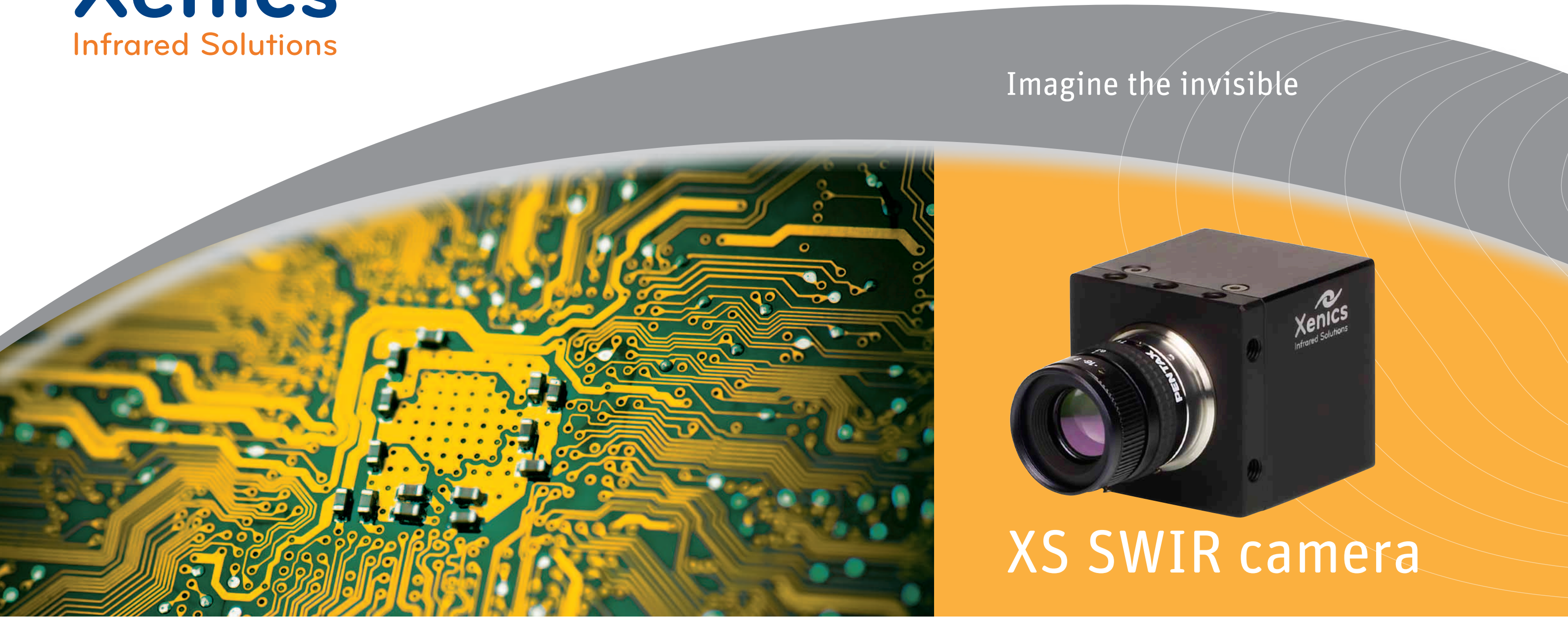
Xenics
Infrared Solutions



Imaging of guided and scattered light from silicon photonic integrated circuits

Photonic Integrated Circuits (PICs) are a key enabling technology in application areas from telecommunications and biosensing, to quantum optics

> "The XS camera is extremely easy to integrate into existing optical set-ups"

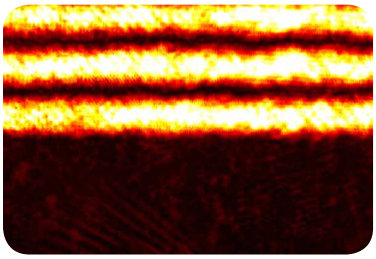


Figure 1: Fibre aligned above chip surface

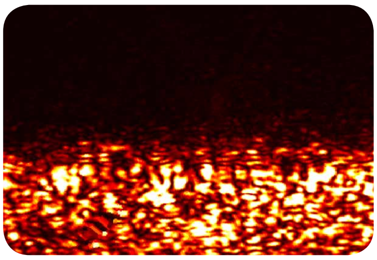


Figure 2: Fibre aligned with substrate

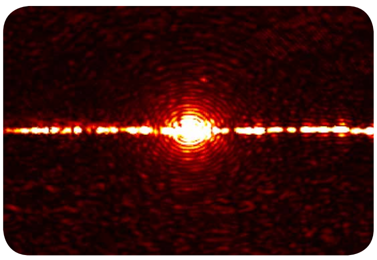


Figure 3: Fibre aligned with the guiding layer

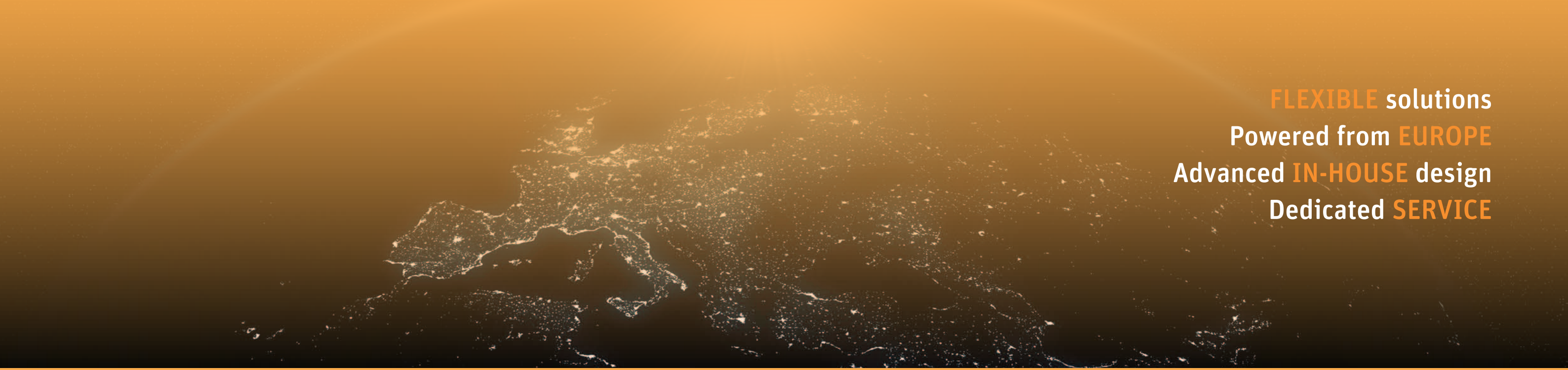
In particular silicon photonics is a rapidly maturing field, enabled by manufacturing compatible with current electronics paradigms and aligning with the low-loss fibre spectral window in the 1.55 µm wavelength range. The strong confinement of light to sub-micron waveguide cross-sections is possible in this material platform due to the large refractive index difference between silicon and its surrounding silica cladding layers. This index contrast also underpins the design of ultra-compact waveguide bends with radii of a few µm, in turn allowing the dense integration of many functional components on chips with mm^2 chip footprints.

SWIR imaging of silicon photonic chips

Fibre alignment to a silicon PIC:

In order to characterise these compact planar optical devices it is necessary to couple light from off-chip sources, and to laboratory based measurement equipment, using standard optical fibre technology. Given the small waveguide cross-sectional area it is often difficult to align both input and output fibres to the PIC using only a top, visible microscope image as a positional guide. In this case the power coupled from the output fibre is used to guide the alignment of both input and output. Given the 3-axis translation stage control on both fibres and the lack of knowledge as to the loss of the on-chip PIC, this can be a prolonged task. This alignment can be significantly accelerated using a SWIR video-rate camera. In the experiments the Xenics XS-1.7-320 InGaAs camera is used.

The output facet of the PIC chip can be imaged onto the camera by coupling the light through an objective lens. Since the full facet is imaged the alignment of the input fibre to the waveguide can be quickly assessed. If the fibre is above the level of the chip then clear interference fringes are visible, while a denser scattering pattern is observed if the fibre is injecting into the substrate, Fig.1-3. When the fibre is aligned to the waveguide a clear output mode is visible with high local intensity.



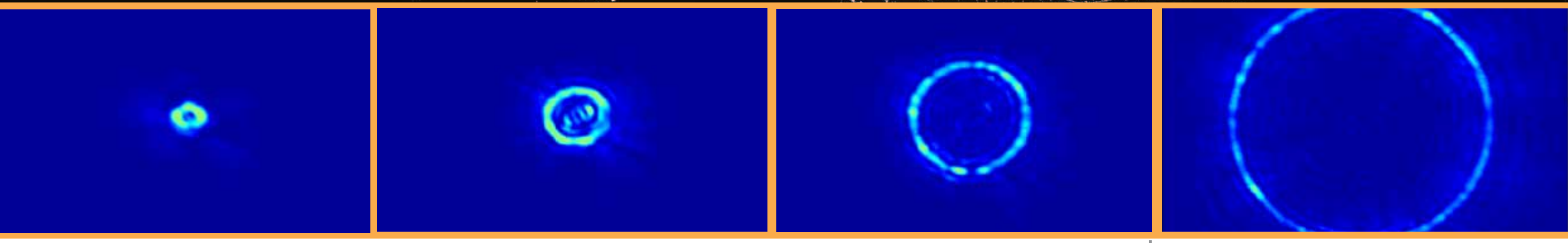


Fig.4.Near-field images of silicon microring emitters with varying diameter,D. (False colour)

Typically the light injected into the PIC is in the order of a few hundred μW, requiring a high sensitivity camera to observe the mis-aligned scattered field images that are orders of magnitude lower power/unit area. Once the input fibre is aligned a second fibre can be used to replace the output imaging lens, where the only degrees of freedom are in the output alignment stage since the input is now well defined.

Imaging of vertically emitted beams

It is often necessary to visualise the surface of the PIC to identify local scatters within the waveguide, or intentionally emitted vertical beams, e.g. on-chip generation of Orbital Angular Momentum (OAM) carrying beams2.

The Xenics XS camera is ideal for this purpose given its small volume and weight. The camera can be integrated onto the vertical column of a trinocular microscope imaging the surface of the chip. Then by varying the microscope optics you can access near and far field images of the surface emission. Again, the power levels of vertical scattering from PICs can be extremely low ‹μW requiring a high sensitivity SWIR camera to capture images. Fig.4. shows images from a variety of vertically emitting silicon ring devices.

> “It is straightforward to reposition the camera to image in-plane with the device or positioned on the microscope setup for top viewing, without disturbing the rest of the experimental apparatus”

Camera Specifications	XS Base	XS Analog	XS Trigger
Array type	InGaAs PIN photodiode array with CMOS ROIC (CTIA topology)		
Resolution	320 x 256		
Pixel size	30 μm x 30 μm		
Spectral band	0.9 to 1.7 μm Optional 0.4 to 1.7 μm (VisNIR)		
Frame rate (full frame)	60 Hz	60 Hz	100 Hz
Digital interface	USB 2.0		
Dimensions	50 W x 50 H x 50 L mm³		

WRITTEN BY G.CANTARELLA, M.J. STRAIN - INSTITUTE OF PHOTONICS, DEPT. OF PHYSICS, UNIVERSITY OF STRATHCLYDE, U.K. (OCTOBER 2015).

Customer quote: “LOT/Xenics were very responsive to queries about their products, and the ability to test devices in our lab was essential to choosing the right tool for our system. The driver software for the camera is easy to use and after purchase service has been great”