch
- Can accept substrates from small chips up to 200 mm

System 1 – dielectric and Si etcher:

- Gases available: C_4F_8, SF_6, O_2, Ar, N_2
- Si, Ge, SiO_2, Si_3N_4 (anisotropic and isotropic), deep oxide and polymer etching

System 2 – metal, dielectric and Si etcher:

- Gases available: C_4F_8, $SiCl_4$, Cl_2, HBr, Ar, N_2, O_2
- Al, Au, Cr, Si, InP, Pt etch chemistries

REACTIVE ION BEAM ETCHING

OPT Ionfab 300Plus:

- Anisotropic ion beam etching technique
- Can take up to 200 mm wafers

OXYGEN PLASMA ETCHING SYSTEMS

- Oxygen plasma ashing system for resist stripping and de-scumming applications
- Can batch process up to 200 mm substrates
- Gases available: O_2, N_2
- Process endpoint monitor

UV OZONE CLEANER

- Decontaminating substrates surface
- UV curing, improve surface hydrophobicity, oxidise surface

WET ETCHING AND CLEANING

- Wet benches for etching and stripping applications
- Cassette processing tanks for 50 to 200 mm substrates
- Wet Si etching by KOH and TMAH
- Wet SiO_2 or Si_3N_4 etching by BOE or H_3PO_4 solutions for SiO_2 and Si_3N_4 etching
- Metal etch capability; commercial etchants for Cr, Al, Au, Ti
- HNO_3 for cleaning and resist/metal stripping
- Solvent bench and flexible bench for general chemical processes
- Wet cleaning processes by organic, particle, oxide, ionic removal from surfaces
- RCA clean, quick dump rinses
- Fuming nitric acid and HF wafer cleaning tanks

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DEPOSITION

CHEMICAL VAPOUR DEPOSITION (CVD) TECHNIQUES

- Dielectrics and semiconductor thin films deposition
- Plasma enhanced CVD technique
- Low temperature deposition options

OPT Sys100 Plasma enhanced CVD (×2)

- a-Si PECVD: PolySi, polySiGe, polyGe, a SiGe, a-Ge
- Dielectrics PECVD: TEOS, Si_3N_4, SiO_2
- From small substrates up to 200 mm wafers
- Maximum processing temperature of 400°C

ATOMIC LAYER DEPOSITION (ALD)

- Monolayer deposition
- Very conformal and uniform coatings
- Can accept up to 200 mm substrates

OPT Flex ALD

- Plasma and thermal processes
- Deposits HfO_2, TiN, Al_2O_3, ZnO
- Processing temperatures from RT up to 200°C

Savannah 200 ALD

- Deposits ZnO and Al_2O_3
- Processing temperatures up to 350°C
- In-situ ellipsometry

HOT WIRE CVD Escherkon Nitor 301

- Si containing thin film deposition system
- High deposition rate and low temperature process
- Gases: SiH_4, Ar, NH_3, H_2, N_2
- Polysilicon, a-Si and nitride deposition
- Can take substrates up to 200 mm

SCS PARYLENE COATER

- Parylene C polymer coater
- Thick uniform and conformal coating
- Accepts up to 200 mm wafers
- Permanent water proof and chemical resistant coating

OPT NANOFAB 1000 AGILE

- Catalyst nanoparticle initiators
- Nanowire and nanotube deposition
- Si, Ge, SiC and Si/Ge
- In-situ p- or n-type doping
- Temperature up to 850°C
- Accepts up to 200 mm substrates

PHYSICAL VAPOUR DEPOSITION (PVD)

- Metal and dielectric film deposition capabilities
- Sputtering, evaporation and electroplating techniques

SPUTTERING TOOLS

Leybold Optics Helios Sputtering System:

- Precise atomic scale deposition
- Reactive sputtering: oxide, nitrides, oxynitrides
- Metals sputtering: Al, Sn, Pt, Ni, Ta, Au
- From small substrates up to 200 mm wafer

AJA International Orion Sputtering System:

- Quick films deposition
- RF and DC single target sputtering
- Heating up to 750°C
- Smaller substrates up to 150mm
- Metal and oxides, targets Al, Si, Ti, SiO_2, Au, Cu, ErO_2, ITO

Angstrom Engineering Evovac Sputtering System:

- Quick film deposition
- RF, DC and pulsed DC sputtering
- Metal and dielectrics film deposition
- Can take up to 200 mm wafer and 4 wafers in one pump down
- Targets available on request

Plasmalab System 400:

- DC, Pulsed DC and RF magnetron
- Can accept wafers up to 200 mm
- Silica, Germania-doped silica, $A_{l2}O_3$ and tantalum pentoxide

DEPOSITION, CONTINUES ON PAGE 4

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DEPOSITION, CONTINUED:

E-BEAM EVAPORATORS

- E-beam evaporated thin film deposition
- Metal, dielectric, ceramic, metal oxides, nitrides films deposition
- Co-evaporation with 2 target sources

Leybold Lab 700:

- Source: Au, W, Ti, Al, Ni, Cr, ITO
- Accepts wafer from 50 to 150 mm diameters
- Leybold Bak 600
- Thermal evaporation option available
- Source: Au, Pt, Ni, W, Cr, Al, Cu, Ti
- Accepts wafer of 100 and 150 mm diameters

Edwards Auto 500:

- Singular evaporation
- Source: Au, Al, Ti, Ni, Co, Silica
- Accepts wafer of 100 and 150 mm diameters

THERMAL EVAPORATOR (×2)

- Thermally melts metal or semiconductor to deposit thin films

Edwards Auto 306:

- Source: Al, Cr, Au, Ni, Nd, Er, ITO, fluropolymers
- Accepts 100 and 150mm substrates

ELECTROPLATING

- Electroplating of thick metal films on substrates
- Metals like Au, Ni can be deposited
- Required deposition materials can be arranged for
- Solution heating option available
- Accepts substrates up to 50 mm

ANNEALING AND GROWTH

FURNACES

- Deposition and diffusion applications
- Small batch furnace for growth and annealing applications
- From 200°C up to 2300°C systems available
- Phosphorus doping available
- Distinct systems exclusive to metal and non-metal coated substrates
- 25-75 wafer capability based on the tube
- Temperature accuracy of +/-1C

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- Distinct systems exclusive to metal and non-metal coated substrates
- 25-75 wafer capability based on the tube
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Tempress TS6304BM clean furnace stack RTA (×2):

- 150 mm wafers
- Dry/wet oxidation and anneal from 600 to 1150°C
- Alloy from 200 to 900°C
- General furnace from 600 to 1150°C

Tempress TTS8603BM LPCVD furnace stack:

- 200 mm wafers
- LPCVD nitride from 600°C to 850°C
- LPCVD polysilicon from 500 to 750°C
- General furnace from 600 to 1160°C

Materials Research 2300°C Furnace:

- 75 mm wafers
- Diffusion and annealing
- Temperature up to 2300°C in vacuum, Ar and N_2
- Temperature up to 1700°C in O_2

Severn (STS) 1200°C Tube Furnace:

- 200 mm wafers
- Diffusion and annealing
- Temperature up to 1200°C in Ar, O_2 or N_2

RAPID THERMAL ANNEALING (RTA)

- High temperature processing for applications like dopants activation, change surface interface or states of grown films
- Attains high temperature in a several seconds
- Temperature reproducibility and accuracy of +/- 5°C
- Heat up rate of 150°C /s
- RTA and rapid thermal oxidation processes

Jipolec Jetfirst 200 (JF200400) rapid thermal annealer (×3):

- Pryometer temperatures from 400 to 1200°C
- Thermocouple temperature from 400 to 1000°C
- Accepts wafers up to 150 mm

OVENS

- Instron 600°C Ion-Exchange Furnaces
- Glass diffusion from salt melts such as KNO_3 for optical device fab
- General annealing

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WAFER BONDERS

- Permanent and temporary wafer bonding available
- Types of bonding: Fusion, eutectic and direct

EVG Bonders 501and 520HE:

- Thermal bonder
- Contact force up to 10,000N
- Temperature to 500°C
- Facility for hot embossing
- Can process pieces to 150 mm wafers

AML Wafer Bonder:

- Forces up to 25,000 N
- 1-5 micron alignment accuracy
- Accepts 50 – 200 mm wafers
- Temperature up to 650°C

CHARACTERISATION METHODS

SCANNING ELECTRON MICROSCOPES

- High-resolution topographical imaging application
- Semiconductors and biological samples
- Working voltages from 0.5 to 30 kV
- Accepts substrates up to 150 mm

Jeol JSM 7500F FEGSEM with EDX:

- 1 nm resolution at 15 kV
- Tilt from -5 to +60°
- Rotation up to 360°
- Working distance from 25 to 2.5 mm
- EDX attachment for material composition analysis

Carl Zeiss EVO LS25 environmental SEM:

- High-resolution imaging of conducting and non-conducting samples
- Resolution 3 nm at 30 kV, 10 nm at 3 kV, 20 nm at 1 kV
- Imaging in liquid medium is possible
- IFG iMOXS X-ray source attachment: X-Ray fluorescence for trace analysis down to 50 ppm
- Xradia nanoXFi fluorescence imaging spectrometer attachment: Sub-100 nm spatial resolution imaging of elements distribution
- Element location, contacts under metals, semiconductor metal failure detection, layered structure analysis
- Gatan X-ray computed tomography attachment: High resolution 2D and 3D x-ray imaging.
- Suitable for materials & life science applications

FOCUSED ION BEAM

Carl Zeiss NVISION40 FIB system:

- Used for high-resolution imaging, deposition, ablation of materials
- E-beam resolution of 1.1 nm at 20 kV, 2.5 nm at 1kV and operates between 100V-30 kV
- FIB resolution of 4 nm at 30 kV and operates between 1kV – 30 kV
- 2 solid precursors, up to 3 gas precursors for deposition
- Mass spectrometer for SIMS, scanning tunnelling microscopy module, TEM

HELIUM ION MICROSCOPE

Carl Zeiss Orion He ion microscope:

- Imaging, milling, deposition and modifying substrates at sub-nanometre range
- Edge resolution of 0.3 nm at 25-30 kV
- Capable of nano-patterning
- Direct milling of materials

X-RAY PHOTOELECTRON SPECTROSCOPY

- Non-destructive surface analysis technique
- Provides quantitative and chemical state information of materials

XPS Theta Probe Thermo Scientific:

- Characterise ultra-thin films
- Spot size range of 15 to 400 microns
- Can accept large or multiple substrates

SURFACE PROFILE MEASUREMENT (SPM)

- Topographical imaging and surface characteristics analysing
- Analysis Modes: Contact, atomic force, lateral force, tapping, electrical

Veeco Multimode Nanoscope V Scanning Probe Microscope:

- SPM for surface, electrical and magnetic imaging for small substrates

CHARACTERISATION METHODS, CONTINUES ON PAGE 6

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CHARACTERISATION METHODS, CONTINUED:

- Fluid scanning, 60°C fluid heater
- 10 × 10 and 125 × 125 micron scanners
- Scans from 0.4 micron (x, y and z axes) up to 200 microns laterally and 10 microns vertically
- Resolution in sub-nm range

Veeco Caliber SPM:

- Imaging for larger substrates
- 90 × 90 micron scanners

Nanonics CryoView 2000 Scanning Probe Microscope:

- Resolution down to 1 nm
- Cryogenic SMP for low temperature
- Tip Enhanced Raman Spectroscopy (TERS)
- Surface strain and defect mapping

MSA 400 POLYTEC (Imaging):

- 3D MEMS dynamics and topography tester
- Microscope based vibrational sensor system
- 3D topography measurements using light interferometry
- Can determine surface height and shape
- Sub-nm resolution
- Easy integration in MEMS probe stations

Zetasizer Nano ZS:

- Charged particle analyser
- Measures particle radius between 0.3 to 10 microns
- Zeta potential measurement of particles sized between 3.8 nm to 100 microns

Raman Spectroscopy Renishaw:

- Micro-Raman system for optical characterisation of nanostructures
- Laser beam spot size of 0.5 microns
- 785, 633 and 532 nm lasers

Multipress LPKF-S BE05:

- Multilayer PCB press tool
- Bench-top press
- 100 × 100 mm to 200 × 75 mm
- Maximum press area of 9 × 12 inches
- Temperature up to 250°C
- Used to bond RF-multilayer substrates

Ellipsometer Woollham M2000D:

- Quick optical technique to investigate dielectric properties of thin films
- Small substrates to 200 mm
- 190 – 1000 nm spectral range
- Focusing to 150 microns spot size

Long Scan Surface Profiler KLA-Tencor:

- Quantifies surface qualities
- Resolution from 100 Å – 300 microns
- Roughness, step height and wafer stress measurement
- 2D and 3D data scan
- Accepts substrates up to 200 mm

Four Point Probe Jandel RM3-AR:

- Sheet resistance and volume resistivity measurement
- Accepts substrates up to 200mm
- 1 milliohm-per-square (103) up to 5×10^8 ohms/square
- Volume resistivity range is from 1 milliohm-cm (10^3) up to 10^6 ohms cm

Thin film Stress measurement KLA-Tencor:

- Accepts substrates up to 200 mm
- Temperature up to 900°C

OPTICAL MICROSCOPES

- Instant magnified surface imaging
- Upright Nikon and Zeiss microscopes
- Dark field and bright field modes
- Polarisation, spectral analysis
- Computer interface

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BACKEND CAPABILITY

JETTING AND DISPENSING SYSTEMS

- Device packaging processes

Nordson Efd Pico Jet Valve with Pico controller:

- Precisely jetting of medium to high-viscous materials
- Deposits volumes ranging from 3 to 200 nL at 15 Hz frequency

Nordson Robot/Teach Pedant:

- 3-axis automated dispensing system
- Dosing of points, lines, curves and circles
- Resolution of 1 micron

Nordson-EFD Ultra TT 325 Dispensing System:

- Automatic dispensing system with fully integrated closed-loop positioning
- 10 micron resolution
- Maximum speed of 500 mm/s

CHIP/WIRE BONDERS

- Methods to bond device dies directly on substrates, boards or carriers, or to make wire interconnections
- Applications: Chip on Board, MEMS, ceramic carriers, Ball grid Array, multi-chip module

Manual Die Bonder Tresky-3002-M:

- Pick and place robot with placement accuracy of 10 microns
- Inbuilt heated plate for many epoxies and solder pastes
- Suitable for Si, Ge, GaAs and InP dies of 30 micron thickness
- Maximum PC board/substrate size is 400 x 280 mm

Wire Bonder – TPT HB16:

- High precision wedge, ball, bump and ribbon bonding
- 17 to 75 micron wire and 25 to 250 micron ribbon

Flip-Chip Bonder:

- Laser bar and diode bonding
- Field view: Minimum of 0.55 × 0.45 mm and maximum field view of 6.7 × 5.4 mm
- Component size: Minimum of 0.1 x 0.11 mm and maximum of 15 x 15 mm

Auto Wire Bonder F&K Delvotec 6200:

- Gold wire bonding at high temperature
- Fully automatic feed and tail operation
- 17 to 75 micron fine Au wire size
- Speed of 2-3 wires per second

BOND PULL TESTER DAGE 4000

- Examines the bond strength on die
- Bond wire pull tester
- 8 standard test heads

CHEMICAL MECHANICAL POLISHING TOOL POLI-500

- Used for chemical/mechanical smoothening of surfaces
- Dielectric and semiconductors thin films
- Accepts wafers up to 200 mmCoarse (>1 micron) and fine (<1 micron) fine polishing setups

MSA 400 POLYTEC (VIBROMETRY)

- Laser Doppler vibration sensor tool
- In-plane motion and vibration measurement by stroboscopic video microscopy
- Characterise out-of-plane vibrations by laser Doppler vibrometry
- Easy to combine with MEMS probe station
- Tests wafers and individual die testing

RAPID PROTOTYPING OBJET CONNEX 350

- 3D printer
- Build resolution x-axis 600dpi/42 microns, y-axis 600dpi/42 microns, z-axis 1600dpi/16 microns
- Two resin setup VeroWhite (hard) and VeroBlack (soft)

DIE SINGULATION

Semi-Automatic Dicing Saw (×3):

- Cuts Si, Ge, GaN, sapphire, glass, ceramic with high accuracy
- Measurement resolution of 0.1 microns
- Accepts up to 4 mm thick substrates and up to 200 mm wafers
- Positioning accuracy of 0.5 microns

BACKEND CAPABILITY, CONTINUES ON PAGE 8

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BACKEND CAPABILITY, CONTINUED:

Scribe:

- Scribes Si, glass and brittle materials
- Two blades for scribing at 155° or 120° angles
- Accepts up to 300 mm wafers and sapphire up to 150 mm
- Minimum die size 3 x 3 mm

Semi-Automatic Surface Grinder

- Processes Si and compound semiconductors
- Accepts up to 200 mm substrates
- Grinding accuracy less than 1.5 microns

PROBE-STATIONS

- Used to acquire signals from semiconductor devices

Cascade Microtech prober

- Agilent semiconductor parameter analyser
- Equipped with CV meter, spectrum analyser, signal generator
- 4 × DCM 210 probes

Cascade Summit 12000B-AP probe station

- Semi-automatic 200 mm probe station with micro-chamber
- Temperature control 65-200°C
- eVue digital imaging system
- 4 × 67GHz infinity probes

AGILENT B1500A SEMICONDUCTOR DEVICE ANALYSERS (×2)

- IV and CV measurement tool
- 1k Hz – 5 MHz capacitance meter

LIQUID HELIUM CRYOSTAT W/ MAGNETIC FIELD CRYOGENIC LTD

- Typically cools down samples less than 4 K
- 1.6 – 325 K temperature range
- Cool down time less than 24 hours
- 300° sample rotation

ELECTRONIC TESTING EQUIPMENT

N8973A Noise Figure Analyzer:

- Used for repeatable noise figure measurement
- Frequency range between 10 MHz to 3.0 GHz
- N-type connector

E4991A RF Impedance Analyzer:

- Used for accurate measurement of complex impedance
- Frequency range between 1 MHz to 3GHz
- +/- 0.8% basic accuracy

E4411B ESA-L Spectrum Analyzer:

- Used for measuring power spectrum of unknown signals
- Frequency range between 9 kHz to 1.5 GHz
- Amplitude accuracy of 1.1 dB

DSO3202A digital oscilloscope (×2):

- Used to display and analyse waveform of electronic signals
- 200 MHz bandwidth
- 2 channels
- 1 GSa/s sample rate

PVE300 Photovoltaic EQE:

- Solar cell spectral response measurement
- Operation range between 300-2500 nm
- Direct determination of device external quantum efficiency (EQC)
- Direct determination of total reflectance and transmittance to convert EQE to internal quantum efficiency

Hall Effect Systems

- Used for measuring resistivity, carrier concentration, and mobility of materials
- Ideal for variable temperature measurement and mobility from 1 to $10^6 cm^2/Vs$
- Standard resistance range of 0.5 m-ohms to 10 M-ohms
- High resistance option widens range to 200 G-ohms
- Low resistance option significantly reduces resistance noise floor

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