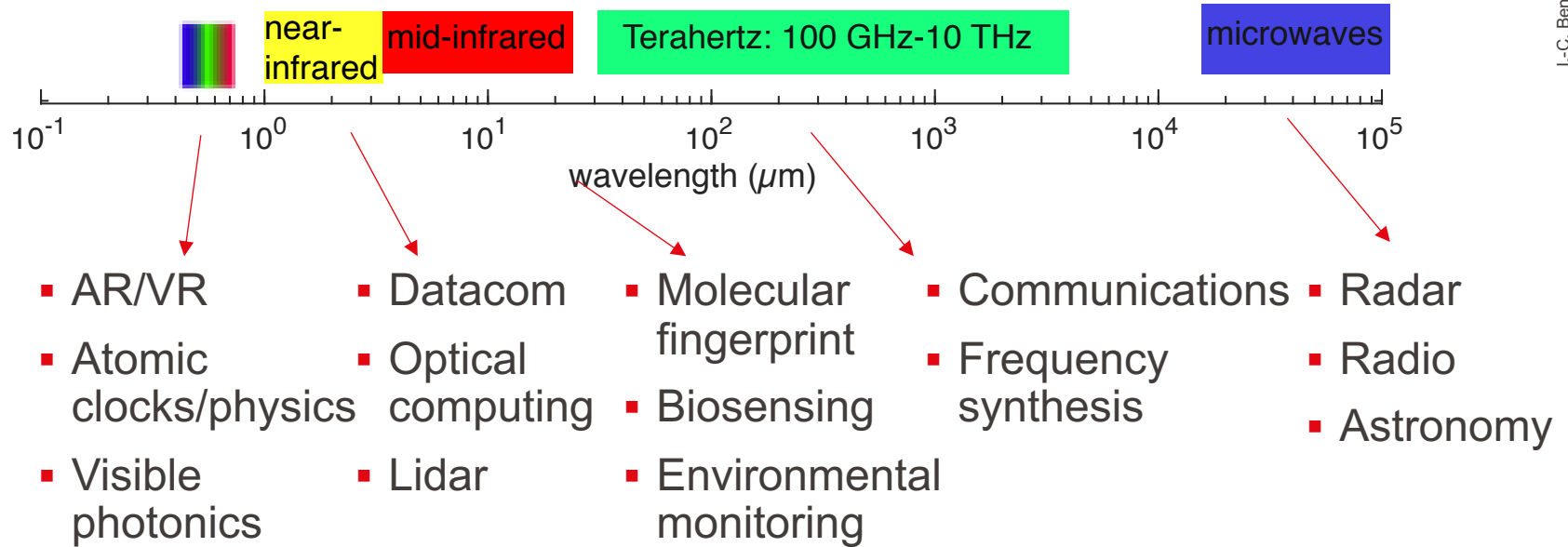
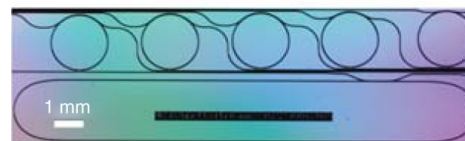
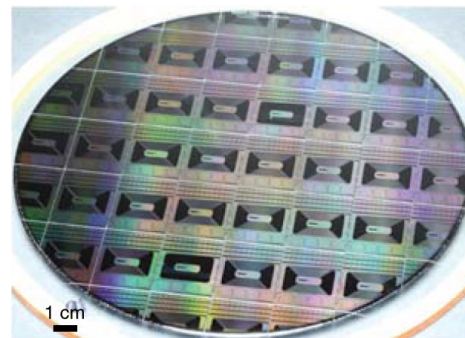
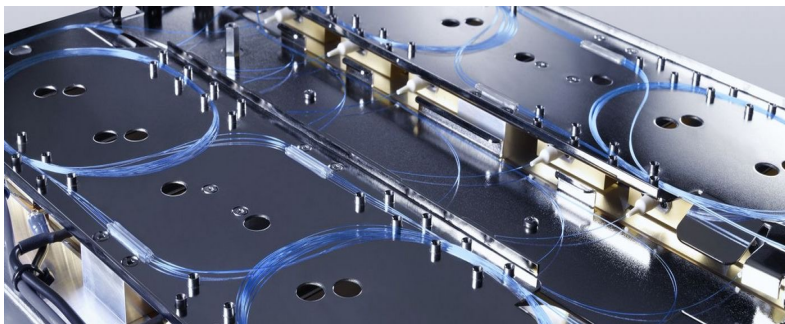


Applications of integrated photonic circuits



Trend in miniaturization

- Fiber-based frequency combs
- 
- Microcombs

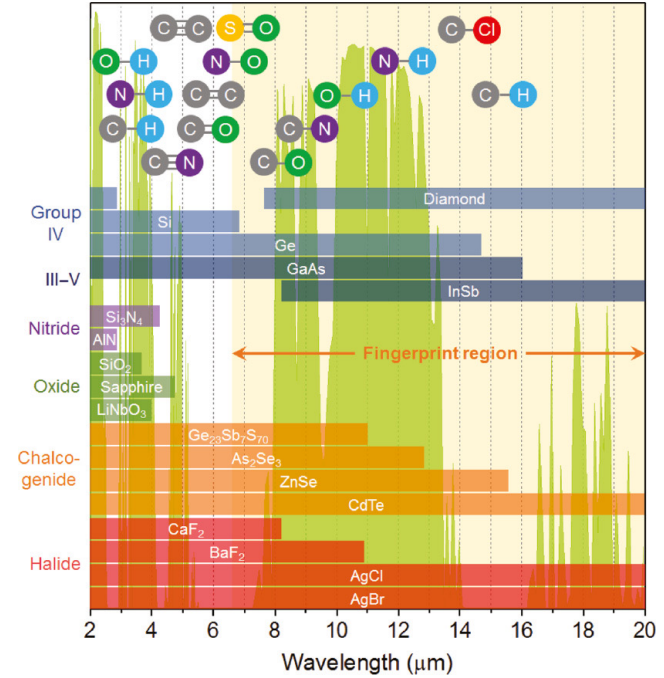
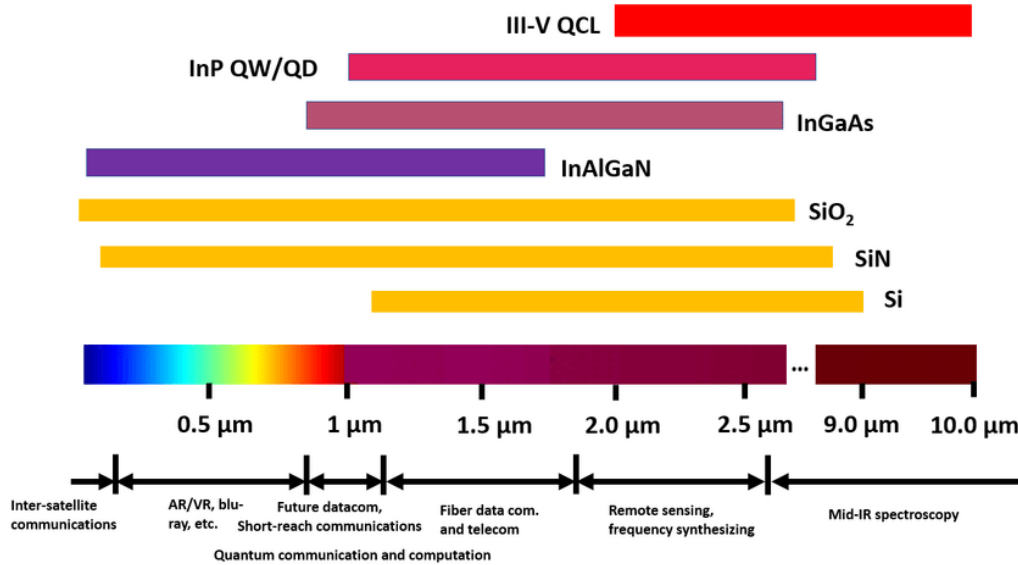


https://www.trumpf.com/de_DE/produkte/laser/faserlaser/

<https://www.nature.com/articles/s41566-021-00761-7>

Material platforms

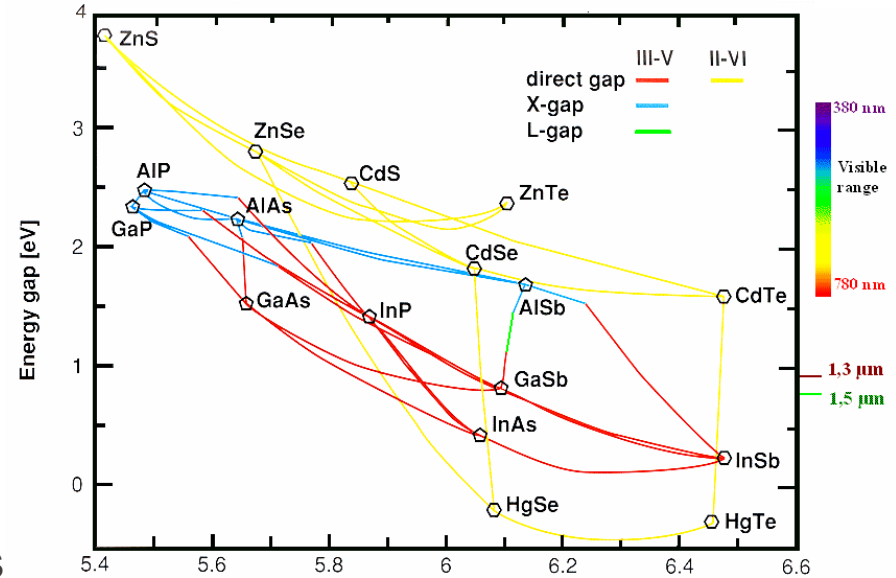
■ Fundamentals of integrated photonic components



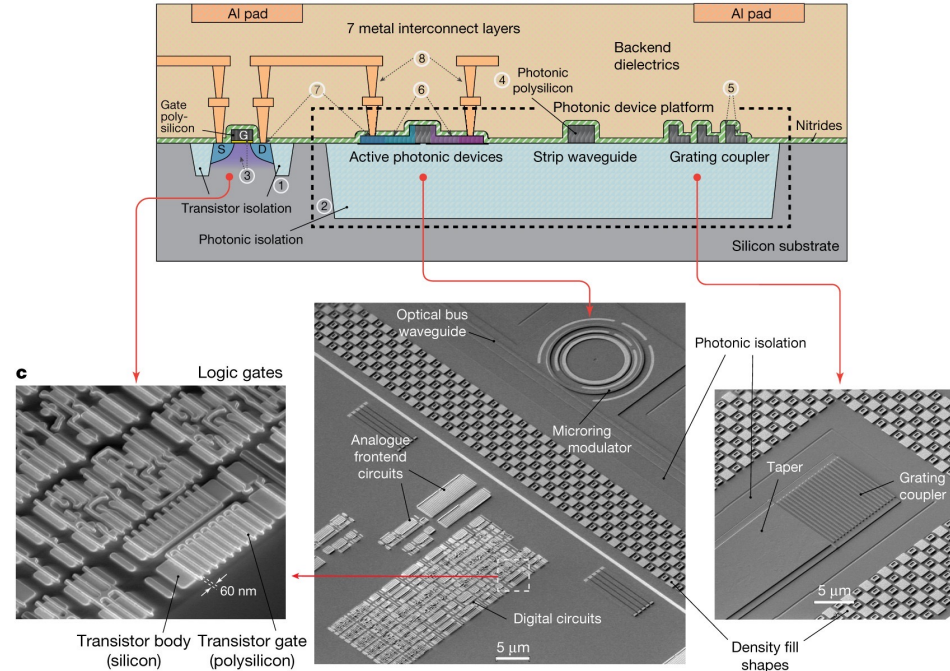
<https://www.degruyter.com/document/doi/10.1515/nanoph-2017-0085/html?lang=en>

III-V integrated photonic circuits

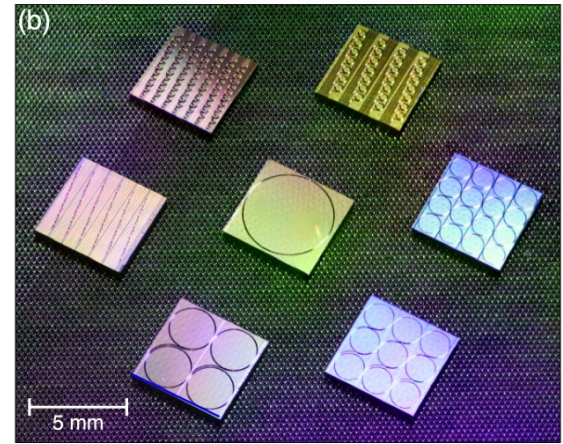
- Bandgap: 1.35 eV (direct)
- Transparency window: near-infrared
- Passive waveguides from Indium Phosphide
- Active components (laser diodes & detectors) from InGaAs/InGaAsP
- Direct bandgap semiconductors
- High refractive index



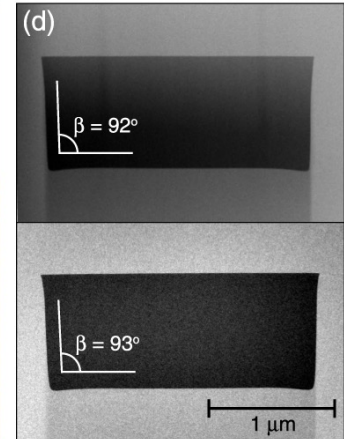
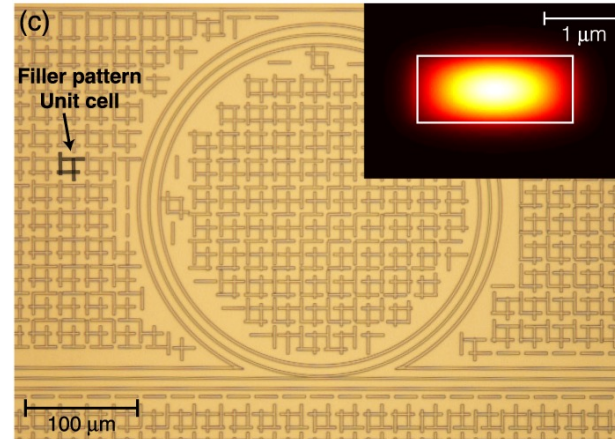
- Bandgap: 1.12 eV
- Transparency window: 1 – 7 μm
- Compatibility with CMOS fabrication technology (mature and low cost)
- high refractive index
- high contrast waveguides
- difficult to have sources/detector



- Bandgap: ~ 5 eV
- Transparency window: 300 nm – 4.5 μm

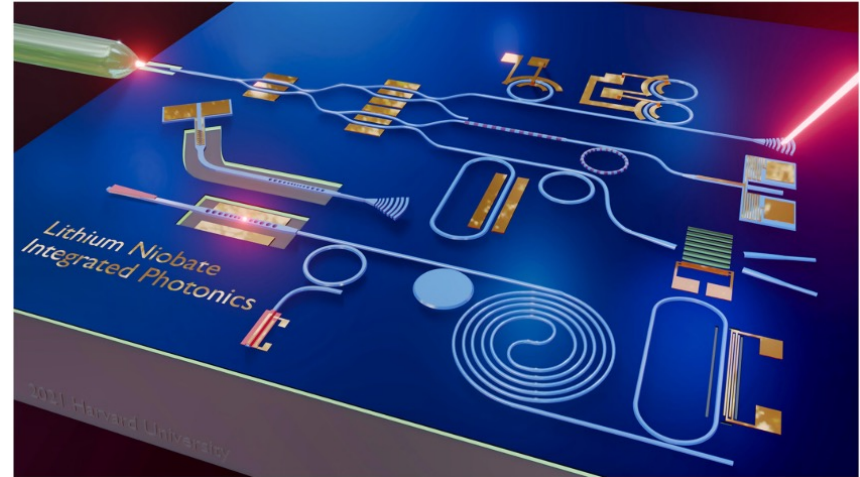


- Low-index contrast
- Very low propagation loss
- High power handling
- CMOS compatibility
- Limitation in waveguide height due to strain



Liu, J., Huang, G., Wang, R.N. *et al.* High-yield, wafer-scale fabrication of ultralow-loss, dispersion-engineered silicon nitride photonic circuits. *Nat Commun* **12**, 2236 (2021)

- Bandgap: 3.8 eV
- Transparency window: 350 nm – 4.5 μm
- Moderate refractive index
- Low optical loss
- High nonlinearities
- High power handling

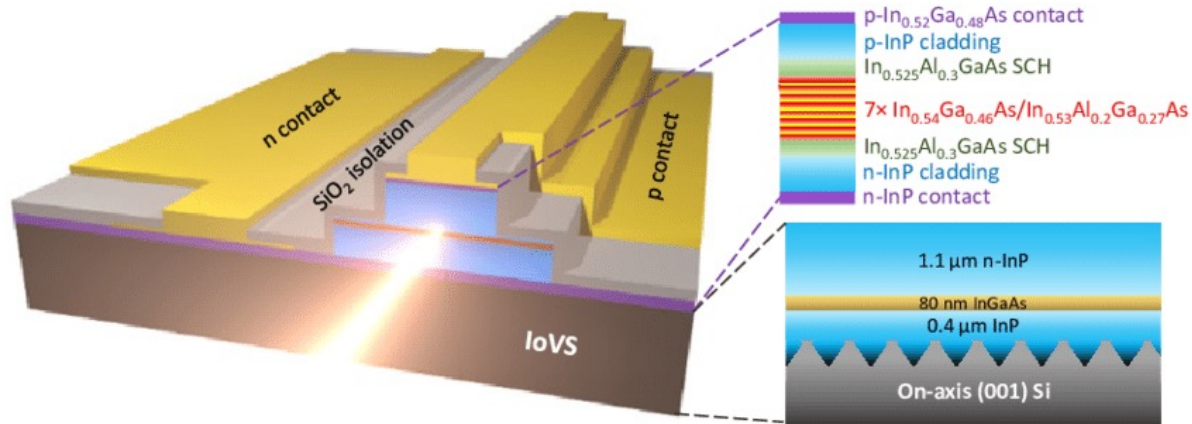


Di Zhu, et al. Advances in Optics and Photonics 13, 242 (2021)

Figures of merit of PICs

- Crystalline/amorphous (→ lattice matched growth)
- Transparency window (→ broad bandwidth important for nonlinear photonics)
- Losses (→ high field enhancement on-chip)
- Nonlinearities (→ generate new frequencies)
- Noise limits (→ fundamental limits in signal quality)
- Compactness (→ packaging density)

- Direct growth III-Vs on silicon



- Polymer bonding

