



Nano Semiconductor
Technology Centre

MIMOS R&D SHARED FACILITIES AND SERVICES

FOR E&E INDUSTRY AND ACADEMIA



Innovation for Life™

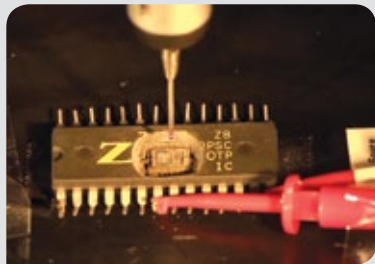
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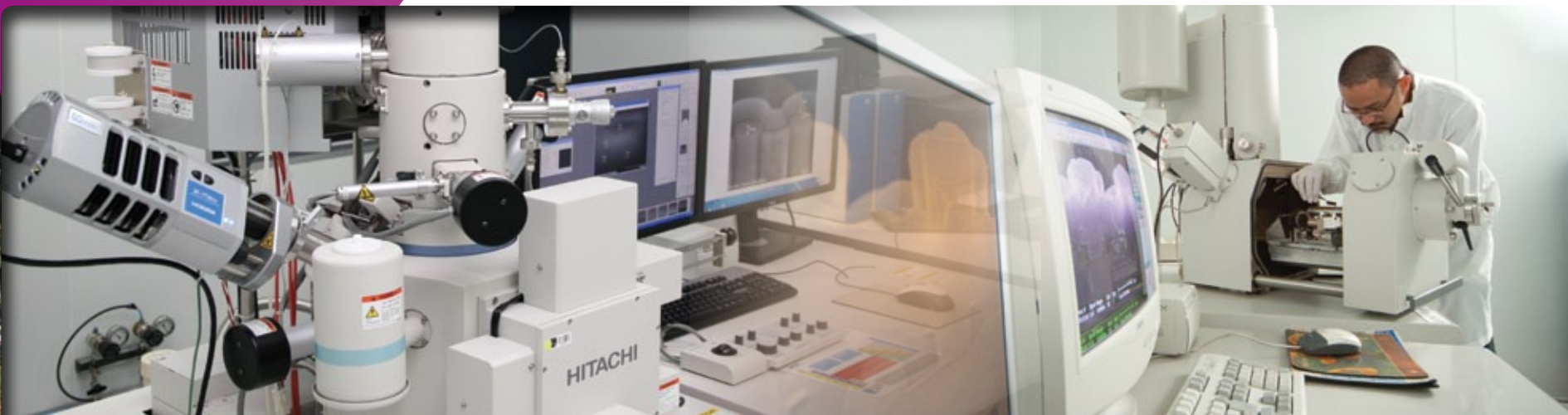
MIMOS Nano Semiconductor Technology Centre (NSTC) provides R&D shared facilities and services as part of the Malaysian Economic Transformation Programme (ETP) under the Electrical and Electronics National Key Economic Area (E&E NKEA).

We aim to be a major catalyst for the development of the E&E industry in Malaysia and the region by offering a flexible engagement model, short turnaround time and integrated value-added services at competitive prices.

Among the services offered are Failure Analysis/Material Analysis, Reliability Testing, Wafer & IC Testing, IC Design, Wafer Fabrication & Wafer Prototyping, Rapid Product Prototyping, Nano & MEMS Fabrication & Synthesis, Nanocharacterisation (under the NANOVerify programme) and Hands-On Skills Development Programme.



MIMOS FAILURE ANALYSIS, MATERIAL ANALYSIS & NANOCHARACTERISATION LAB



MIMOS Failure Analysis, Material Analysis & Nanocharacterisation Lab is equipped with a complete spectrum of advanced analytical tools to provide high value-added services for the E&E industry and academia.

The lab is a strategic cross-cutting enabler to complete E&E ecosystem support by providing much needed services in Malaysia.

Innovative and flexible engagement models are offered to suit the needs of the industry, academia and local Failure Analysis consultants.

MIMOS NSTC has more than 20 years of experience in areas of semiconductor wafer fabrication and devices to ensure optimal analytical solutions.

We are MS ISO/IEC certified and a NANOVerify programme centre.

Capabilities

Electrical Verification

- **Logic and High Voltage Curve Tracer (CT - Logic + HV)**
Electrical/parametric test verification tool for logic and high voltage devices

Non-Destructive Inspection

- **Real-time X-Ray (X-Ray)**
2D inspection tool to determine internal conditions of sealed devices
- **3D X-Ray**
2D and 3D inspection tool to determine internal conditions of sealed devices
- **Scanning Acoustic Microscope (SAM)**
Inspection tool using ultrasonic waves to locate internal discontinuities of sealed devices

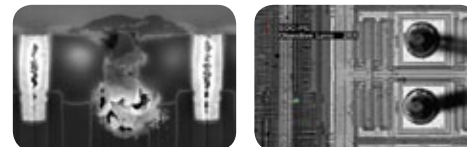


Fault Localisation

- **Photon Emission Microscope (PEM) Front and Backside, and Optical Beam Induced Resistance Change (OBIRCH)**
Fault localisation system for low leakage failure and OBIRCH capability to localise metal defects
- **Thermal Emission Microscope (TEM)**
Fault localisation system for high leakage and shorting
- **Magnetic Current Imaging (MCI)**
Fault localisation system for short, leakage (IDDQ and I/O) and low resistive open failures

Physical Analysis

- **Laser and Chemical Decapsulator**
Package opening tool for semiconductor packages
- **Confocal and Digital Microscopes (CM)**
Visual inspection tool with Brightfield, Darkfield, DIC (interference contrast) and Confocal capabilities
- **Reactive Ion Etching (RIE)**
Etching dielectric materials for IC stripping
- **Dual-Beam (FIB - Focused Ion Beam and FESEM - Field Emission Scanning Electron Microscope)**
High resolution inspection system for precision micro cross sections of IC features and deposition of conductor and insulator within sub-micron tolerances, and EDS for elemental information.
- **Field Emission Gun (FEG)-Scanning Electron Microscope with EDS**
Inspection system to examine fine details within nanometre-level resolution and equipped with EDS for elemental information



- **Transmission Electron Microscope (TEM) with EDS**

Inspection system to examine fine details within angstrom-level resolution and equipped with EDS for elemental information

- **Atomic Force Microscopy with Raman Spectroscopy**

3D imaging profile for topographical information used in surface roughness analysis with Raman spectroscopy for chemical and molecular analysis

Material Analysis

- **Auger Electron Spectroscopy (AES)**

Inspection system to perform minute surface elemental analysis, elemental mapping, depth profiling and chemical state analysis

- **Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS)**

Inspection system to perform surface elemental analysis, molecular species analysis (organic and inorganic composite materials), depth profiling and elemental/chemical mapping

- **X-Ray Photoelectron Spectroscopy (XPS)**

Inspection system to perform surface chemical bonding analysis (organic and inorganic species) and depth profiling

- **TEM with Electron Energy Loss Spectroscopy (EELS)**

Inspection system to examine atomic composition, chemical bonding, electronic properties (valance and conduction bands), surface properties and element-specific pair distance distribution functions

- **Fourier Transform Infrared Spectroscopy (FTIR)**

Inspection system to identify polymers, organics and contamination

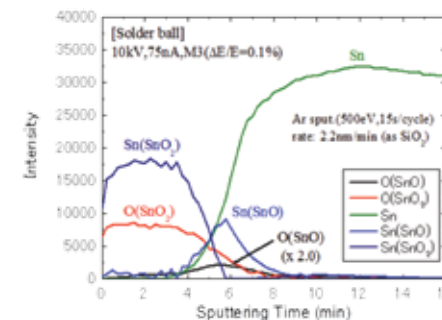
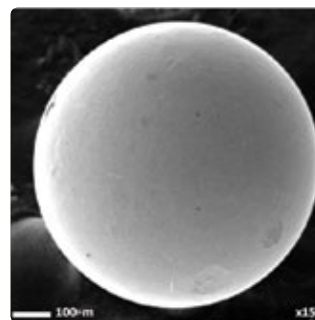
- **Ultraviolet, Visible and Infrared Spectroscopy (UV-Vis-IR)**

Inspection system to examine absolute specular reflectance, direct transmission/reflection/absorption, and scattered transmission/reflection

- **Inductively Coupled Plasma Mass Spectrometry (ICP-MS)**

Inspection system to examine bulk composition, trace and ultratrace elements, and distribution mapping of impurities

Chemical state profile of a solder ball



- **Gas Chromatography-Mass Spectrometry (GC-MS)**

Inspection system to identify and quantify volatile organic compounds in mixtures, outgassing, residual solvents, liquid and gas injection

Nanocharacterisation

- **Integration of Atomic Force Microscopy (AFM) with Raman Spectroscopy**

- Simultaneous measurement of AFM and Raman maps of the exact same sample area to provide complementary information on the physical properties (3D surface topography) and chemical composition (Raman spectra) on a nanoscale level
- Additional measurement modes allow nano-mechanical, magnetic and electrical characterisations such as Force Modulation, Kelvin Probe, Magnetic Force and Electrostatic Force analysis to be performed

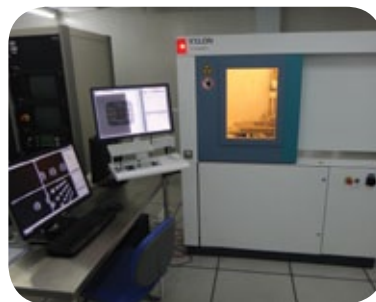
- **Inspection, Verification and Characterisation of Nanomaterials**

- Surface morphology using AFM
- Physical and material analysis using FESEM and TEM

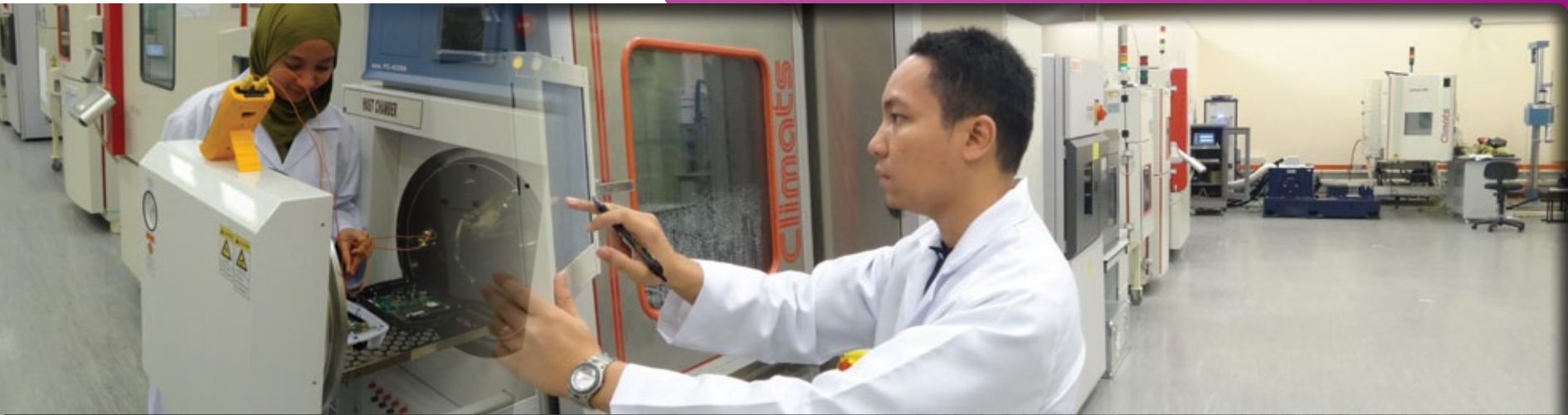
Equipment List

- Real Time X-Ray
- 3D X-Ray
- Scanning Acoustic Microscope (SAM)
- Curve Tracer
- Photon Emission Microscope (PEM) and Optical Beam Induced Resistance Change (OBIRCH)
- Thermal Emission Microscope
- Magnetic Current Imaging (MCI)
- Chemical Decapsulator
- Laser Decapsulator
- Confocal Microscope
- Digital Microscope
- Reactive Ion Etching (RIE)
- Mechanical Polisher
- Ion Polisher
- Precision Etching Coating System (PECS)
- Field Emission Scanning Electron Microscope (FESEM) with EDS
- Energy Dispersive Spectrometer (EDS)
- Dual-Beam (FIB - Focused Ion Beam and FESEM - Field Emission Scanning Electron Microscope)

- Transmission Electron Microscope (TEM) with EDS and EELS
- Electron Energy Loss Spectroscopy (EELS)
- Small-Angle Scattering System (SAXS)
- Atomic Force Microscopy (AFM) with Raman Spectroscopy
- Raman Spectroscopy
- Fourier Transform Infrared Spectroscopy (FTIR)
- Gas Chromatography-Mass Spectrometry (GC-MS)
- Inductively Coupled Plasma Mass Spectrometry (ICP-MS)
- Ultraviolet, Visible and Infrared Spectroscopy (UV-Vis-IR)
- Auger Electron Spectroscopy (AES)
- X-Ray Photoelectron Spectroscopy (XPS)
- TOF Secondary Ion Mass Spectrometry (TOF-SIMS)



MIMOS RELIABILITY LAB



MIMOS Reliability Lab was established in 2009 to provide strategic, internationally-compliant reliability testing and engineering services. The lab provides comprehensive technical support for a wide range of industries from telecommunications and automotive to consumer electrical and electronic products and appliances for multinational corporations, local industries and universities.

MIMOS Reliability Lab is accredited with MS ISO/IEC 17025 Testing Lab Competency by Standards Malaysia (DSM), and staffed by highly competent R&D engineers in testing, internationally-compliant standards and product qualification.



Capabilities

Mechanical Testing

Determines robustness of products and mechanical properties such as housing material and sealing mechanism against dynamic stresses during storage, transportation and operation.

- **3-Axis Vibration Shaker**
Resonance check, shock, random and sinusoidal waveforms (5 to 2000Hz at max 30GRMS)
- **Drop Tester**
Free fall testing on concrete or steel plate (up to 1m in any direction, max 85kg load)
- **Ingression Protection Tester**
Water testing; complies with IEC 60529 (water jet IPX5 and IPX6, immersion tank IPX7)
- **Impact Tester**
Material ruggedness (up to 1kg in 1m fall)

Environmental Testing

Determines resistance of products to various environmental conditions during storage, transportation and operation. Applies to product's ability to withstand stresses related to rapid temperature change, hot, cold and high humidity weather, heavy rain, direct sunlight or sea mist.

- **Temperature/Humidity Cycling Chamber**
-70°C to 180°C; up to 98% RH
- **Thermal Shock Chamber**
-80°C to 180°C
- **Combined Temperature/Humidity/Vibration**
-70°C to 180°C up to 98% RH and max 30GRMS
- **Autoclave Chamber**
105°C to 150°C, max 2 bar pressure; up to 100% RH

- **High Temperature Ovens**
25°C to 300°C
- **Salt Spray Chamber**
Corrosion testing
- **Blowing Rain Chamber**
Simulates heavy rain with winds up to 40mph
- **Xenon Weather-Ometer**
Solar radiation testing

Electrical Testing

Determines product compliance with safety requirements.

- **Electrostatic Discharge (ESD) Stimulator**
- **Electrical Safety Test**
 - **Insulation Resistance**
 - **Overload Protection**
Short Circuit Strength

Custom (Specialised Testing)

Customised tests can be designed per product or end user application such as usability, life cycle, simulation jig for manufacturing and green house application.

- **Cyclic Latch/Unlatch**
- **Switch and Joystick Life Cycle**
 - Altitude Test
 - High Air Pressure Test
 - Hydrostatic Pressure Test
- **Chemical Resistance Test**
- **Flex 10-pin Connectivity Tester**
- **Water Pressure Pipe Endurance Test**

Future Expansion (2016)

- **Component Reliability Testing**

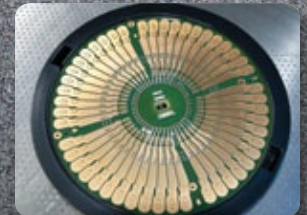
MIMOS WAFER & IC TESTING LAB



MIMOS Wafer & IC Testing Lab provides wafer sort and testing services for processing of up to 200mm wafers. The lab is equipped with Automatic Test Equipment (ATE) for evaluating and testing Digital, Analog/Mixed-Signal (AMS) and Power Devices, and provides engineering support for product prototyping.

The key services provided are:

- Parametric Test (PCM)/Wafer Acceptance Test (WAT)
- Wafer Sort Capabilities/Chip Probe Test (CP)
- Wafer-Level Reliability Testing and Monitoring
 - *Including Hot Carrier Injection (HCI) and Mobile Ionic Contamination (MIC)*
- Device and Interconnect Modelling
- Test Program Development Consultation
- Test Engineering Training
- Test Data Analysis Tools



Capabilities

Parametric Test (PCM)/Wafer Acceptance Test (WAT)

Auto Parametric Test Systems enable semiconductor manufacturers to significantly reduce test time for DC and capacitance measurements in semiconductor wafer manufacturing processes.

- **4072 Auto Parametric Test System**
 - Agilent 4072A Advanced DC Auto Parametric Tester with 4 Source Measurement Units (SMUs) and 48-pin switch matrix
 - Tester is directly docked to Electroglas 4090µ Fully Automatic Prober
- **4073 Auto Parametric Test System**
 - Agilent 4073A Ultra Advanced DC Auto Parametric Tester with 8 Source Measurement Units (SMUs), 48-pin switch matrix and 1fA low current measurement capability
 - Tester is directly docked to Accretech UF200 Fully Automatic Prober with 150°C Hot Chuck capability
- **4082A Auto Parametric Test System**
 - Agilent 4082A Advanced DC Auto Parametric Tester with 4 Source Measurement Units (SMUs), 38-pin switch matrix and high throughput testing
 - Tester is directly docked to TEL Precio Octo Fully Automatic Prober with 150°C Hot Chuck and 150µm Thin Wafer capability

Wafer Sort Capabilities/Chip Probe Test (CP)

Wafer-level functional chip testing provides sorting of good and fail die binning to ensure cost-effective assembly and support further test processes. There is available tester integration to Electroglas 4090µ Fully Automatic Prober with 150°C Hot Chuck or TEL Precio Octo Fully Automatic Prober with 150°C Hot Chuck and 150µm Thin Wafer capability.

- **Analog/Mixed-Signal Test Sytem**

LTXC ASL1000 Tester for advanced linear and analog/mixed-signal markets

- **Functional Test System (Microcontroller and Consumer ICs)**

LTXC Diamond 10 (D10) Tester is a low-cost and high-throughput production test solution with speeds up to 200MHz and a 96-pin digital channel

Wafer-Level Reliability Testing and Monitoring

Wafer-level reliability determines the reliability and lifetime of devices at wafer level to ensure faster characterisation, even prior to packaging.

- **Plasma Damage and Hot Carrier Injection (HCI Degradation) Test System (Automatic)**

PDQ-WLR Test Software and PDQ-AT Analysis Software for Hot Carrier Injection (HCI) and Plasma Damage integrated to MIMOS 4073 Auto Parametric Test System

- **Mobile Ionic Contamination (MIC), Electromigration, CV Measurement and Gate Oxide Integrity Test System (Manual)**

Keithley CV and IV System bench equipment with up to 250°C Hot Chuck capability for Bias Temperature Stress (BTS) characterisation

Device and Interconnect Modelling

This modelling method determines the circuit simulator models for behaviour of electrical devices based on fundamental physics and wafer fab processes to ensure accuracy of integrated circuit (IC) designs.

- **Device Modelling and Simulation for Device & IC Design (BSIM3v3)**
Integrated Circuit Characterisation and Analysis Program (ICCAP) device modelling software and SPICE Circuit Simulation
- **Interconnect Parasitics Modelling**
Mentor Graphics XCalibrate modelling software

Bench Test Equipment

Bench test equipment allows for verification of auto tester results and manual test investigation. This is available with Micromanipulator 8060-FS8-VO-1-C Manual Probe Station (with and without light-tight enclosure), Temptronic TP0315A-TS-2 Temperature Controller (from 25°C to 250°C) and Metric ICS software.

- **Keithley CV System**
Keithley 230 Programmable Voltage Source, Keithley 595 Quasi Static CV Meter and Keithley 590 High Frequency CV Analyser
- **Keithley IV System**
Keithley 236 Source Measurement Unit and Keithley 2361 Trigger Controller
- **HP IV System**
HP 4145B Semiconductor Parametric Analyser

Wafer Thinning Services

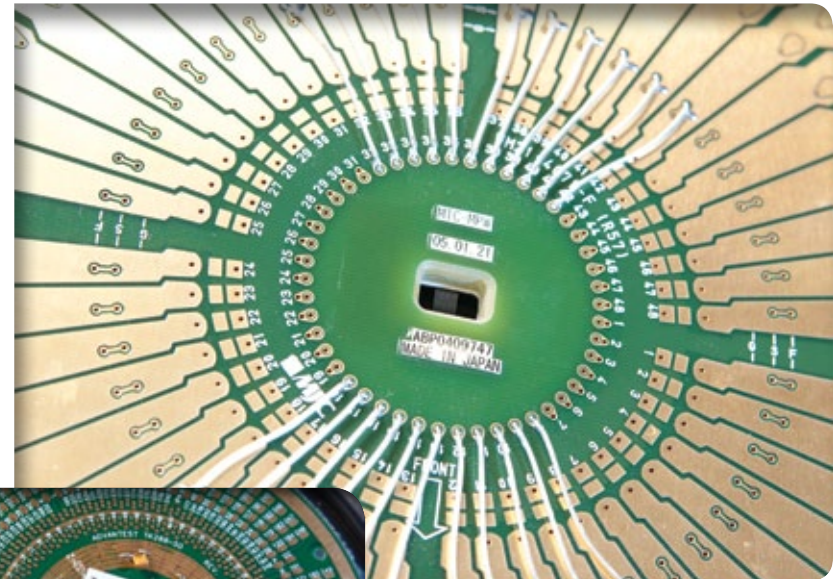
Also available is a complete backgrinding system for wafers inclusive of taper and detaper.

- **Backgrinding System**
Disco DFG840 Wafer Back Grinder (with capability to backgrind wafers up to 250µm thickness), Takatori ATM-1100E Wafer Protective Tape-Laminating Machine (Taper) and Takatori ATM-2100D Wafer Protector Tape Remover (Detaper)

Data Analysis

For in-depth process and yield, these software provide statistical analysis and integrated data analysis.

- **Standalone Tools**
JMP and Minitab Statistical Analysis Software
- **Integrated Data analysis**
Galaxy Examiner Pro Software (for data testing, device characterisation, test program qualification and yield analysis from standard semiconductor data files integrated to MIMOS Automatic Testers)



MIMOS WAFER FABRICATION & WAFER PROTOTYPING LAB

MIMOS NSTC's second facility, Fab 2, produces 200mm wafers at medium volume capacity. Our operation is backed by robust technologies from IMS Germany and NTT Japan.

The 200mm wafer fabrication plant is fully-equipped with industry-standard technology as well as machinery, to cater to various industrial and research requirements. We are able to provide a wide range of services including Design Support, Customised Processes, Multi-Project Wafer (MPW) programmes and Product Development & Fabrication in CMOS, HVMOS, Digital, Analog and Microelectromechanical Systems (MEMS) technology platforms.



Capability	Process Technology	Process Description	Features
CMOS	0.35 μ m	CMOS Analog/Mixed-Signal Technology	2P3M, 3.3V I/O, Device Model Verification
	0.5 μ m		2P2M, 5.0V I/O, Device Model Verification
HVMOS	0.2 μ m	Trench HVNMOS	Low RDSon, Trench, 20V and 30V Manufacturing Proven
	0.4 μ m		Low RDSon, Trench, 60V and 70V Manufacturing Proven
Schottky Diode	0.2 μ m	Trench Schottky Diode	Low Vf, 45V and 60V Manufacturing Proven

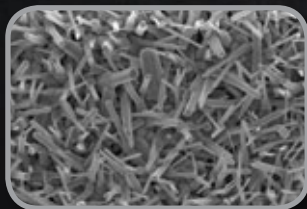
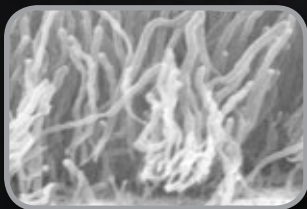
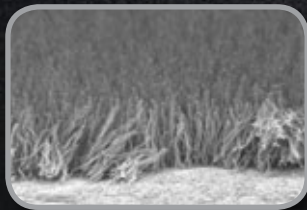
Equipment List

- Furnaces for Annealing and Various Film Deposition/Growth
- High Clean Bench
- Low Clean Bench
- Etch Bench
- Aluminum Etch Bench
- Metal Etch (Silicide Etch)
- Wafer Scrubber System
- Solvent Bench System
- High Current Ion Implanter System
- Medium Current Ion Implanter System
- Physical Vapour Deposition (PVD) System
- Rapid Thermal Processing (RTP) System
- Spin-on Glass (SOG) Coater System
- Film Stress Measurement System
- Four Point Probe System
- Fourier Transform Infrared Spectroscopy (FTIR)
- Wafer Marker
- Surfscan Inspection System
- Plasma Enhanced Chemical Vapour Deposition (PECVD) for Silicon Dioxide and Silicon Nitride Deposition
- Tungsten Silicide CVD System
- Tungsten CVD and Etchback System
- Sub-Atmospheric Chemical Vapour Deposition (SACVD) System
- Chemical Mechanical Polishing (CMP) System
- Bare Wafer Inspection System
- Reactive Ion Etching (RIE) equipment for Films (Oxide, Nitride, Poly, AlCu, AlSiCu, Silicon) Etching
- Poly Backside Etcher
- Resist Asher
- Step Height System
- Film Thickness Measurement System
- Ellipsometer System
- Stepper System
- Scanner System
- Coater/Developer
- Deep Ultra Violet (DUV) System
- Oven System
- Overlay System
- Pattern Wafer Inspection System
- Critical Dimension Scanning Electron Microscope (CDSEM) System
- Inspection Microscope System



MIMOS NANO-ELECTRONICS, MEMS FABRICATION & MATERIAL SYNTHESIS

MIMOS Nanofabrication Lab is a state-of-the-art facility for high-specification nanofabrication and nanomaterials synthesis. Services provided include specialised process technologies developed in-house through a novel process integration of traditional top-down wafer fabrication processes with leading edge bottom-up nanomaterials synthesis on a full-scale 200mm wafer or on a selective region. Available nanomaterials developed include Graphene, Carbon Nanotubes (CNTs), Nanowires, Nanoparticles and their hybrid derivatives.

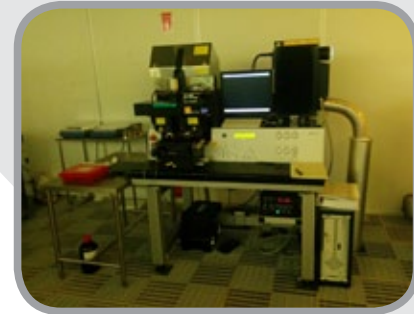
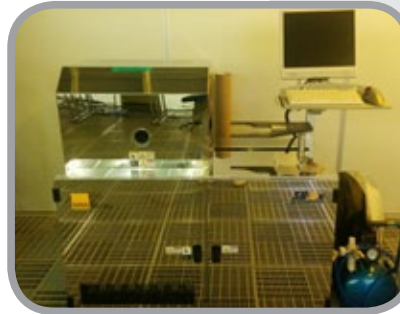


Nanomaterial	Process Technology	Process Description	Features
Carbon Nanotubes	PECVD	Carbon Nanotubes on Wafer	Multi-wall CNTs, aligned
Graphene	CVD	Graphene on Catalyst Wafer	Single Layer/Multi-layer Graphene
Nanowires/ Nanoparticles	PECVD	Nanowires/Nanoparticles on Wafer	Nanowires: Silicon, Zinc Oxide Nanoparticles: Ferromagnetic (Co, Ni, Fe), Metallic (Pt, Au) and others
Zinc Oxide Nanowires	Hydrothermal	Low Temperature ZnO Nanowires on Wafer	Temperature: <100°C

Note: All nanomaterials can be synthesised on a full 8-inch wafer or on a selective region.

Equipment List

- PECVD System for Nanomaterial Growth (CNTs, ZnO Nanowires and Silicon Nanowires)
- PECVD System for Graphene Growth (Available in Q4 2015)
- Deep Reactive Ion Etcher (DRIE) System
- RF-Magnetron Sputtering System
- Electron Beam Evaporator System
- Wafer Coating System
- Wafer Development System
- Double-Sided Mask Aligner System
- Anodic Wafer Bonder
- Wet Chemical Benchess



MIMOS IC Design Services

MIMOS NSTC's IC Design Lab is fully equipped with the latest EDA tools and provides consultation services to industries and academia.

The team consists of experienced designers and experts with years of experience in the semiconductor industry.

The lab's technical capabilities include:

System Architecture/SoC

- MCU, DSP, ASIC, Memory, Peripherals
- System Specification
- System Analysis and Modelling
- System Budgeting

Analog IC

- Interface/Driver for Chemical and Physical Sensors
- 12-bit and 10-bit SAR Analog-to-Digital Converter
- 16-bit SD Analog-to-Digital Converter
- 10-bit Pipeline Analog-to-Digital Converter
- Auto Digital Calibration

ASIC

- Top Level and Module Specification
- Design Partitioning: Microarchitecture
- RTL
- Verification: RTL, Formal, Netlist and System Verification
- Synthesis and DFT
- STA and Timing Closure

Layout

- Deep Nanometre APR (Multi-Mode Multi-Corner APR)
- Floorplanning, Place and Route
- DRC and LVS
- ECO and Timing Closure
- High Performance Analog IC Layout

FPGA and System Prototyping

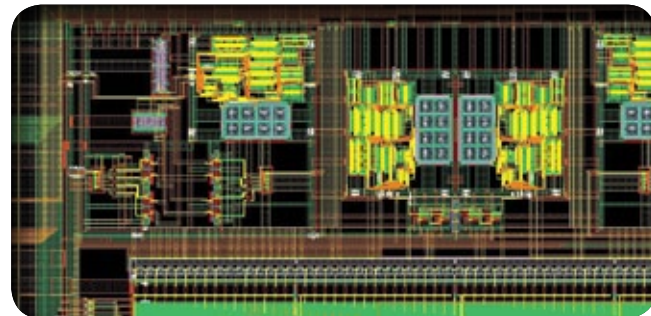
- System Design
- ASIC to FPGA Prototyping
- ASIC Emulation on Multi-FPGA Platform
- System Integration
- Verification and Validation on Hardware

Technology Library

- CMOS 90nm Logic
- CMOS 0.18 μ m Logic and Mixed-Signal
- CMOS 0.18 μ m (MVdd, MVth)
- CMOS 0.35 μ m Logic and Mixed-Signal

EDA Tools

- Cadence, Synopsys and Mentor Graphics
- FPGA



MIMOS HANDS-ON SKILLS DEVELOPMENT PROGRAMME



With over 20 years' experience in Wafer Fabrication, Failure Analysis, Wafer & IC Testing and IC Design. MIMOS NSTC offers on-the-job, high-end customised training schemes based on real industry needs. To date, we have trained more than 1,200 engineers to become highly qualified experts in semiconductors. Courses are built on a 20:80 ratio of theory and hands-on experience.

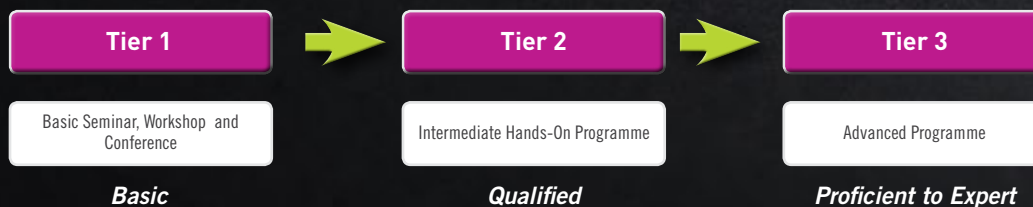
The skills development programme focuses on:

- 1) Wafer Fabrication Processes
- 2) Failure Analysis
- 3) Reliability Testing
- 4) Semiconductor Testing
- 5) Integrated Circuit Design

Programme Objectives

- Equip undergraduates with relevant industry experience through structured development schemes
- Enhance graduates' and engineers' skills through upskilling and advanced skills development courses
- Experiential hands-on learning environment using MIMOS' industry-grade facilities

Development Programme Track



OTHER R&D SERVICES



Rapid Prototyping, 3D Printing, Industrial and Mechanical Design and Appearance Modelling

In design development, 2D drawings or 3D CAT data add to the difficulty in evaluating and understanding a design. Physical models have been known to provide quick, clear and precise definition of a design leading to easier and faster visualisation. Rapid prototyping models function as a powerful visualisation tool during conceptualisation stages, assembly review and functional analysis. With this, potential issues on quality, time, cost and service life can be

predicted and avoided altogether. Designers are also able to view and feel a design for evaluation, and manufacturing teams can easily provide inputs for design improvement.

MIMOS Rapid Prototyping & Design Consultation Services is equipped with facilities to carry out prototype fabrication, reverse engineering and part inspection analysis. **3D Systems' Selective Laser Sintering Rapid Prototyping Machine** is known for producing accurate, quality, durable and stable parts for a variety of materials including metal. For reverse engineering, there is **ATOS II 50 3D Digital Scanner**, a practical tool to scan any surface for conversion into 3D digital surface data.



CONNECT WITH US

BUSINESS AND TECHNOLOGY COLLABORATION

MIMOS Nano Semiconductor Technology Centre (NSTC) provides Wafer Fabrication & wafer prototyping, IC Design, Failure Analysis/Material Analysis, Hands-On Skills Development Programme, Reliability Testing, Wafer & IC Testing, Rapid Product Prototyping, Nano & MEMS Fabrication & Synthesis, and Nanocharacterisation (under the NANOVerify programme). We offer a full chain of services with excellent business value through technology collaborations with fabless design houses, end product customers and technology partners.



Nano Semiconductor Technology Centre

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MIMOS Malaysia



MIMOS Wafer Fab Semiconductor Services



MIMOS Nano Semiconductor Technology

ENERGISING MALAYSIA'S E&E ECOSYSTEM



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