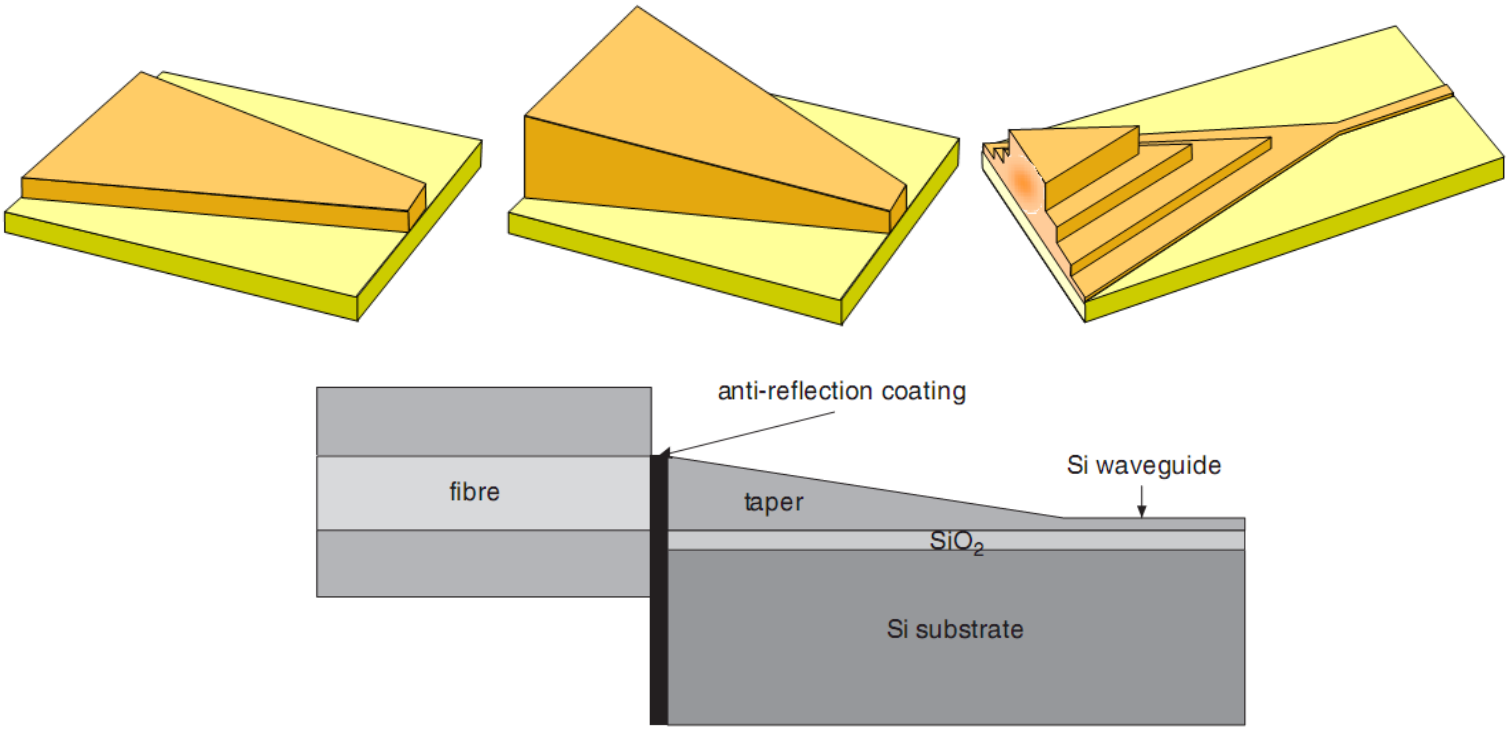
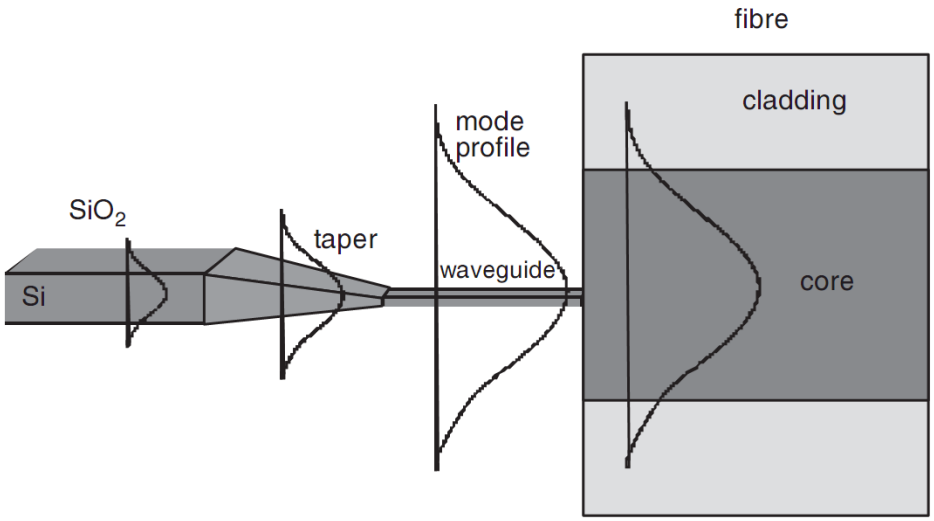
Tapered and Inverse Tapered Mode Converters:

1. Tapered Mode Converters:
   - Regular (planar) taper
     - Multi-mode
     - Facet coating required
     - No vertical matching
   - 3-D taper
     - Difficult to fabricate



2. Inverse Tapered Mode Convereters:

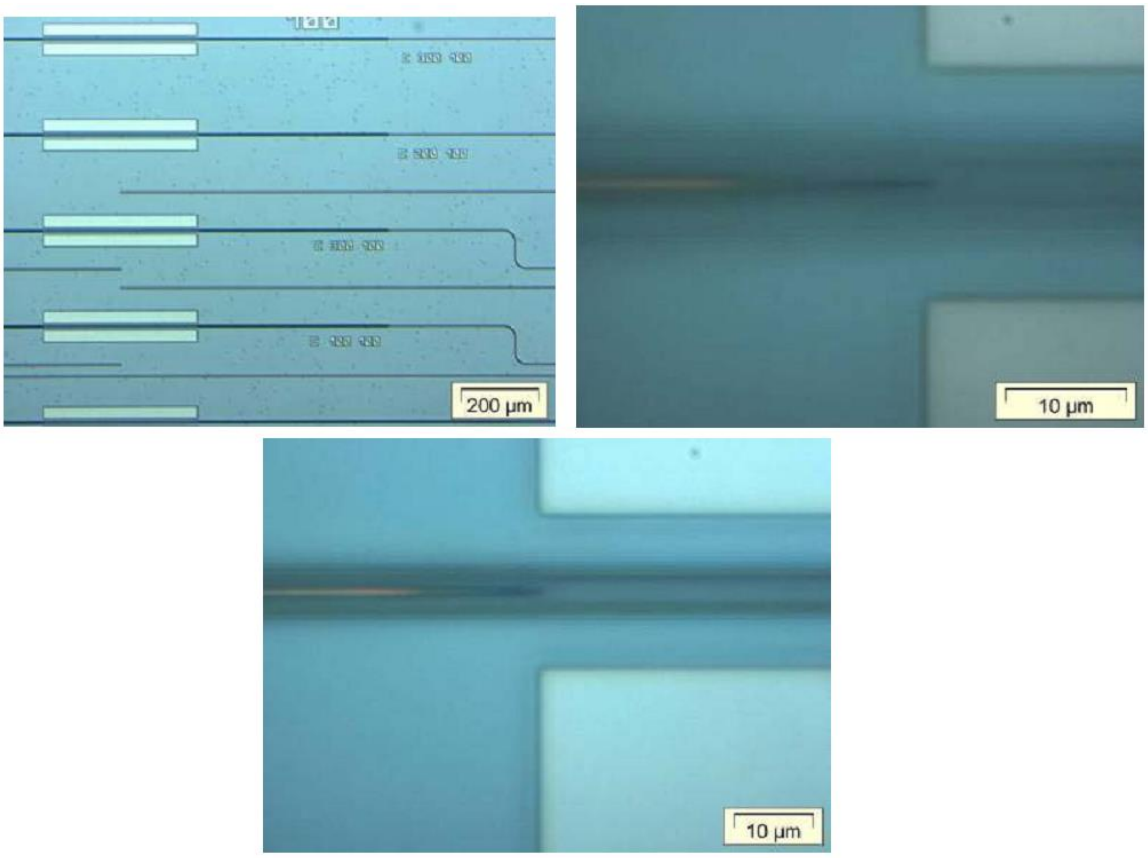
Narrow waveguide tip ➔ mode is ‘squeezed out’ of core and captured by overlay waveguide



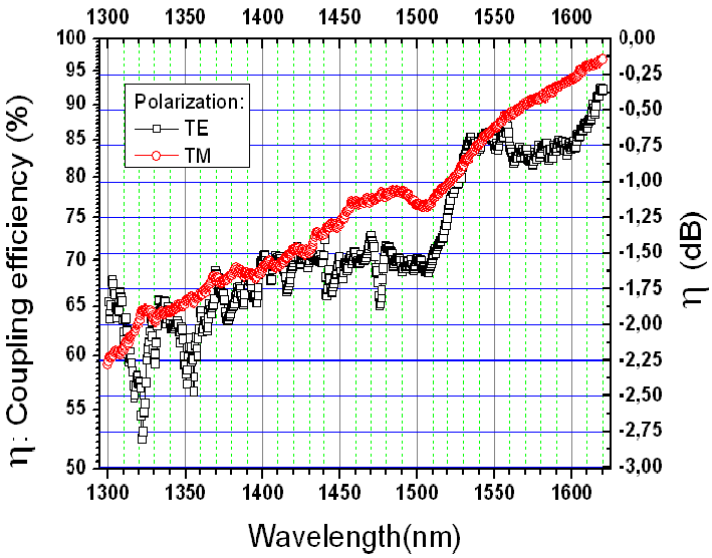
Advantages:

- Broad wavelength range
- Single mode
- Easy to fabricate (if you can make the tips)
- Low facet reflections

Examples:



(lensed fiber mfd 3.5µm)



Inverted taper coupler couples both polarizations TE and TM in the photonic wire.

BUT: photonic wires are very polarization sensitive

- You want just one polarization in your wire

Solution

- polarization splitter
- polarization-diversity approach

Advantages of Horizontal Coupling:

- High coupling efficiency
- Broadband operation
- Works for both polarizations

Disadvantages of Horizontal Coupling:

- Large footprint on a ‘nanophotonic’ chip
- Requires post-processing

  • dicing and polishing

  • no wafer-scale testing possible

Alignment tolerances

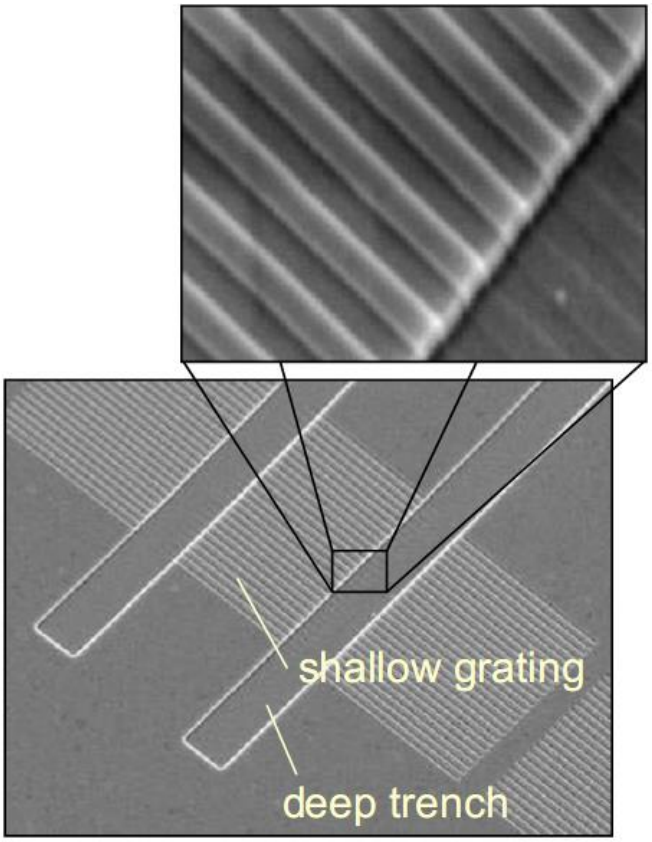
• larger spot is larger gives better tolerances

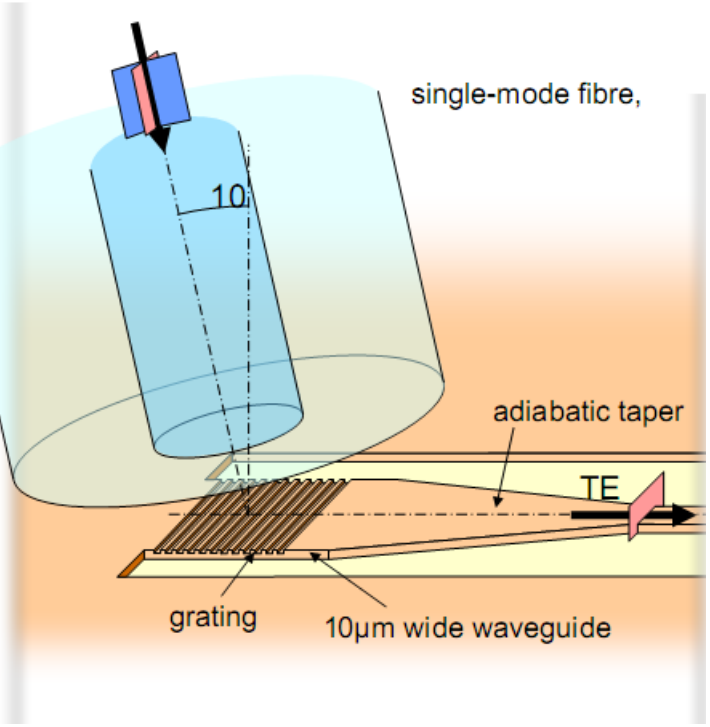
• larger spot is harder to fabricate

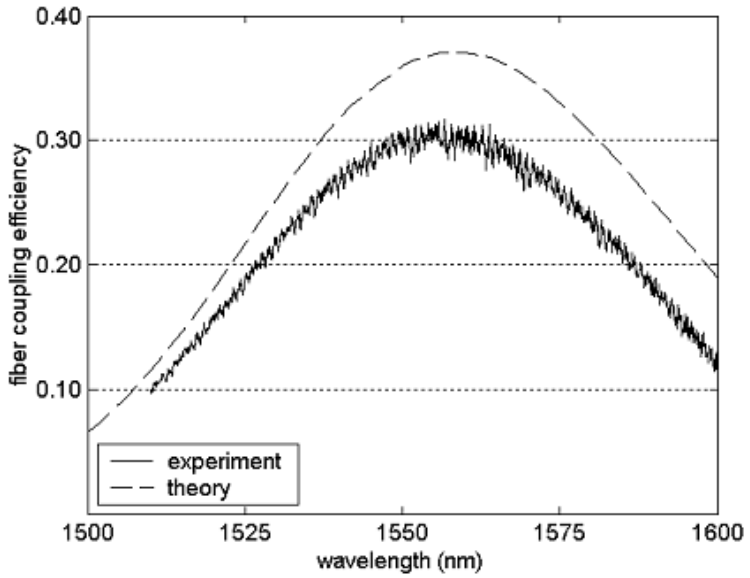
• larger spot needs longer taper

Vertical Grating Couplers:

- Compatible with SMF-28
- No need for a polished Facet
- Wafer-scale testing
- Wafer-level packaging
- Flexible and cheap!





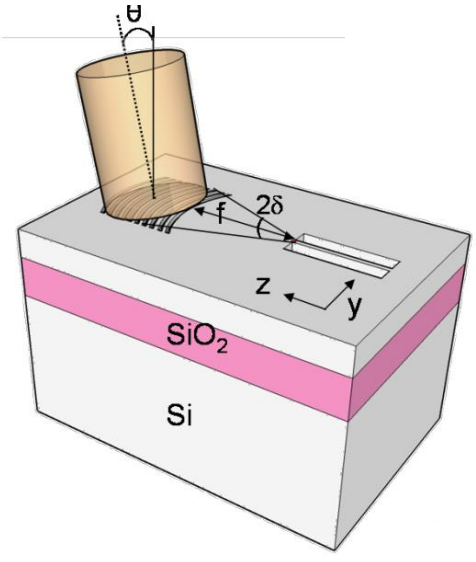


Focusing Grating Couplers:

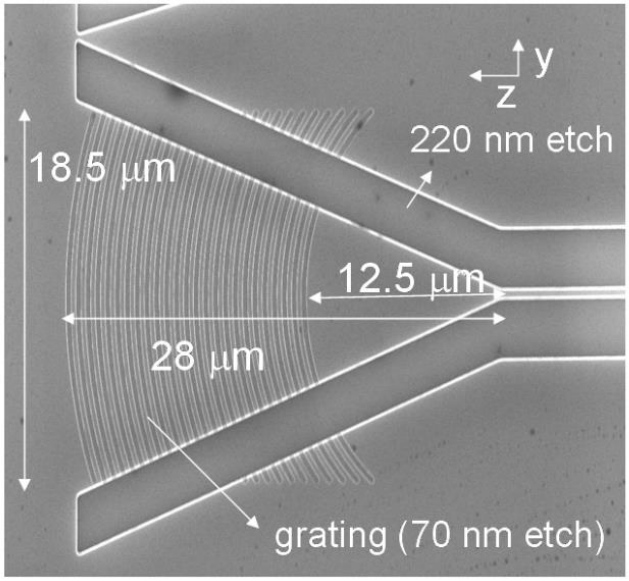
Curved gratings: focus light in submicron waveguides

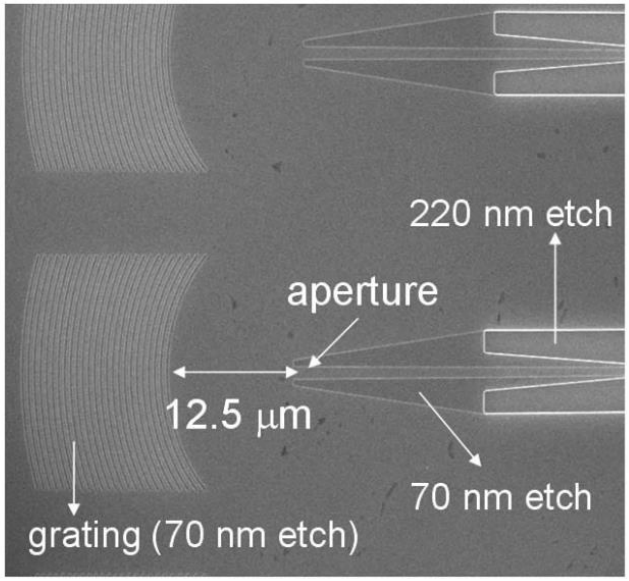
No adiabatic transition needed

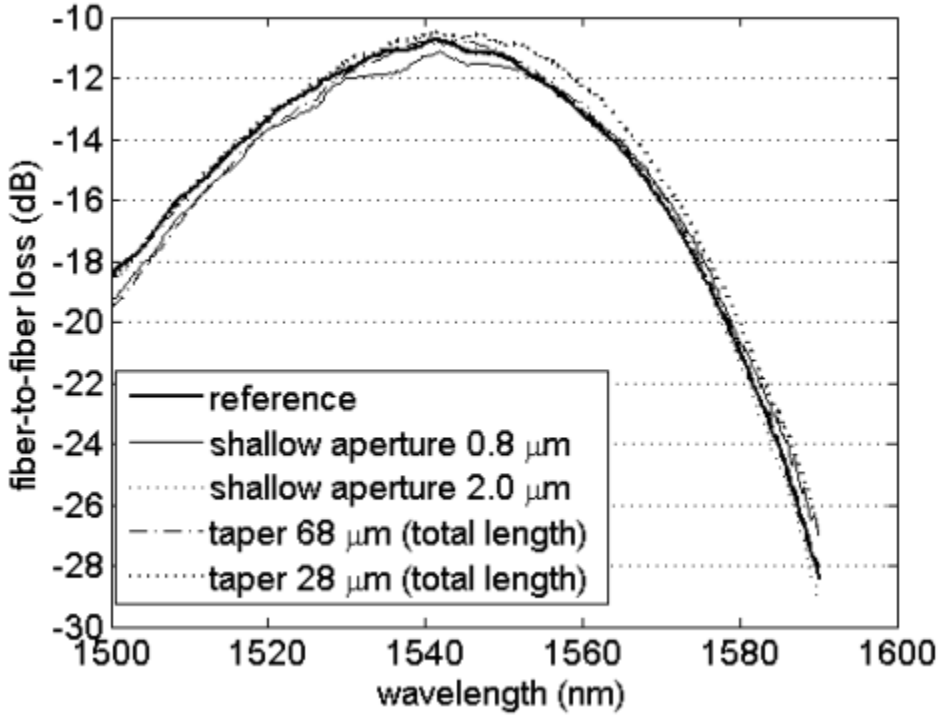
- Grating in linear taper
- Grating in slab, focus on low-contrast aperture



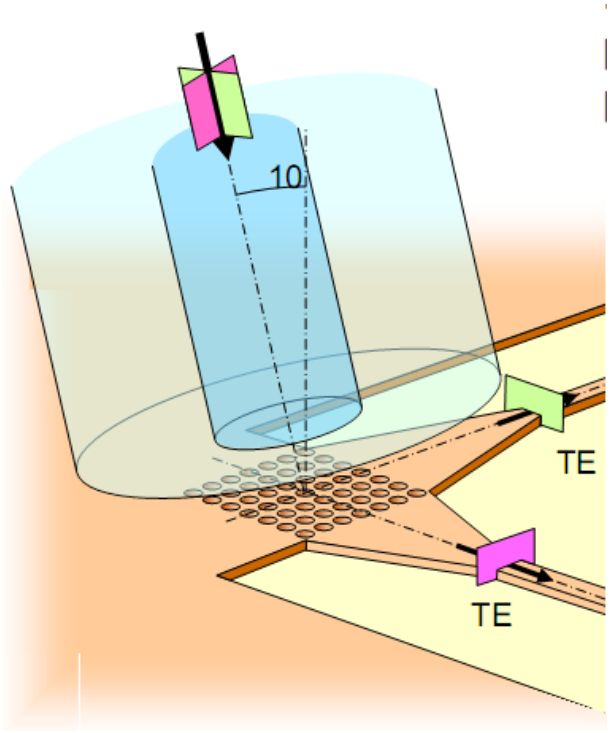
- Grating in taper
  - focusing on taper point
- Grating in slab
  - Focusing on waveguide aperture (shallow etched)



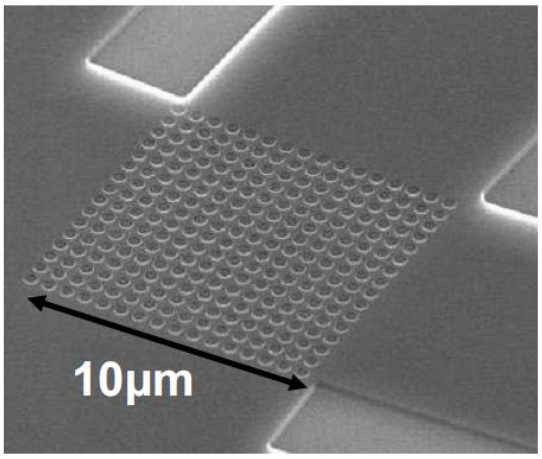


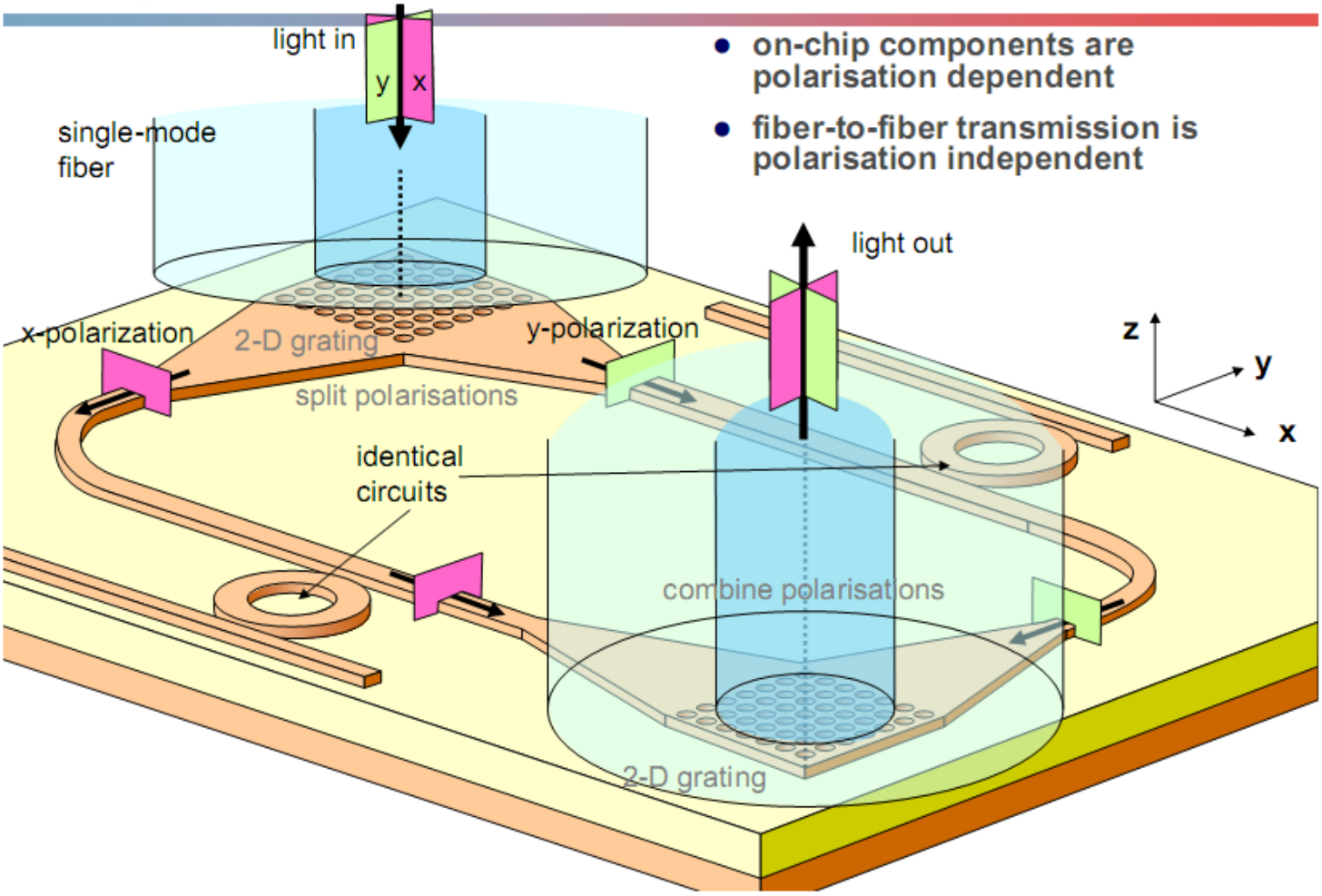


2D Gratins and Polarization Diversity Circuits:

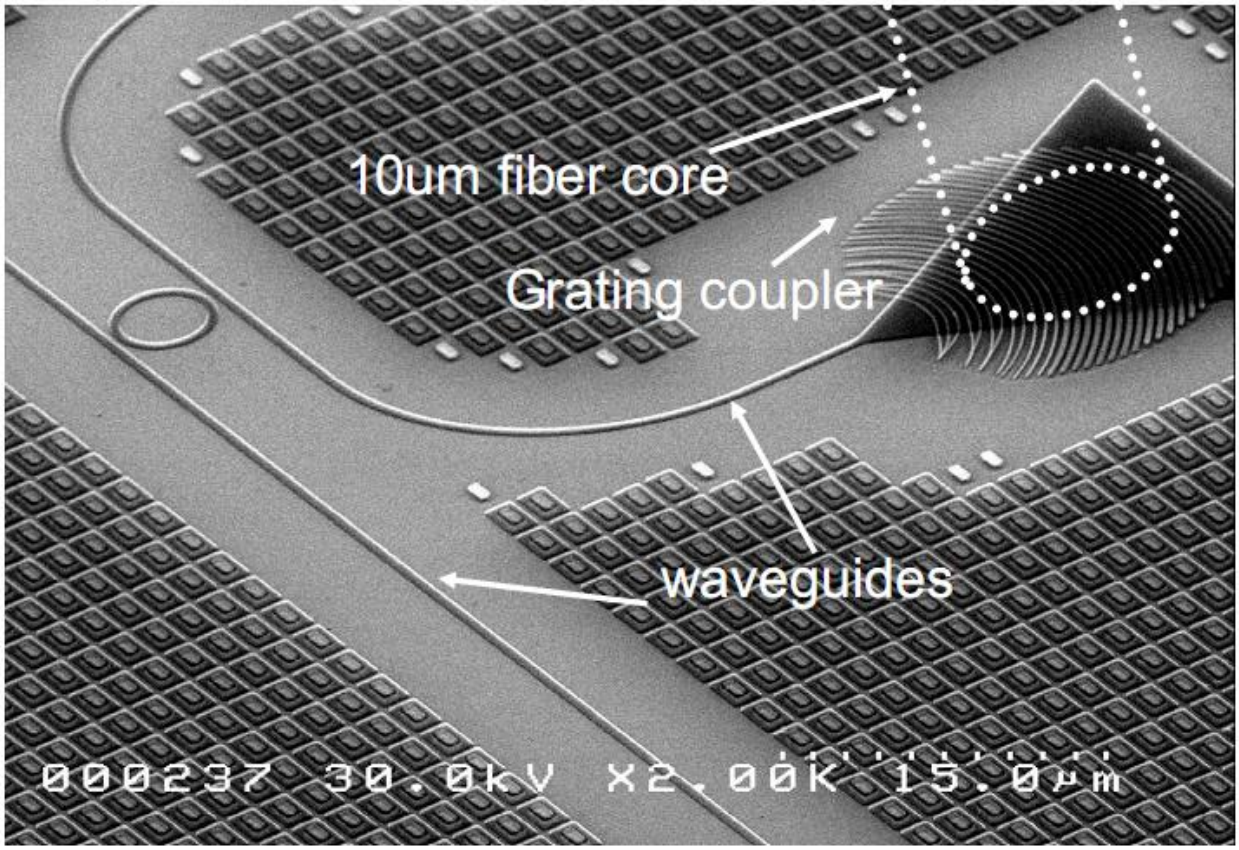


- Efficiency: -6.7dB (21%)
- Extinction ratio: > 18dB
- 3dB bandwidth: 60nm



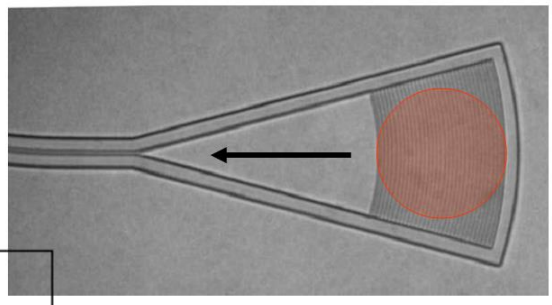


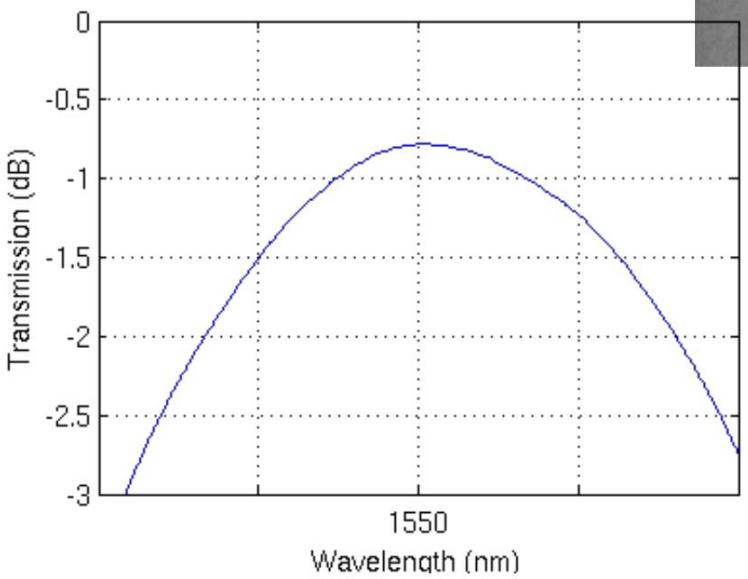
Holographic Grating Couplers: (Luxtera gratings)



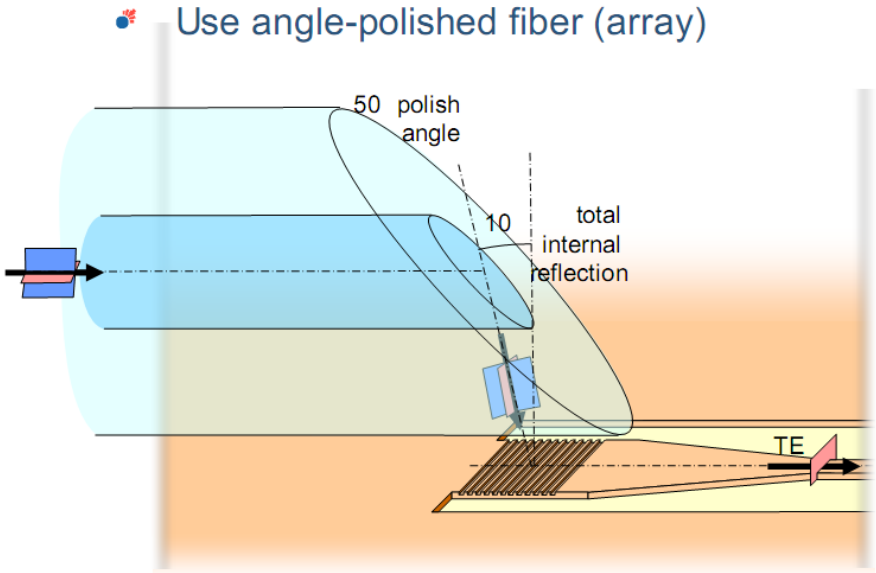
Demonstrated performance:

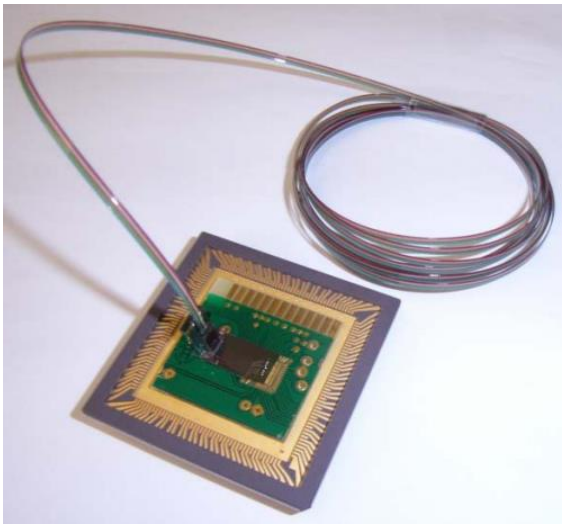
– 0.8 dB loss to/from fiber





Grating Coupler Packaging: For many purposes, the fibers should be horizontal

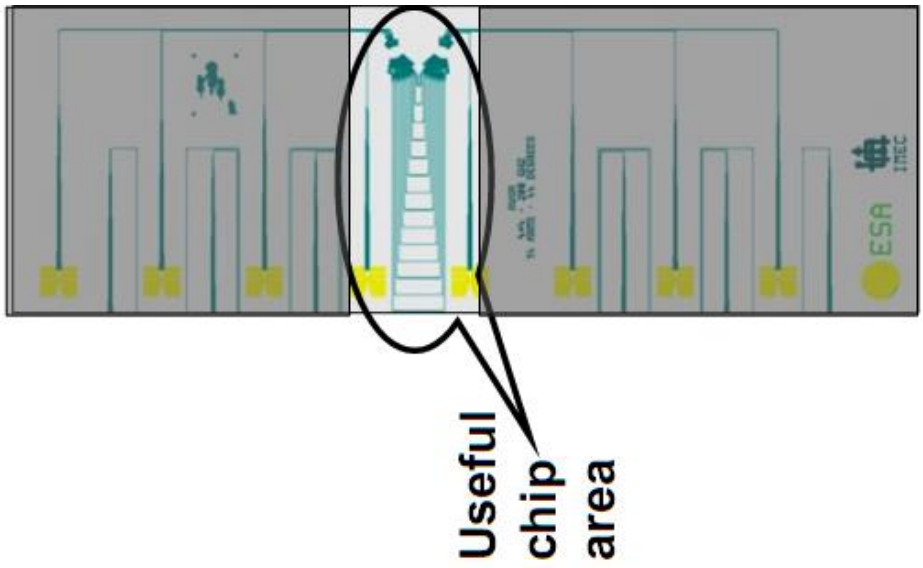




Fiber density?

- Fiber pitch: 125 or 250µm
- Coupler pitch can be as low as 25µm

⇨ **Waste of expensive chip**



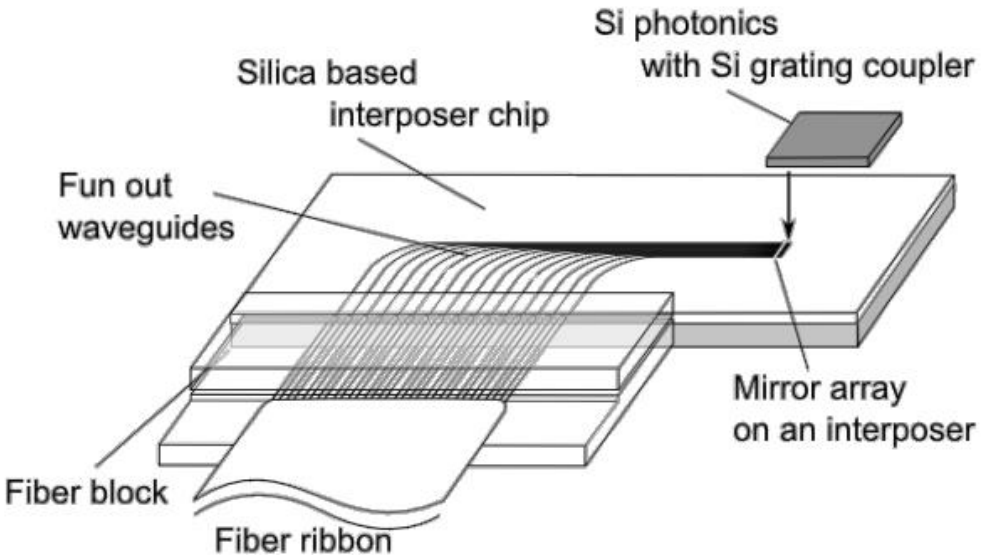
Photonic Interposer:

- Silica-based interposer chip

  Fan-out of photonic waveguides to fiber array

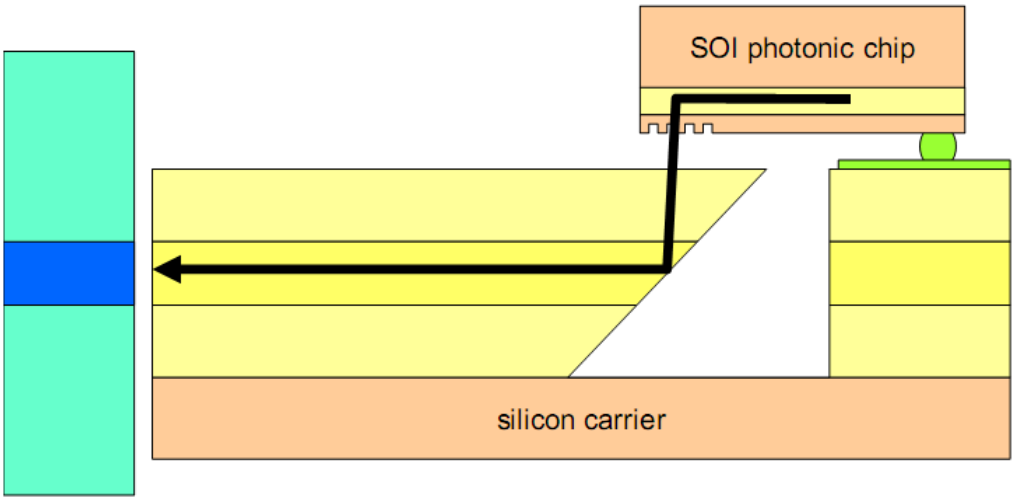
  Fan-out of electronic connection to wire bond pads

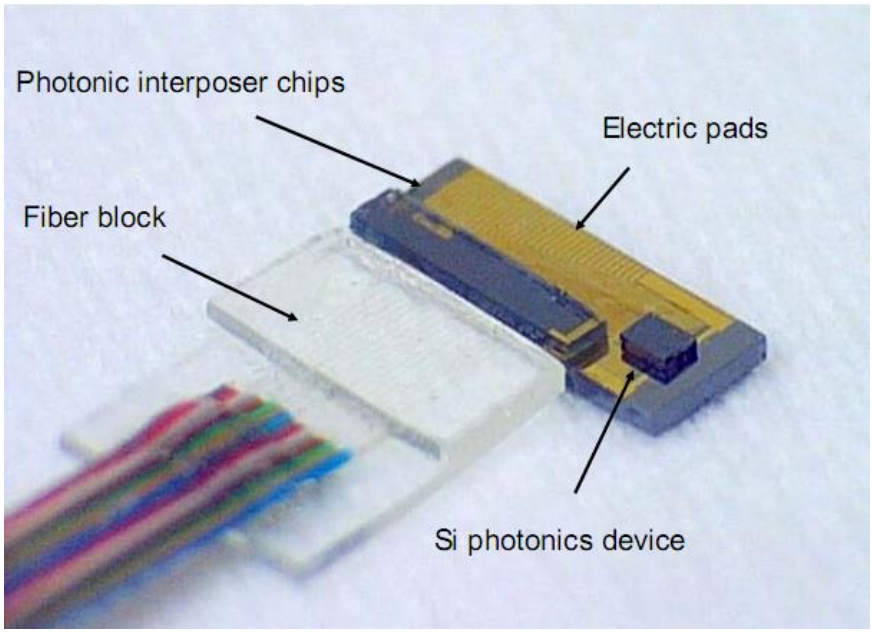
- Silicon chip can be kept small (cost, yield)
- One interposer design can serve many chip layouts



Use TIR mirror to couple to the silica waveguide:

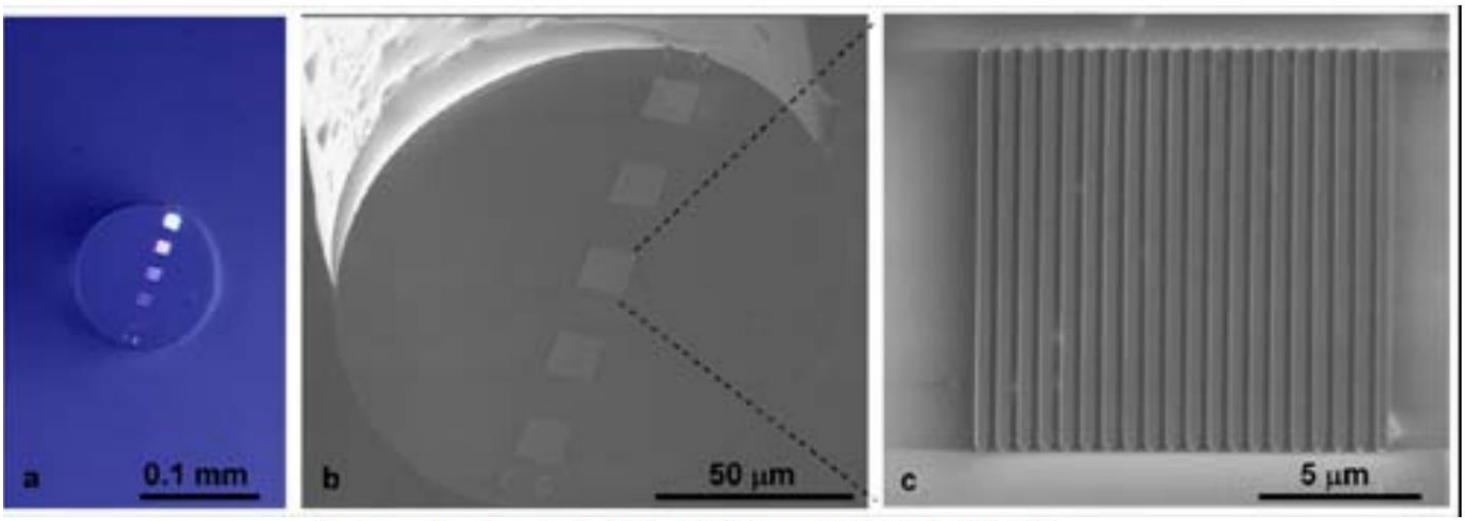
- Difficult to fabricate!




Photonic interposer chips
Electric pads
Fiber block
Si photonics device

Optical Probe: True equivalent of an electrical probe

- Allows for testing of individual components in a PIC without the need for dedicated coupling structures on the PIC
- Optical fiber with a diffraction grating (gold stripes) defined on the core of the optical fiber
- Fabricated using a nano-imprint and transfer technique



Scheerlinck et al.APL 92(3), p.031104 (2008)