Silicon-Photonic Backplane for Focal Plane Array Communications

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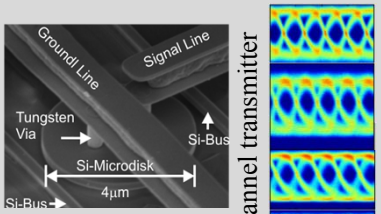
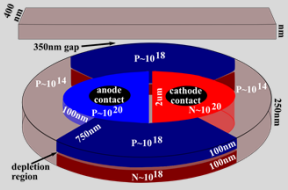
Silicon photonics is an enabling technology for space systems in SWAP reduction and performance enhancement

Some attributes include: ***re-configurability*** ***RADHARD*** ***compatibility with standard CMOS***

most parts function at 1V or less

High Speed Low Power Modulators





Best In Class Devices

- Lowest energy (3.2 fJ/bit) 12.5 Gb/s optical modulator [1]
- Low-voltage, compact broadband phase modulators and 2 × 2 thermo-optic switches [2]
- Full C-band tunable second-order filters [3]
- Fastest (2.4 ns) reconfigurable 2 × 2 wavelength selective switches [4]
- Ultra-low V-π length product of < 1V-cm in 10 Gb/s broadband Mach Zehnder modulator [5]
- Among the highest speed (>> 22 GHz) Germanium on Si detectors

Best In Class Integration

- Integration of a micro-heater, sensor with the modulator and thermal stabilization of resonant wavelength over 55C° [6]
- Integration of silicon photonics with rad-hard 0.35 CMOS7 [7]
- 1st reported measurement and analysis of uniformity of manufactured resonant wavelength [8]
- 1st reported operation of a resonant modulator over 70 km of fiber for telecomm. applications. [9]

Current Research Focus

- Low loss/low temp coupling
- Cryogenic performance
- Active radiation testing
- Parts returning form ISS in 2011

For Example 100M Pixel Array

- Optical Power: 100-Tb/s @10fJ/bit 1W
- Electromagnetic Interference Eliminated direct connections from optics to CMOS
- Packaging: Direct leverage of mature, scalable electronic packaging

Applied Photonics Microsystem Group at Sandia

The Applied Photonic Microsystems department develops, matures, and applies biophotonic, silicon photonic and metamaterials technology

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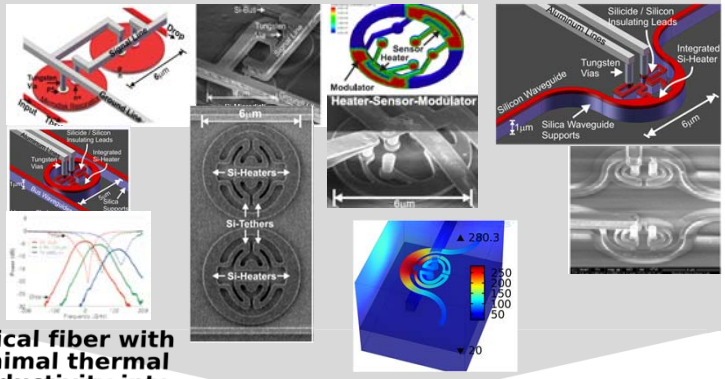
References

[1] W. A. Zortman et al, OSA CLEO, San Jose, 2010.
[2] C. T. DeRose et al, IEEE OFC Los Angeles 2011.
[3] M. R. Watts et al, OSA CLEO, *Baltimore*, 2009 *postdeadline*.
[4] M. R. Watts et al, IEE OFC 2008 *postdeadline*.
[5] M. R. Watts, IEEE Journal of Selected Topics in Quantum Electronics, 159-164 2010.
[6] C. T. DeRose et al, OSA CLEO 2010.
[7] W. A. Zortman et al SPIE Photonics West, San Francisco 2011.
[8] W. A. Zortman et al Optics Express 18, 23598-23607 2010.
[9] W. A. Zortmanin, IEEE OFC, San Diego, CA, 2010.

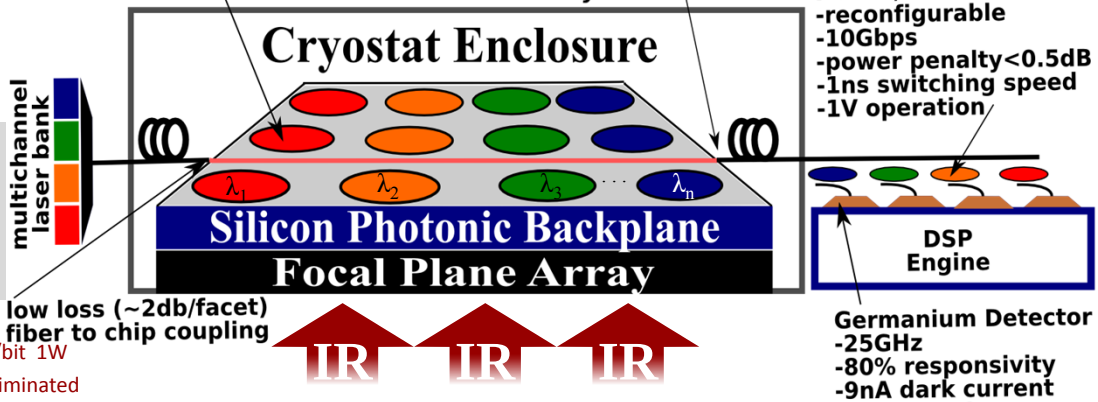
Filters/Swithes for DEMUX/Routing



WDM Modulator
-12.5Gbps
-3fJ/bit
-<1V
-BER<1e-12

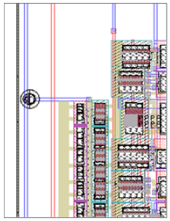
optical fiber with minimal thermal conductivity into cryostat

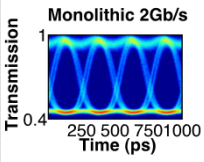
Filters/Switches for DEMUX/Routing
-reconfigurable
-10Gbps
-power penalty<0.5dB
-1ns switching speed
-1V operation

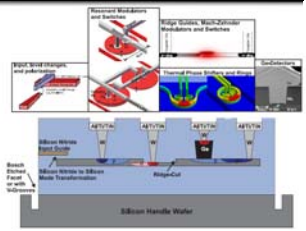


Germanium Detector on SOI
-25GHz
-80% responsivity
-9nA dark current
-1V operation

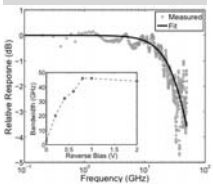
Small, Lightweight and Integrated with RADHARD CMOS Electronics

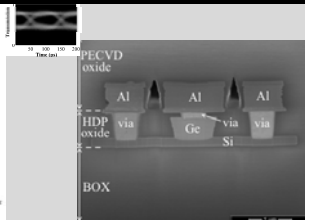






Opto–Electronic Conversion





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