SHINE

Singapore Hybrid-Integrated
Next-Generation μ-Electronics Centre

Seeds a National Heterogeneous Integration Pilot Line to Enable Hybrid Electronic Technologies for Diverse IoT Applications.

NUS National University of Singapore

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

The Contents

SHINE Facilities

Singapore Hybrid-Integrated Next Generation μ-Electronics (SHINE) is bolstered by cutting-edge facilities at both the National University of Singapore (NUS) and Nanyang Technological University (NTU) Singapore. Key facilities include:

E6NanoFab: An advanced micro and nanos fabrication center situated within the NUS College of Design and Engineering is equipped to handle intricate and precise technological processes essential for advancing semiconductor research.

iFlex: An innovative Centre for Flexible Devices, based at NTU, dedicated to pioneering advancements in flexible electronics and related technologies.

SHINE proposes a unique integrated interdisciplinary research platform approach that includes System Design, Novel Material Development, and Manufacturing Methods focused on the realization of a complex state-of-art technology demonstrator for commercial interests and dual-usage.

Research Community

Technical / Scientific

Inter-college Disciplinary

Collaboration

SHINE New Sandbox R&D Facilities

SHINE @ NUS

Class 10,000 Cleanroom

- 150 sqm
- Mainly for back-end-of-line processing and packaging

BEOL and Packaging

- 1080.77 m^2 dry lab
- Mainly for failure analysis, testing characterisation, and board-Level assembly

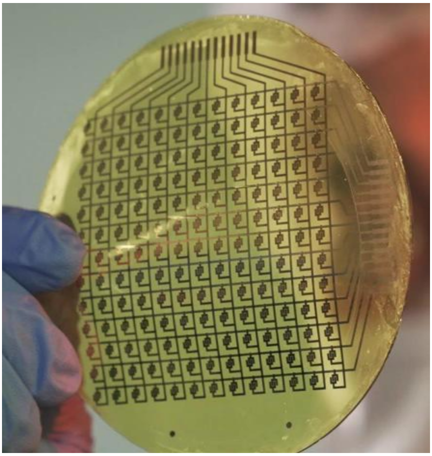
Wet Lab

- 85 m^2 shared wet processing lab
- Mainly for chemical reagent preparation and experiments

SHINE @ NTU

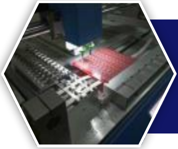
Class 10,000 Cleanroom

- Approximate 200 sqm
- For flexible electronics processing



Soft Composite Material Processing System

Customized Flexible Circuit Board Fabrication System



Integrated Packaging System

BEOL Packaging Process Summary

Precision Bonding and Assembly

The AmicraNANO Ultra-Precision Die & Flip Chip Bonder and the Laser Solder Jetting System enables ultra-precise die attachment, flip-chip bonding, and soldering processes.

Pick &-Place Integration Scaling

The AMICRA Nano Micro Transfer Printing enables superior chip performance in the simple form factor of a monolithic IC wafer that is further processed by a wide range of advanced packaging techniques for monolithic dies.

Advanced Material Processing

The facility is equipped with essential tools such as the Automatic Grinder and Fully Automatic DIE Separation System for wafer grinding, die separation, and processing complex microelectronics materials. Additionally, it Key Features

an Ultrasonic Spray Coating System and Aerosol Jet Printing capabilities for precision coating applications and interconnect printing using advanced materials.

Co-Packaged Optics Capability

Equipment such as the Silicon Photonics Measurement and Probe System (SPMPS) and the 3D Two-Photon Lithography Printer are utilized for high-precision testing of silicon photonics and facilitate the on-chip hybrid integration of photonics components.

Characterisation and FA Inspection

The Nordson DAGE 4000Plus Bond Tester, Microsaj Infrared & Thermoreflectance Thermography and the Infrared Microscope provide capabilities for rigorous bond testing, defect analysis, and non-destructive internal inspections, ensuring the highest quality in semiconductor device fabrication.

Advanced Packaging

Recent breakthroughs in low-cost packaging and high-density substrates have further fueled its adoption, making it the go-to choice for smart phones, tablets, personal computers, servers, and more.

With continuous evolution and recent developments in bumping solutions for advanced packaging, flip-chip technology is poised to conquer challenges and continue its dominant role in the semiconductor world.

Amicra NANO Ultra-Precision Die & Flip Chip Bonder

- Support ±0.3 µm @ 3 sigma placement accuracy
- Support all die attach and flip-chip applications including all AFC^{Plus} capabilities
- Higher resolution alignment optics
- Active vibration damping system
- Automatic placement offset tuning system
- High resolution 300 mm bonding station
- Dynamic alignment system
- Quantitative parallelism calibration

Applications / Industry / Market

- Single mode / Si Photonics / PIC AOC / WLP
- Optical device packaging
- Direct bond interconnect

Location: NUS SHINE Centre, E6, Level 2 Cleanroom

FINEPLACER SIGMA Flip Chip Die Bonder

- Sub-micron placement accuracy
- Capable for substrates up to 450x150mm.
- Bonding forces up to 500N.
- Temperature: Stage 300ºC; Bonding head 450ºC.
- Semi-automatic mode.

Location: NUS E6NanoFab, E6, Level 5 Cleanroom

WESTBOND 7674E Wire Bonding

- Deep access 90º wire or ribbon feed
- Single point tab/lead bonding
- Bond force range: Adjustable, 10 to 250 grams.
- Transducer: ½ wave, 63 KHz (nominal)
- Ultrasonic: Built-in, 8 bit, 4 watts (Ultrasonic Positioning Utility).
- Wire range: 0.7 to 2.0 mils , 1x10 mil gold ribbon.

Location: NUS E6NanoFab, E6, Level 5 Dry Lab

Pactech Laser Solder Jetting System

- Support ±0.3 µm @ 3 sigma placement accuracy
- Single step solder ball placement and reflow
- Flux-free reflow with laser
- Solder ball diameter: 40 µm to 760 µm
- High solder alloy flexibility: Eutectic SnPb, high-lead SnBb, lead-free SnAg, SnAgCu, etc.
- Up to 10 balls/sec
- Resolution: 1 µm, repetition accuracy: 3 µm
- Ball rework and repair capability

Applications / Industry / Market

- Optical device packaging
- Semiconductor packaging
- Microelectronics assembly

Location: NUS SHINE Centre, E6, Level 2 Cleanroom

AMICRA NANO Micro Transfer Printing (MTP)

- Ultra-precision placement: Utilizes X-Celeprint's MTP technology for high-volume, heterogeneous integration.
- High throughput: Capable of handling ultra-thin dies with high accuracy

Key Features

- Placement accuracy: ±0.5 microns for precise applications like photonics.
- High-speed operation: Fully automatic with a 50x50mm MTP stamp for parallel pick-and-place
- Integration capabilities: Handles multiple process technologies for creating 3D ICs

Specifications

- Max workpiece size: Up to 300mm wafers
- Placement accuracy: ±0.5 microns
- Cycle time: Approximately 40 seconds
- Equipment dimensions: Customizable based on specific system needs

Applications / Industry / Market

- Semiconductor manufacturing
- Photonics
- MEMS fabrication
- Advanced packaging
- Integrate multiple technologies onto a single platform with high precision and efficiency

Location: NUS SHINE Centre, E6, Level 2 Cleanroom

Siansonic SUT-UC330 Ultrasonic Spray Coating System

- Precision Spray Technology: Utilizes high-frequency ultrasonic vibrations to generate uniform micron-sized droplets, ensuring consistently even coatings.
- Versatile Applications: Ideal for a range of materials including thin film solar cells, electronic displays, and semiconductor devices.
- High Throughput: Efficiently handles large substrates up to 330mm in diameter with fast processing times.

Specifications

- Max Substrate Size: Up to 330mm in diameter
- Coating Uniformity: Achieves uniformity with precision control over droplet size from 10 to 40 microns.
- Cycle Time: Capable of rapid cycling with an average time of 30 seconds per substrate
- System Dimensions: Customizable to fit specific industrial applications and workspace requirements.

Applications / Industry / Market

- Semiconductor Manufacturing: Enhances chip production with precise coating of functional materials
- Photovoltaics: Applies anti-reflective coatings on solar panels for improved energy efficiency
- Electronics: Delivers protective and conductive coatings on electronic components for enhanced performance.

Location: NUS SHINE Centre, E6, Level 2 Wet Lab

Optomec Aerosol Jet 3D printing

- Enables printing of interconnects on both 2D and 3D substrates.
- Multi-level interconnects can be created by printing a dielectric material at circuit cross over points – in essence emulating a multi-layer circuit board but on a single layer.
- Can print conformal interconnects on 3D surfaces eliminating the need for wire bonding - for example printing electrical connections on 3D stacked die or for LED chip fabrication.
- Effectively produces 3D printed electronics such as resistors, capacitors, antennas, sensors, and thin film transistors.

Key Features

- Digital printing – no masks or stencils
- No plating or etching required
- Feature sizes from 10 µm to several mm (typically around 1-3 mm) for broader applications
- Print thickness from 100 nm to 10’s of µm
- Conformal printing on non-planar and 3D surfaces
- Print interconnects and active/passive components, bio-materials
- Print using commercially-available materials
- Print on plastic, ceramic, and metallic substrates
- Scalable to support high-volume production requirements

Location: NUS E6NanoFab, E6, Level 1 Cleanroom

* *Restricted* access, T&Cs applies.

DISCO Automatic Grinder, Single Spindle*

- Simple and compact single-axis grinder:
- Designed for workpieces up to 8" in diameter
- One spindle and one chuck table
- Processes a variety of materials
- Space-saving design: Equipment dimensions: 600 (W) x 1,700 (D) x 1,780 (H) mm
- Precision grinding:
- High-rigidity, low-vibration spindle for superior results
- Capable of in-feed grinding and creep feed grinding (user-specified specification)
- Unlimited materials:
- Processes hard or brittle substrates of various diameters
- Suitable for a wide variety of electronic components
- Supported workpiece size: Ø8 inch (Ø4, 5, 6, 8 inch with universal chuck table use)
- Grinding method: Anomalous in-feed grinding with wafer rotation
- Grinding wheels: Ø200 mm Diamond Wheel
- Spindle:
    - ➢ Rated output: 4.2 kW
    - ➢ Rated torque: 5.9 N·m
- Rotation speed range: 1,000 – 7,000 min^{-1}

Applications / Industry / Market

- Semiconductor wafer grinding
- Material removal and surface finishing
- Precision component manufacturing
- Semiconductor, Electronics manufacturing, Precision engineering, Automotive and Aerospace

Location: NUS SHINE Centre, E6, Level 2 Cleanroom

* *Restricted* access, T&Cs applies.

ASMPT Surface Mount Screen Printer

- System Alignment Capability: 2 Cmk @ +/- 20 µm, 6 Sigma
- Board Size (Print Area, X-Y): 50 x 40.5 mm to 510 x 508.5 mm
- Substrate Thickness: 0.2 mm to 6 mm
- Screen/Stencil Frame Size (max): 736 mm x 736 mm, height 25 mm to 38 mm
- Stencil Loading: Semi-Auto-Load with squeegee drip tray
- Substrate Transport: Board clamp regulator
- Squeegee Pressure Mechanism: Software controlled, motorized with closed-loop feedback
- Squeegee: Clamped double trailing edge squeegee
- Tooling Pins: 30 magnetic pins (19 mm)
- Print Speed: 2 mm to 300 mm/sec
- Stencil Alignment: Motorized via actuators X, Y, and Theta
- Fiducial Recognition: Automatic fiducial teach and find incorporating 0.1 mm fiducial capture
- Operator Interface: Touch screen display, keyboard, trackball with DEK InstinctivTM software

Applications

- Precise screen printing for electronics fabrication
- Stencil printing for printed circuit boards (PCBs) or textile
- High-accuracy alignment and print processes for surface mount technology (SMT)

Location: NUS SHINE Centre, E6, Level 6 Dry Lab

Invacu Infrared Vacuum Reflow Oven

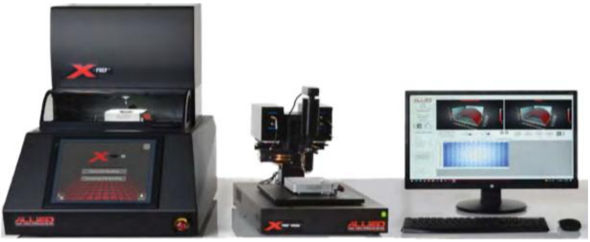
- Process Environment: Nitrogen, inert gas, formic acid, forming gas
- Maximum Temperature: 450°C
- Heating Area: 320 x 320 mm
- Heating Plate: Removable graphite
- Clearance Above Heating Plate: 60mm
- Heat Up / Cool Down Ramp Rate: 250°C/min
- Control Deviation: +/- 0.5°C
- Heating Elements: 8x infrared lamps (under graphite)
- Heating Control: Individual/adjustable
- Cooling of Heating Plate: Nitrogen flow
- Temperature Measurement: 2x thermocouples, K Type
- Pressure Measurement: Integrated pressure transmitter
- Maximum Vacuum: 1x10-2 mbar
- Cooling of Chamber Body: Water/ Ethylene/Glycol
- Display: 10" LCD with touch screen
- User Interface: Remote control over relay I/Os

Applications

- Reflow soldering
- Bonding
- Thermal processing

Location: NUS SHINE Centre, E6, Level 6 Dry Lab

X-Prep Automatic Milling, Grinding & Polishing Machine



Key Features

- Process Area: 50mm (X) x 50mm (Y)
  *Up to 100mm (X) x 100mm (Y)
  (*with a different fixture)
- 3 points levelling tolerance: 0.5um.
- Feed rate: 40um/s - 20mm/s
- Closed-loop X/Y-axis positioning: 1um resolution.
- Closed-loop Z-axis positioning: 0.1um resolution, 1um accuracy
- Closed-loop Z-axis force control: 0.5 - 10 N.
- User Interface: Easy to use with workflow guides.
- Software X-vision: Automatic 3D mapping/profiling (convex & concave).

Process Mode & Material Removal

Position (Milling/Grinding)

- FR-4
- Copper heat sink/lead frame
- Mold encapsulant
- Silicon
- Ceramic

Position Force (Grinding/Polishing)

- Passivation
- Remaining Mould compound
- Wire bonds
- Metal layers
- ILD/IMD

Floating Force (Polishing)

- Polishing cloth
- Diamond Paste
  (1,3,6,9, and 15um)
- Colloidal Silica (0.04um)

Applications

- Metallography
- Microelectronics
- Failure Analysis

Location: E6NanoFab, SHINE Centre (Dry Lab)

DISCO Fully Automatic DIE Separation System*

- Improves cut quality of thin wafers with DAF
- Effective for DAF cutting after DBG process
- Stable die separation after Stealth Dicing™ process
- Cool expansion increases DAF separation quality
- Smooth tape frame transport to the next process
- Max. workpiece size: Ø300 mm
- Cooler Stage Temperature range: 0 or -5°C
- Max. upthrust: 30 mm
- Heater Stage: Temperature: 200, 220, or 250°C
- Max. upthrust: 20 mm

Application of Industry / Market

- DAF separation after blade dicing
- DAF separation after DBG
- Die separation after Stealth Dicing™

* *Restricted* access, T&Cs applies.

Location: NUS SHINE Centre,
E6, Level 2 Cleanroom

DISCO Fully Automatic SD Laser System*

- Improves cut quality of thin wafers with DAF
- Laser processing method: Focuses a laser within the workpiece to form a modified layer
- Die separation: Achieved with a tape expander
- Minimal cutting waste: Only subsurface layer processed, ideal for contamination-sensitive workpieces
- Dry process: No cleaning required, suitable for applications like MEMS that are sensitive to mechanical load
- Extremely narrow kerf widths: Allows significant reductions in street width
- Max workpiece size: Ø300 mm
- Processing method: Fully automatic
- X-axis max feed speed: 0.1 - 1,000 mm/s
- Y-axis positioning accuracy: Within 0.003 / 310 mm

Applications / Industry / Market

- MEMS fabrication
- Semiconductor wafer processing
- Microelectronics assembly

Location: NUS SHINE Centre, E6, Level 2 Cleanroom

* *Restricted* access, T&Cs applies.

LOGITECH Chemical Mechanical Planarization (CMP)

- Wafer size: up to 200mm or 8”.
- Chip carrier: 15mm x 15mm.
- Metal and dielectric Planarization (Cu, Al, SiO_2, SiN, W).
- Within wafer non-uniformity 5%.
- Run to run non-uniformity 5%.
- Finishing surface roughness 1nm.

Location: NUS E6NanoFab, E6, Level 1 Cleanroom

ACCRETECH Wafer Dicing

- Dicing of full wafers up to 8” and piece-parts.
- Feature extremely thin diamond blade to dice or groove semiconductor wafers and other work pieces.
- Automatic work-piece loading, alignment, and unloading.
- Automatic, Semi-automatic and Manual mode.

Location: NUS E6NanoFab, E6, Level 3 Metrology Lab

EOULU Silicon Photonics Measurement and Probe System (SPMPS)

System Overview

- The SPMPS merges measurement and probe capabilities into a unified platform designed for high-precision silicon photonics testing. This system simplifies complex procedures, ensuring efficiency and accuracy for both research and production environments.

Key Features

- Integrated Software: Manages both measurement and probing operations through the future C SIPH software, enhancing workflow continuity.
- Advanced Positioning: Utilizes Hexapod and Nanocube for precise six-axis control, crucial for exact alignment in photonics testing.
- Precision Positioning Technology: Utilizes Hexapod and Nanocube technologies for six-axis positioning, crucial for the exact alignment required in silicon photonics testing.

Specifications

- Flexible Network Setup: Detailed guidelines support seamless integration with existing networks.
- High Precision Calibration: Offers extensive calibration options, including MTR, PZT, and PVT calibrations, ensuring high accuracy and repeatability across all testing and probing operations.
- Automated Testing Procedures: Automated protocols streamline the testing process, significantly reducing manual intervention and increasing throughput.
- User-Friendly Interface: Offers an intuitive control panel for straightforward system operation.

Location: NUS SHINE Centre, E6, Level 6 Dry Lab

NANOSCRIBE GT2 3D Two-Photon Lithography Printer*

Scientific 3D printer designed for ultra-precise and rapid scientific microfabrication

Key Features

- Printing technology Layer-by-layer Two-Photon Polymerization
- Minimum XY feature size 160 nm typical; 200 nm specified*
- Finest XY resolution 400 nm typical; 500 nm specified*
- Finest vertical resolution 1,000 nm typical; 1,500 nm specified*
- Max. scan speed from 100 to 625 mm/s*

Specifications

- High-speed 3D Microfabrication with high precision and true design freedom
- Straightforward workflow with open software architecture
- Broad range of application-specific and universal printing materials
- Open system for custom-made and third-party materials

Location: NUS E6NanoFab, E6, Level 2 Cleanroom

** Restriction access, T&C applies*

Microsanj Infrared & Thermo-reflectance Thermography

Transient Resolution: 12.5 ns Delay, 50 ns Pulse Duration (FWHM)

Sensors: CMOS & VO Microbolometer

Active Thermal Pixels:

- TR mode: 2048 x 2048 (4 MP); Pixel pitch 5.5um
- IR mode: 640 x 512 (0.33 MP); Pixel pitch 12um
- InGaAs mode: 636 x 508 (0.33 MP) ; Pixel pitch 25um

Spectral coverage range: 365 nm to 1700 nm (TR+IR)

Spatial Resolution: Diffraction limited: 336 nm
(470 nm LED, 100x, NA=0.7)

Pixel Resolution:

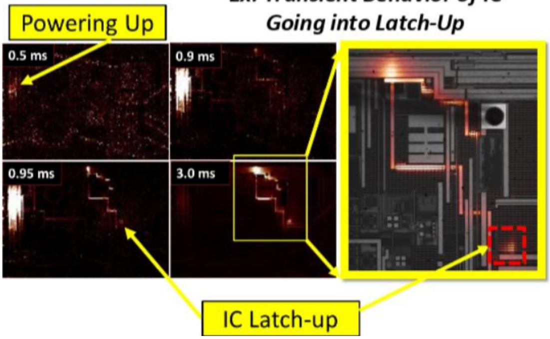
- 55nm/pixel at 100x (TR mode)
- 24um/pixel at 0.5x (IR mode)
- Noise Equivalent Temperature Difference (NETD): <0.25°C (Typical with 5 min averaging)

Illumination Sources:

- VIS LEDs: 365 nm, 470 nm, 530 nm, 780 nm.
- NIR LEDs: 985nm, 1064nm, 1210nm, 1370nm
- Microscope Objectives: 5x, 20x, 100x

Stage – Probe Station:

- 125 mm x 125 mm Stage
- 500 W Cooling Capacity
- 20 °C to 150 °C
- 200 x 200 x 200 µm Piezo Stage Travel
- 150 x 150 mm Vacuum Stage X-Y Travel



Ex: Transient Behavior of IC Going into Latch-Up

Location: NUS SHINE Centre, E6, Level 6 Dry Lab

NEOCERA Magnetic Field Imaging (MFI) System

Key Features

Scan Area: 100mm (X) x 100mm (Y)

SQUID (Package/Wafer level)
- Spatial Resolution: 2um
- Imaging depth: 100um to 1mm, a closer sensor will have better resolution.
- Operating Frequency: 4kHz – 10kHz

GMR (Wafer level)

- Spatial Resolution: 500nm
- Imaging depth: lesser than 100um with 10uA @ 10um distance
- Operating Frequency: ~100 kHz

Scanning Mode

<u>Short Scan</u>
SQUID Scan type – AC & DC
GMR Scan type – AC (RF)

<u>Open Scan</u>
SQUID Scan type – AC (RF)
GMR Scan type – RF

Capability

- Open Defect Localisation (SDR) within 30um.

Applications

- NDT Failure Analysis
- Device Characterisation

Location: E6NanoFab, SHINE Centre (Dry Lab)

Nordson DAGE 4000Plus Bond Tester

Key Features

- High-precision bond testing for semiconductor devices
- Shear test capabilities
- Advanced cartridge technology for accurate measurements
- Intuitive software for easy setup and analysis
- Automatic test routines for better throughput
- High magnification imaging
- Compact footprint: 630 mm (W) x 600 mm (D) x 830 mm (H)
- Lightweight: 90 kg
- Flexible power: 90-264 VAC single phase
- Reliable pneumatic: 4 bar minimum, 6 mm OD pipe
- Efficient vacuum: 500 mm Hg minimum, 6 mm OD pipe
- Precision accuracy: +/- 0.1% full scale deflection
- Shear load accuracy: +/- 1 µm over 2 mm (Z-axis)
- S25 accuracy: +/- 0.25 µm over 2 mm (Z-axis)

XY Stages

- High Speed: Zone shear up to 25 kg @ 50 mm/s or 50 kg @ 25 mm/s, 160 x 160 mm, Max. Y force: 50 kg
- High Force: Die shear up to 200 kg @ 0.7 mm/s, 160 x 160 mm, Max. Y force: 200 kg
- High Precision: Ultra fine pitch ball shear up to 10 kg @ 0.7 mm/s, 210 x 300 mm, Max. Y force: 10 kg

Applications / Industry / Market

- Semiconductor defect analysis & characterization
- Wire bond testing
- Validation of process & machine setup
- In-process quality control
- Wire bond strength analysis
- Materials testing
- Die shear & bond shear strength checks including Ball shear/solder ball shear, cold bump, die shear, high strain rate, ribbon peel, wedge shear & zone shear

Location: NUS SHINE Centre, E6, Level 2 Cleanroom

Hitachi Ion Miller* Precision and Versatility for Advanced Sample Preparation

Gas Utilized: Argon (Ar) gas for optimized ion beam performance.

Accelerating Voltage: Adjustable from 0 to 8 kV for various experimental needs.

Cross-Section Milling

- MaxiMaximum Milling Width: 8 mm (using wide-area cross-sectional milling holder).
- Sample Size Capability: Up to 20(W) × 12(D) × 7(H) mm.
- Sample Movement Range: X ±7 mm, Y 0 to +3 mm.
- Ion Beam Intermittent Irradiation: Standard feature for enhanced precision.
- Swing Angle Options: ±15°, ±30°, ±40°.
- mum Milling Rate: ≥ 1 mm/h (Silicon).

Flat Milling

- Milling Area: ϕ32 mm.
- Maximum Sample Size: ϕ50 × 25(H) mm.
- Sample Movement Range: X 0 to +5 mm.
- Rotation Speed: 1 rpm, 25 rpm.
- Tilt Range: 0 to 90°.
- Ion Beam Intermittent Irradiation: Standard function.

Applications

- Cross-sectional analysis
- Precise milling of semiconductor devices
- Internal structures and layers inspection

Location: NUS SHINE Centre, E6, Level 6 Dry Lab

* Restricted access, T&Cs applies.

QATA Grinding and Polishing Machine*

- User-Friendly: 4.3" touchscreen interface.
- Variable Speeds: 30-600 rpm (grinder), 30-160 rpm (head).
- Versatile Discs: Supports Ø 200/250 mm.
- Sample Capacity: Holds 1-6 samples (ø 40 mm).
- Adjustable Pressing Force: 5-80 N (single), 20-350 N (central).
- Integrated Cooling: Effective cooling and debris removal with a fresh-water connection up to 6 bars.
- Automated Efficiency: Load detection, start/stop functionality.

Applications

- Preparation of electronic components and materials for failure analysis
- Fine polishing for surface layer removal.

Location: NUS SHINE Centre, E6, Level 6 Dry Lab

** Restriction access, T&C applies*

Stereomicroscope with Camera*

- Trinocular Head: 50/50 split ratio, 45° inclined, 360° rotation.
- Eyepieces: WF10x/21 mm, high eyepoint with secure rubber cups
- Objective: Parfocal achromatic zoom 0.7x to 4.5x
- Working Distance: 100 mm.
- Stand: Precision fixed with handle and focus.
- Focusing Mechanism: Rack and pinion.
- Illumination: EcoLED™ with brightness control, colour temperature of 6,300 K, and multi-plug power supply.

Applications

- Inspecting semiconductor wafers and components for defects or irregularities.
- Performing quality control checks in fabrication processes

Location: NUS SHINE Centre, E6, Level 6 Dry Lab

** Restriction access, T&C applies*

Nikon Eclipse L200N Infrared Microscope

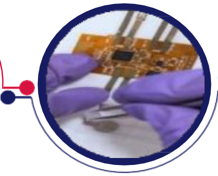
- Observe in the infrared (IR) region for non-destructive internal inspection of silicon wafers, IC chips, MEMS, and other semiconductor devices
- IR plan achromat objectives enhance contrast and improve flat-field imaging for reliable measurements
- Long working distance reduces the risk of sample damage
- Optimal transmission in the NIR region (700–1300 nm)
- Chromatic aberration correction adjusts to varying thicknesses of silicon or glass for clearer images

Applications / Industry / Market

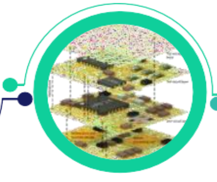
- Semiconductor inspection
- Material science research
- Forensic analysis

Location: NUS SHINE Centre, E6, Level 2 Cleanroom

Material Innovations



Manufacturing capabilities

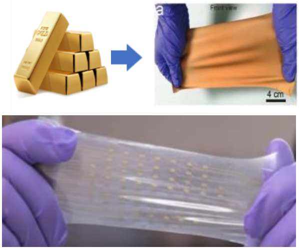


Sensing Mechanisms

Industry Standards

System Integration

NTU Differentiating Solutions



Nature ***2023****, 614,456*

Stretchable Metal Electrodes

✓ Superior stretchability (~400%)

✓ Electronic conductor

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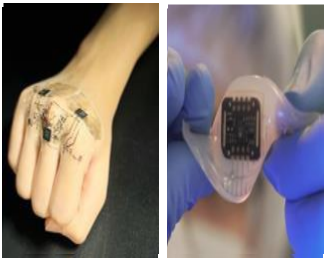


Conformal & Bendable Soft Electronic Devices

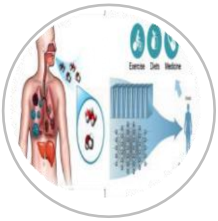
✓ Tunable properties
✓ Biocompatibility
✓ Durability & stability
✓ Seamless integration
✓ Scalable production

Human-Machine Interface Myoelectric Prosthetic Control

✓ Dexterous grasp & precise placement

✓ Highly accurate amputee movement prediction

Key Verticals



Healthcare

Consumer electronics

IoT

Automotives

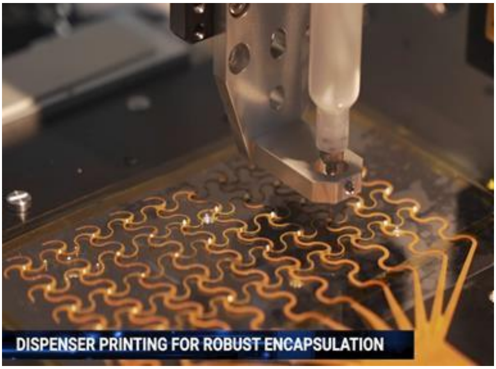
Soft Robotics

Smart Desktop Dispensing Robots

Key Features

- Edge detection for various work shapes
- Dispense correction function
- Gap measurement data retention
- Dimension measurement, dispense path trace, map generator, dispense shape judgment
- Other Functions: 3-D alignment, work height measurement, nozzle height detection, nozzle gap correction, & automatic focus
- Efficient programming
- Complete 3D alignment
- CE Marking Certified, EU RoHS compliant

Capabilities



- ➢ High print quality
- ➢ Precise & consistent applications
- ➢ Adaptable to varying material
- ➢ Versatility and precision in manufacturing processes.

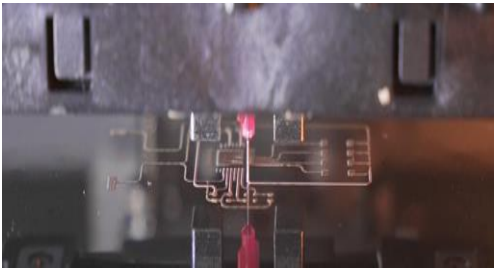
Location: NTU SHINE Centre, ABN-B3a-08

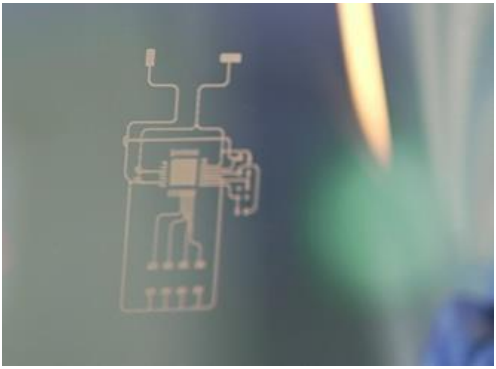
Microelectronic Printing

Key Features

- **Inkjet printing:** Automatic angle devices and inkjet algorithms ensure the effect of inkjet and printing efficiency.
- **Dispensing function:** Applicable for a variety of needles. Support all kinds of dispensing solutions and automatic height calibration.
- **Scraping function:** Accurate to 1kpa air pressure control, greatly reduces the possibility of uneven coating of the scraping material.
- Wide-ranging film thickness from tens of nanometres to micro-controllable.

Capabilities





- ➢ High print quality and efficiency
- ➢ Consistent 3D printing
- ➢ Precise material application (fine hair thickness)
- ➢ Versatile with varying materials
- ➢ Even coating and scraping with controllable thickness.

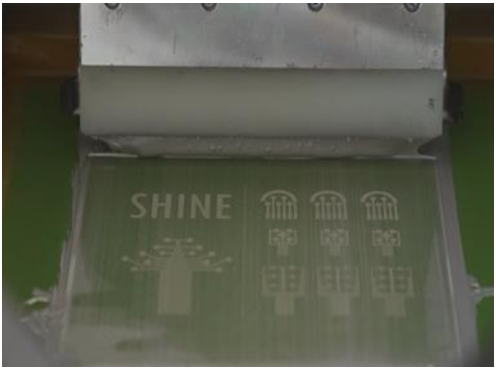
Location: NTU SHINE Centre, ABN-B3a-08

Screen Printing

Key Features

- Equipped with a CCD camera.
- Fine adjustment of XYΦ of the printing position (table side)
- Maximum print size (mm): 150 × 150
- Frame size (mm): 320 × 320

Capabilities



- High-resolution imaging
- Precise alignment and refinement
- Batch production of electrodes or circuits
- Accurate patterning

Location: NTU SHINE Centre, ABN-B3a-08

Digital Thermal Processing Platform

Key Features

- **Sintering**: For conductive silver and copper inks on PET, polyimide, paper, or textiles, e.g., CIGS and CdTe nanocrystal depositions.

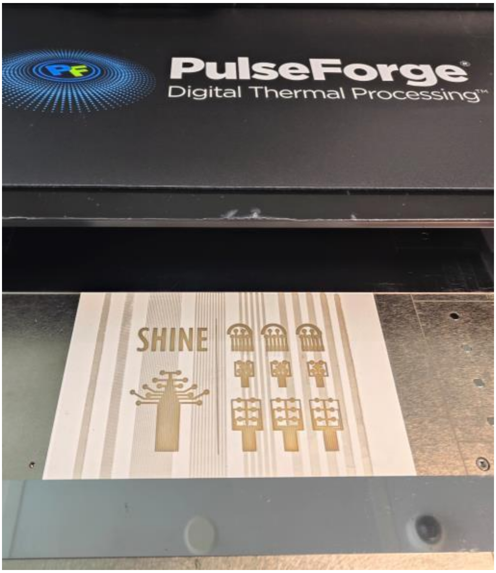
- **Drying**: For functional and graphic inks, and sintering plastic coatings. Ideal for printed and flexible electronics in AR/VR, displays, IoT, wearables, and more.

- **Crystallization**: For perovskite or OPV materials.

- **Soldering**: For standard RoHS lead-free solder paste on low-temperature polymers.

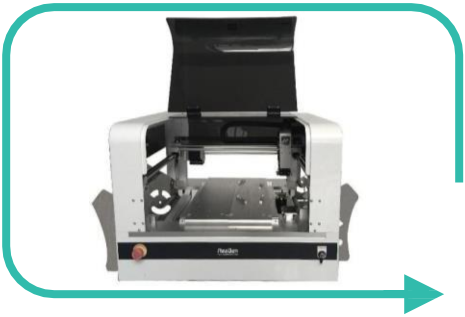
- **Reduction:** For graphene oxide and copper oxide.

Capabilities



- ➢ Batch processing
- ➢ Sintering printed materials
- ➢ Applicable for varying materials
- ➢ Enhanced electrical performance

Location: NTU SHINE Centre, ABN-B3a-08



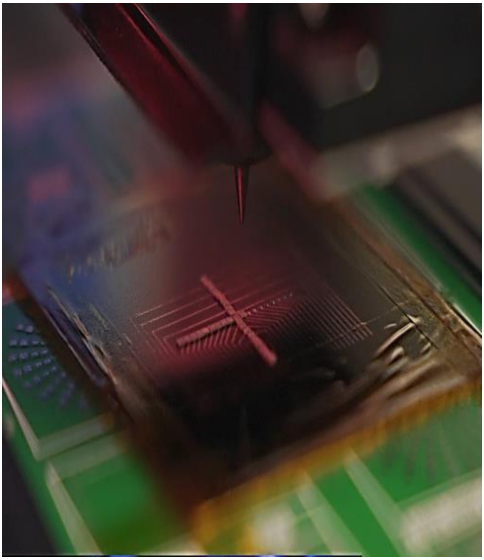
Pick and Place Machine

Key Features

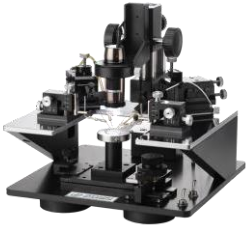
- Automated rails with variable feeding position settings
- **Four nozzles** mount simultaneously at 360 degrees
- Equipped with high-speed industry CCD cameras
- Improve placement accuracy from 0201 to BGA
- Adopt feeding adjustment techniques

Location: NTU SHINE Centre, ABN-B3a-08

Capabilities



- ➢ Precise positioning
- ➢ Efficiently integrate electronic components
- ➢ High-speed precision machining capability with fast feed movement
- ➢ Adaptable for varying chip size



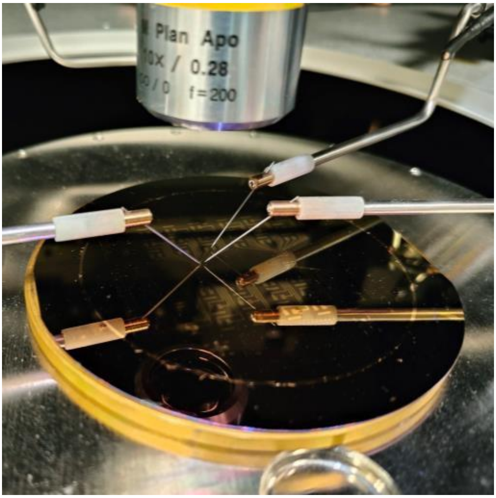
Manual Thermal Triaxial Probe Station

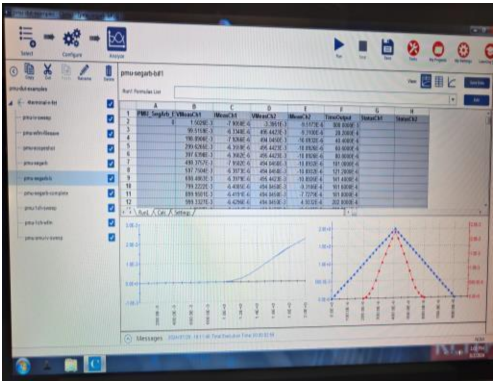
Parameter Analyzer

Key Features

- **Semiconductor Device Testing** evaluates electrical characteristics under diverse thermal conditions.
- **Advanced measurement hardware** for DC I-V, C-V, and pulsed I-V measurement types
- **Frequency resolution** from 1 Hz to 10 MHz
- **Measure on up to four channels** with the 4200A-CVIV Mult-switch

Capabilities

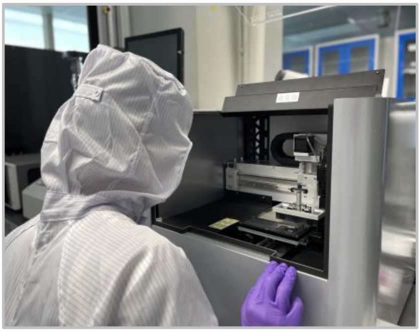




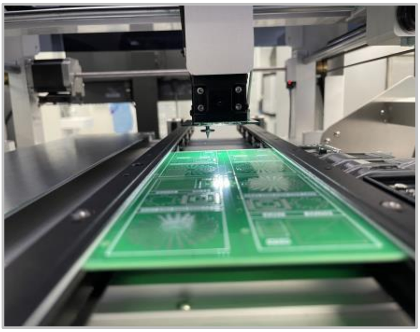
- ➢ Effective semiconductor testing
- ➢ Precise positioning inside a 4' wafer
- ➢ Multiple electrical test modes
- ➢ Optimal characterization range and resolution

Location: NTU SHINE Centre, ABN-B3a-08

Roll-to-Roll Manufacturing of Flexible Electronics

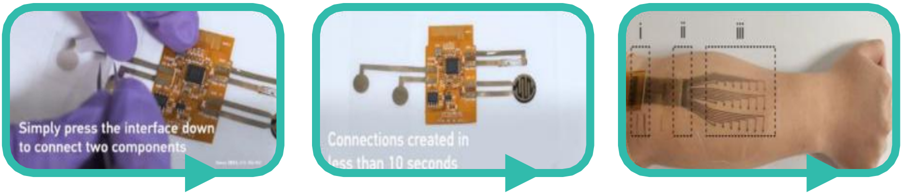


Customized Flexible Circuit
Printing System



Integrated Packaging System
- Automated Pick & Place

"Lego-like" device integration



A Universal Interface for Plug-and-Play Assembly of Stretchable Devices

Nature, ***2023, 614***, *456–462.*

Location: NTU SHINE Centre, ABN-B3a-08

Join Us

The SHINE Consortium

Promote private-public collaboration, and use-inspired research, translation and technology awareness in the area of hybrid electronics that combine material, chip and large-area form factor innovation

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