Packaging of Integrated Photonic Devices; Applications, User Foundry Services & Design Rules

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Ireland’s Largest Research Institute

- Photonics
- Microsystems
- Nanotechnology
- Theory Modelling & Design
Photonic Integration at Tyndall

Simulation & Design
Materials & Epitaxy
Fabrication & Devices
Packaging & Integration (2009)
Photonic Systems
Photonic Integration Laboratory
Photonic Integration

Monolithic Integration

Hybrid Integration
Photonic Integration (Many Challenges)
Optical Integration (Fibre Coupling)

Fiber: ~125μm diameter

Core: ~10.4μm mode diameter at 1550nm

Grating: 12μm x 20μm

SOI Waveguide: 0.45μm x 0.22μm
Optical Integration (Fibre Coupling - Silicon)

1. Edge Coupled

Lensed Fibre (MFD ~ 3 μm)

Si Substrate

SiO₂ Layer

Mode Convertor

Si Waveguide

2. Grating Coupled

40° Angled Facet

Challenge: Fibre coupling to sub-micron waveguides
Optical Integration (Fibre Coupling)

- Mode field diameter ($MFD$)
  - $3.0 \mu m \pm 0.5 \mu m$
  - $4.0 \mu m \pm 0.5 \mu m$
  - $4.7 \mu m \pm 0.3 \mu m$

- Working distance ($W_d$)
  - $75 \mu m \pm 15 \mu m$
  - $120 \mu m \pm 15 \mu m$
  - $45 \mu m \pm 5 \mu m$
Optical Integration (Fibre Coupling)
Optical Integration (Fibre Coupling - Silicon)

"Packaging Process for Grating-Coupled Silicon Photonic Waveguides Using Angle-Polished Fibers",
Optical Integration (Fibre Coupling Arrays - Silicon)
Optical Integration (Sources - Lasers)

ceramic substrate (active alignment)

SOI waveguide

electrical connections (flexible substrate)

pick & place collet

Alignment over waveguide grating (packaging equipment vision system)
Optical Integration (Sources - Lasers)

Manufacturing tolerances designed using Zemax

Laser placement tolerance to couple into SOI grating

Ball lens height tolerance to couple into SOI grating
Optical Integration (Sources - Lasers)

AlN ceramic submounts for laser integration on Silicon
Optical Integration (Sources - Lasers)

Electronic Integration (Drivers, Modulators, ...)
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Solder Sphere Jetting (50 μm Spheres)
Electronic Integration (Drivers, Modulators, ...)
Thermal Effects

Temperature (°C)

\[ \Delta T \approx 15 \, ^\circ C \]
Photonics Integration (Medical Devices)

Silicon photonic integrated laser doppler vibrometer for screening of arterial stiffness and stenosis
Photonics Integration (Vascular Guidewires)

- optical fibre in guidewire
- maintain guidewire diameter
- maintain guidewire flexibility
Photonics Integration (Vascular Guidewires)

Trials at CUH

3m guidewire

optical sidefire
European Integrated Photonics Foundries (Silicon)

Design → Wafer Fab → Device → Packaging

www.epixfab.eu
We want to avoid this ...
Photonic Integration Design Rules (Design Kit)
Summary

MPW Foundry Services

Research Resources

"Valley of Death"

Commercialization Resources

Research

level of development

Commercialisation

Resources