

Advanced Packaging

Singapore Hybrid-Integrated Next-Generation μ -Electronics (SHINE) Centre Technical Capabilities

EIC-PIC Heterogeneous Integration and Optical Interposer	Silicon-Based Optical Interposer	- CMOS-compatible low-loss waveguide: 0.3 dB/cm - Min in-plane optical coupling: 0.25 dB - Min out-of-plane optical coupling: 0.5 dB - Max laser integration: 8 - Min optical engine size: 6 x 9 mm
	High-Precision Flip-Chip Bonding	- Die size: 0.1 – 2 mm - XY placement/alignment accuracy: $\pm 0.3 \mu\text{m}$ @ 3σ - Rotation accuracy: $\pm 0.03^\circ$ @ 3σ - Min heat-affected zone: 280 μm via laser-assisted bonding - Max wafer size: 300 mm
Flexible Hybrid Electronics and Packaging	Biphasic Nano- Dispersed (BIND) Stretchable Electrical Interface	- Max electrical stretchability: 180% strain - Max mechanical stretchability: 600% strain - Max relative resistance change: 4x @ 50% strain - Anti-tearing stretchability: 500% with a cut - Cyclic durability: 600 cycles under tensile, bending & twisting loading - Metal thickness: 45 – 60 nm - Min interface/connection resolution: 100 μm - Interconnect patterning line resolution: $\pm 0.1 \text{ mm}$
	Hydrogel Encapsulation for High-Enthalpy Thermal Dissipation (HEAT) and Flame- Retardance (FR)	- Heat absorption capacity: $1180 \pm 5 \text{ J/g}$ - Max flame protection: 10 s exposure - Max temperature protection under flame: $\approx 100^\circ\text{C}$ - Min stretchability: 100% strain - Stretchability recovery: Near-full recovery within 10 min - FR-layer thickness: 100 / 200 / 300 μm - Compatible substrates: PDMS, SEBS, SIS, PET, Ecoflex
	Digital Light Processing (DLP) 3D-Printed Hybrid Thermal Interface	- Max in-plane thermal conductivity: 22.3 W/m-K - Max through plane thermal conductivity: 2.1 W/m-K - Contact thermal resistance: $(6.3 \pm 1.3) \times 10^{-6} \text{ m}^2\text{K/W}$ - Young's modulus: $0.07 \pm 0.01 \text{ MPa}$ - Stretchability: $31 \pm 3\%$ - Printing wavelength: 405 nm - Printing area: 119 x 67 mm - Max process temperature: 200 $^\circ\text{C}$ - Uniformity: $\pm 3\%$ - Min feature size: 20 μm



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Hybrid Sensor and Wearable Systems	Highly Sensitive and Robust Wearable Strain Sensing Platform	• Max strain range: 100% • Gauge factor (GF): 79 @ 100% strain • Hysteresis: ~5% @ 100% strain • Max mechanical durability: 5,000 stretch-release cycles @ 50% strain
	Spray-Coating Nanocomposite Fabrication	• Max coating area: 300 x 300 mm • Coating thickness: 20 nm – 100 μm • Max heating plate: 300 °C • Uniformity: $\pm$5% • Min feature size: 10 μm
Magnetic Field Imaging for Non-Destructive Localisation of Defects in 2.5D/3D Packaging	• Max Z-depth accuracy: 7 μm • Margin of error: $\pm$5% of imaging depth (140 – 1040 μm) • Max scan area: ○ SQUID: 10 x 10 cm ○ GMR: 1 x 1 mm • Min stand-off distance between sensor and DUT: ○ SQUID: 5 μm ○ GMR: in-contact • Min biasing current: ○ SQUID: 9 nA @ 50 μm stand-off ○ GMR: 10 μA @ in-contact *MFI: Magnetic-field imaging *SQUID: Superconducting quantum interference device *GMR: Giant magnetoresistance	

