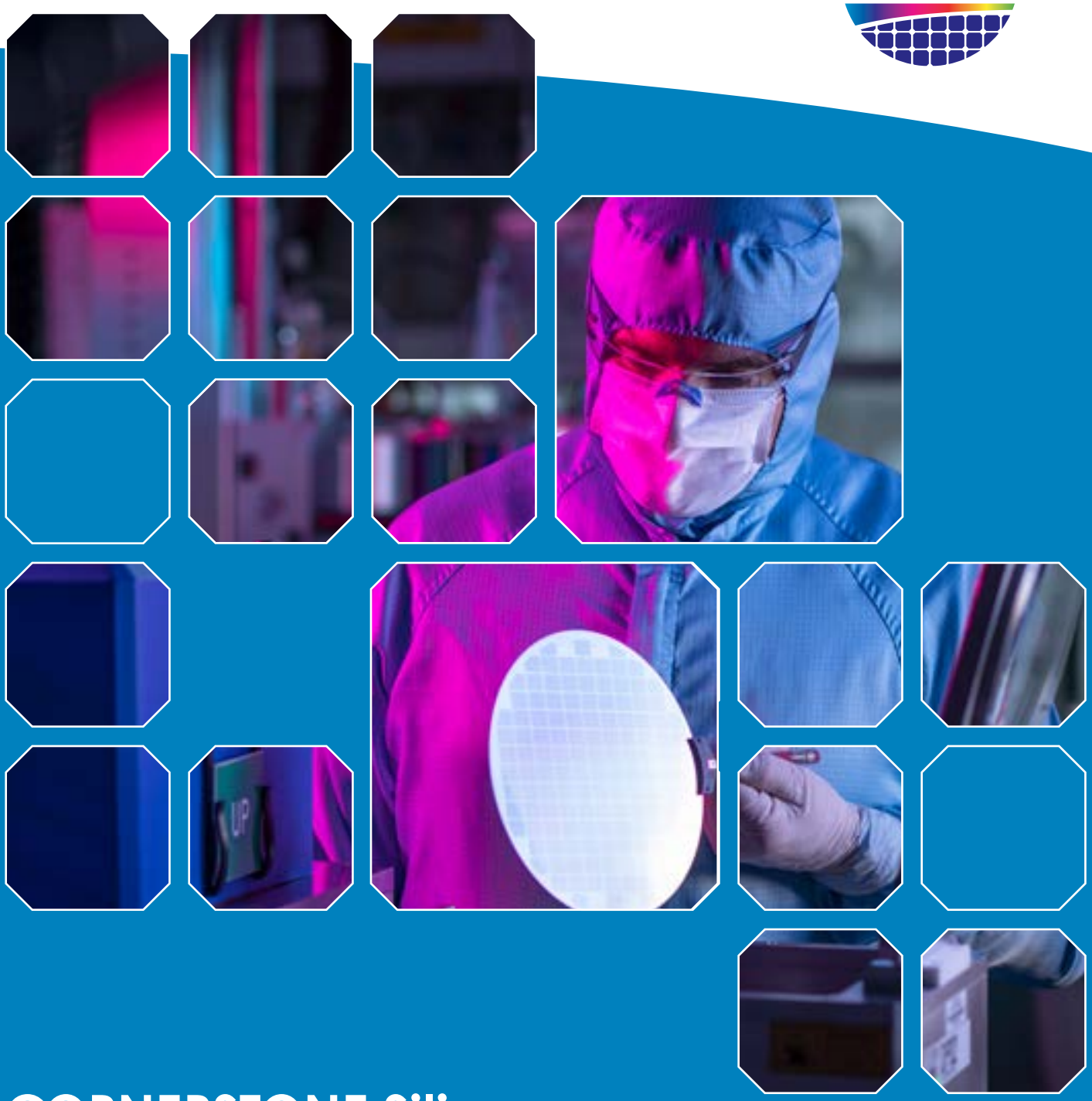
CORNERSTONE



CORNERSTONE Silicon Photonics Capabilities

at the Universities of Southampton and Glasgow, UK

UKRI Engineering and Physical Sciences Research Council
University of Southampton
University of Glasgow

CORNERSTONE brings the future closer by turning your ideas into reality

CORNERSTONE is an open source, license free silicon photonics rapid prototyping foundry. We offer a plethora of different platforms to support a wide range of applications ranging from telecoms to sensing, LiDAR, quantum and more. Each platform possesses a standard component library to lower the barrier to entry for non-photonics experts. We will gladly experiment and try new things for the benefit of our users. This flexible approach helps us to support early stage R&D projects and successfully fabricate proof of concept prototypes.

CORNERSTONE fulfils a long awaited requirement for a 'researcher's foundry', offering our users the flexibility to enable scientific innovation at the device level, in addition to more conventional foundry services towards scale up and commercialisation."

Professor Graham Reed
CORNERSTONE Principal Investigator

CORNERSTONE Capabilities

Multi-project-wafer (MPW) services on a variety of platforms:

- Silicon-on-insulator (220 nm / 340 nm / 500 nm thick silicon layers)
- 300 nm thick silicon nitride
- Suspended silicon (500 nm silicon thickness)
- 3 µm germanium-on-silicon
- Bespoke training courses

Deep-UV projection lithography service:

- Minimum feature size: 250 nm
- Resist thicknesses ranging from 600 to 1300 nm
- 200 mm silicon substrates

Additional capabilities:

- Bespoke fabrication batches with a tape-out date to suit your requirements
- Electronic-photonic integration via flip-chip bonding
- Design consultancy
- Training courses including the chance to spend a day in our cleanrooms

Our facilities include:

- Deep-UV projection lithography
- E-beam lithography
- Contact lithography (i-line)
- Wet and dry etch systems
- Furnaces and RTA systems
- PECVD, LPCVD, ALD systems
- Thermal evaporation and sputtering systems
- CMP, wafer dicing and bonding systems
- Optical wafer-scale testing
- Materials characterisation

Why CORNERSTONE?

The **CORNERSTONE** team prides ourselves on the level of service and personal touch provided to our users. Every member of our team is ready to go above and beyond to help our users at every stage of their journey by providing expert advice and guidance.

Reasons to choose CORNERSTONE:

1. Flexibility in both our platforms and our fabrication process flows.
2. Fast turnaround times:
   < 3 months for passive device batches.
3. Our PDK and component libraries are all open source and license free.
4. Our sign-up and design submission processes can be done in less than one minute.
5. We treat confidentiality and data-handling with the utmost care.

Our values:

- The power of collaboration
- Equal opportunities for all
- Accessibility
- Curiosity
- Courage
- Quality
- Efficiency
- Loyalty

We entered into an agreement with **CORNERSTONE** to produce 2 x 2 couplers for operation in the mid-infrared based on a suspended-silicon platform. We ended up with multiple functioning devices close to the predicted performance. Given the sensitivity of producing devices based on a completely new platform, we were pleased regarding the disposition of IP and the care with which confidential information was handled. The interaction was simultaneously successful and enjoyable."

Dr Andrew Sappey
Director of New Technology Development
at OnPoint Digital Solutions

Technologies

Refer to our website for the MPW schedule and access costs.

Our team has an exemplary track record in silicon based modulators having demonstrated several world firsts, including the first 1 Gb/s carrier depletion modulator in 2004, now the industry standard, and the first 50 Gb/s carrier depletion modulator in 2012. In 2020, we demonstrated a fully integrated silicon MZI modulator with CMOS driver operating at 100 Gb/s OOK.

220 nm silicon-on-insulator (passive devices / active devices)	
Technology details	– **Si etch depths:** 70 nm, 120 nm & 220 nm – TiN based thermal phase shifters – 4 implantation layers for active device batches – High resistivity handle wafer for improved RF performance (750 ohm.cm)
Performance (TE single mode @ λ = 1.55 µm):	– **Rib waveguide propagation loss:** < 3 dB/cm – **Strip waveguide propagation loss:** < 4 dB/cm – **Grating coupler loss:** 5-6 dB/grating – **Phase shifter efficiency (MZI):** < 20 mW/π – **Modulator performance (1.8 mm long MZI based carrier depletion):** • Speed @ 2 V dual drive: > 40 Gb/s • Insertion loss @ 2 V dual drive: < 5 dB • Extinction ratio @ 2 V dual drive: > 3 dB
Logistics	**Design area options:** 11.47 x 4.9 mm² / 5.5 x 4.9 mm² **Delivery timeframe:** < 3 months (passive devices) / < 8 months (active devices)

Our flexibility enables users to add customised steps into all of our MPW batches. For example, in this platform a user could add e-beam written apodised grating couplers capable of coupling efficiencies of < 1 dB. A user could also add customised etch depths or sensing windows in the top cladding layer.

340 nm silicon-on-insulator (passive devices)	
Technology details	– **Si etch depths:** 140 nm & 340 nm – TiN based thermal phase shifters
Performance (TE single mode @ λ = 1.55 µm):	– **Rib waveguide propagation loss:** < 0.8 dB/cm (shallow etch) – **Strip waveguide propagation loss:** < 3.5 dB/cm – **Grating coupler loss:** 5-6 dB/grating – **Phase shifter efficiency (MZI):** < 20 mW/π
Logistics	**Design area options:** 11.47 x 4.9 mm² / 5.5 x 4.9 mm² **Delivery timeframe:** < 3 months

All of our platforms are supported by an open source process design kit (PDK), which is available to download in GDSII format via our website or is accessible via Luceda Photonics' IPKISS software.

500 nm silicon-on-insulator (passive devices)	
Technology details	– **Si etch depths:** 160 nm & 300 nm – TiN based thermal phase shifters
Performance (TE single mode @ λ = 1.55 µm):	– **Rib waveguide propagation loss:** < 3 dB/cm – **Grating coupler loss:** 5-6 dB/grating – **Phase shifter efficiency (MZI):** < 20 mW/π
Logistics	**Design area options:** 11.47 x 4.9 mm² / 5.5 x 4.9 mm² **Delivery timeframe:** < 3 months

Technologies

Refer to our website for the MPW schedule and access costs.

The SiN platform extends the available operating wavelengths of CORNERSTONE's portfolio into the visible range. This is of particular interest for quantum photonics technologies. The lower refractive index of SiN also makes it less susceptible to fabrication tolerances and temperature fluctuations relative to Si.

Silicon nitride	
Technology details	– **Platform:** 300 nm SiN / 3 µm BOX – **SiN etch depth:** 300 nm
Performance (TE single mode @ λ = 1.57 µm):	– **Strip waveguide propagation loss:** < 0.5 dB/cm – **Grating coupler loss:** < 10 dB/grating
Logistics	**Design area:** 11.47 x 15.45 mm² **Delivery timeframe:** < 3 months

The SOI BOX layer becomes highly absorbing at wavelengths above ~3.8 µm. CORNERSTONE's suspended-Si platform alleviates this problem by locally removing the BOX layer underneath suspended waveguides to extend the transparency of the SOI platform up to ~8 µm.

Suspended-silicon	
Technology details	– **Platform:** 500 nm Si / 3 µm BOX – **Si etch depth:** 500 nm, followed by HF etching for undercutting / suspension
Performance (TE single mode @ λ = 3.8 µm):	– **Waveguide propagation loss:** < 3 dB/cm
Logistics	**Design area options:** 11.47 x 4.9 mm² / 5.5 x 4.9 mm² **Delivery timeframe:** < 2 months

The Ge-on-Si platform supports wavelengths up to ~14 µm, which makes it well suited for a broad variety of applications including environmental, biological, chemical and pharmaceutical sensing, industrial process control, toxin and contaminant detection, point-of-care diagnostics and astrophysics.

Germanium-on-silicon	
Technology details	– **Platform:** 3 µm Ge-on-Si (n-type) – **Ge etch depth:** 1.8 µm – Edge couplers formed by custom dicing process
Performance (TE single mode):	– **Waveguide propagation loss:** < 3 dB/cm @ λ = 6.0 µm, < 8.5 dB/cm @ λ = 9.9 µm
Logistics	**Design area:** 11.47 x 15.45 mm² **Delivery timeframe:** < 2 months

I think **CORNERSTONE** is a great service and I am really excited about the work we are able to do using the variety of platforms. **CORNERSTONE** was flexible with our requests for modifying certain fabrication steps to help us out on our end."

Dr Krishna Balram
Associate Professor
Photonic Quantum Engineering
University of Bristol

CORNERSTONE has been integral to my spin-out journey as I transform optical fibre-based inertial sensors into miniature chip-scale devices for the first time. From the design phase through to chip-testing, **CORNERSTONE** have offered advice throughout, supporting me as both an early career researcher and now as an entrepreneur."

Dr Ying Lia Li
CEO
Zero Point Motion Ltd

The **CORNERSTONE** facilities are world class and the personnel highly professional and expert in silicon photonics. The **CORNERSTONE** programme has helped establish this facility as the UK leader in silicon photonics MPW fabrication."

Dr Iain Crowe
Associate Professor
University of Manchester

At CompoundTek we specialise in volume production of silicon photonics designs. We work with **CORNERSTONE** by referring customers who are interested in research and development work, whilst offering **CORNERSTONE** customers a seamless route to volume production."

KS Ang
COO and Co-founder
CompoundTek

Our Partners

Accessing CORNERSTONE couldn't be easier

1. **Follow us on social media or sign-up to our mailing list for MPW call announcements.**
2. Download our open source design rules and design kit from our website.
3. Complete our online sign-up form before the sign-up deadline.

   The CORNERSTONE team will then contact you with a quotation.
4. Complete our online mask submission form and upload your Purchase Order before the mask submission deadline.
5. Share your design file.

   The CORNERSTONE team will then perform design rule checking on your submitted file and allow you several days to correct any errors before tape-out.

Contact us: cornerstone@soton.ac.uk

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CORNERSTONE Administrator

www.cornerstone.sotonfab.co.uk