



National Security Photonics Center

Our Vision: Serve the nation as a center of excellence for national security photonics through scientific excellence, responsive pathfinders, and fielded products.

David Peters / MMs and PhCs
dwpeter@sandia.gov

Chris Long / Si Photonics
cmlong@sandia.gov

Erik Skogen / Optoelectronics
ejskoge@sandia.gov

Capability



MESA
Microsystems and Engineering Sciences Applications

MESA Complex

- 60,000 square feet of cleanroom space with state-of-the-art growth and processing toolsets
- 100,000 square feet of laboratories, including dedicated Si photonics and III-V device development labs
- Prototype systems incorporating silicon photonics, digital and mixed signal rad-hard CMOS, FPAs, MEMS, microfluidics, and optics



60+ Photonics Staff
Device Design, Modeling, Simulation
Semiconductor Device Fabrication
Microsystem Fabrication
Testing, Rad Effects, Cryo
Reliability

Compound Semiconductor Fab

- Custom epitaxial growth of GaAs, InP, GaSb and GaN materials
- Custom III-V devices

Silicon Photonic Research Foundry

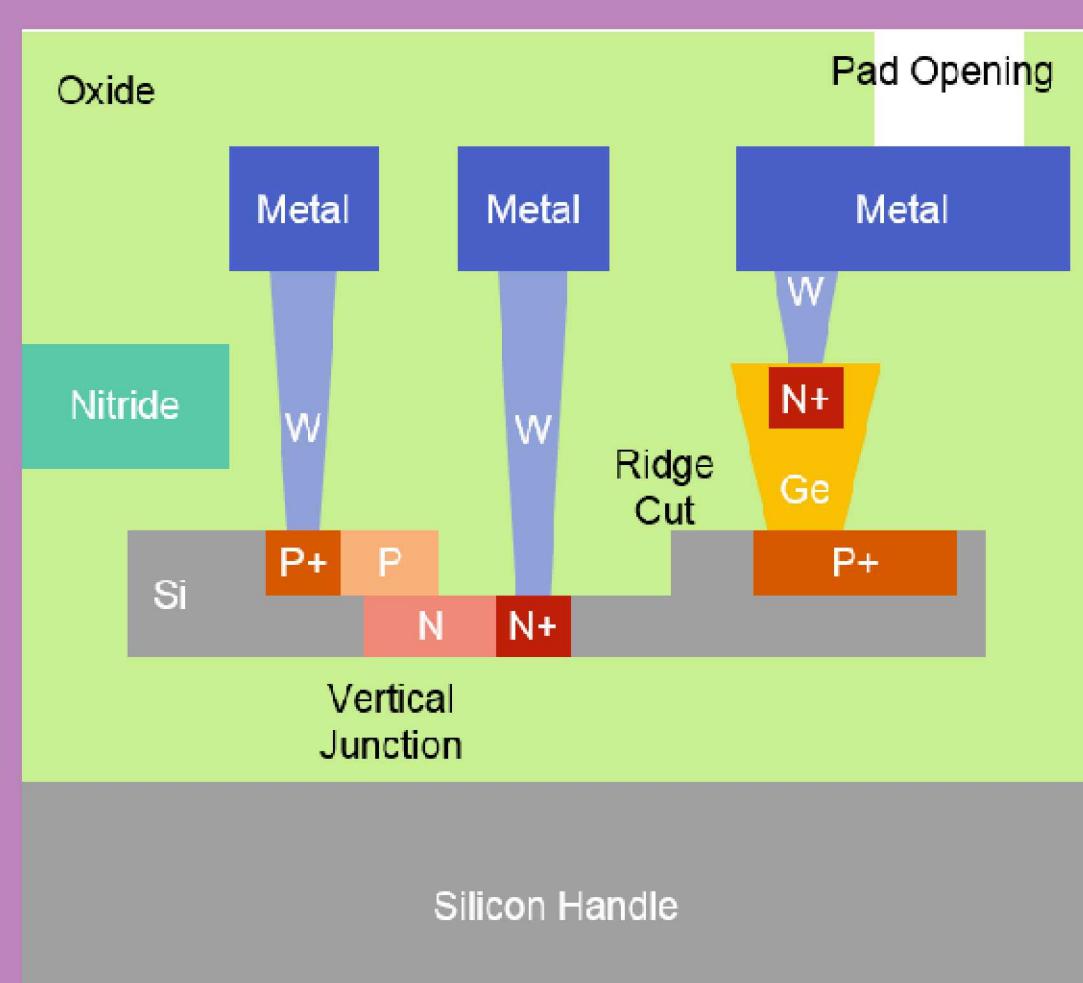
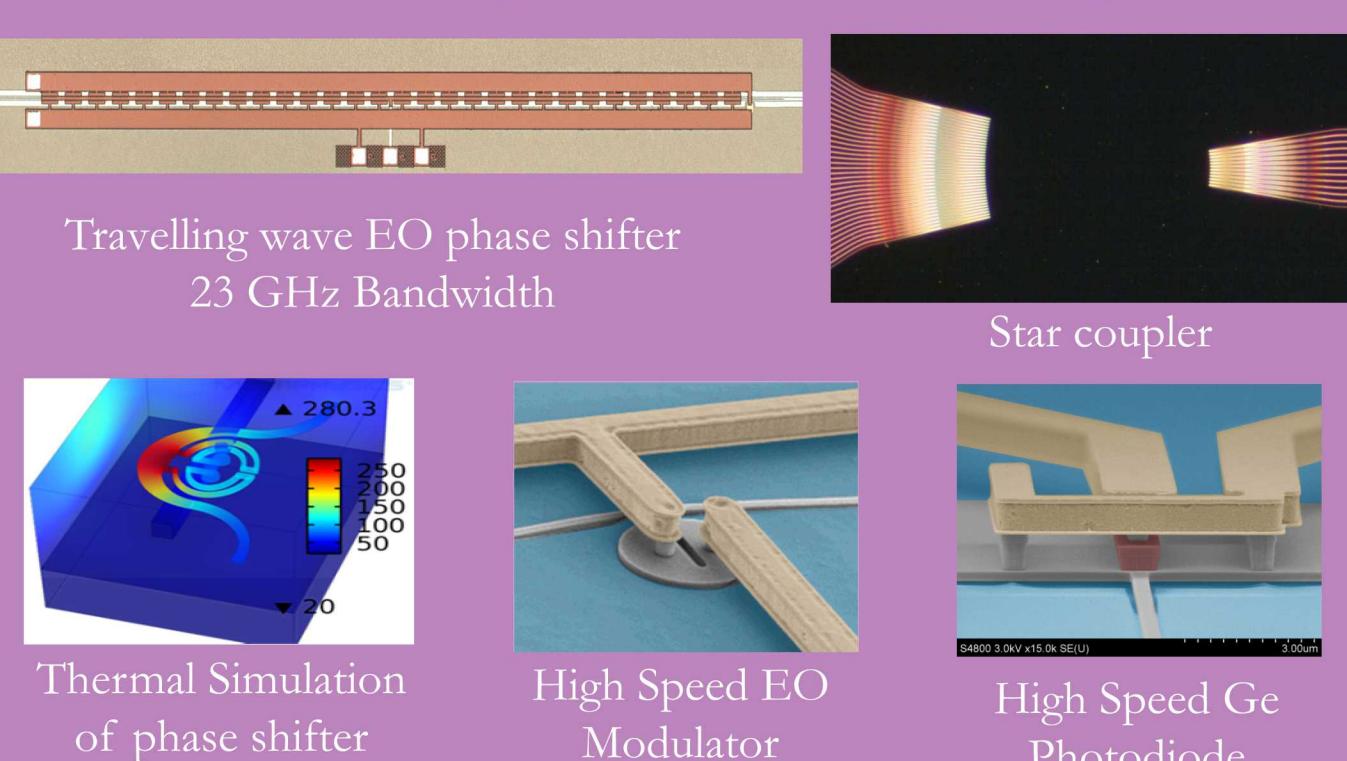
- 6 in. SOI wafers: 250nm device layer and 3 μ m buried oxide layer
- Active devices and passive structures
- Selective area epitaxy of Ge
- Multi-Project Wafers and library devices available

Flexibility

Silicon Photonics Platform

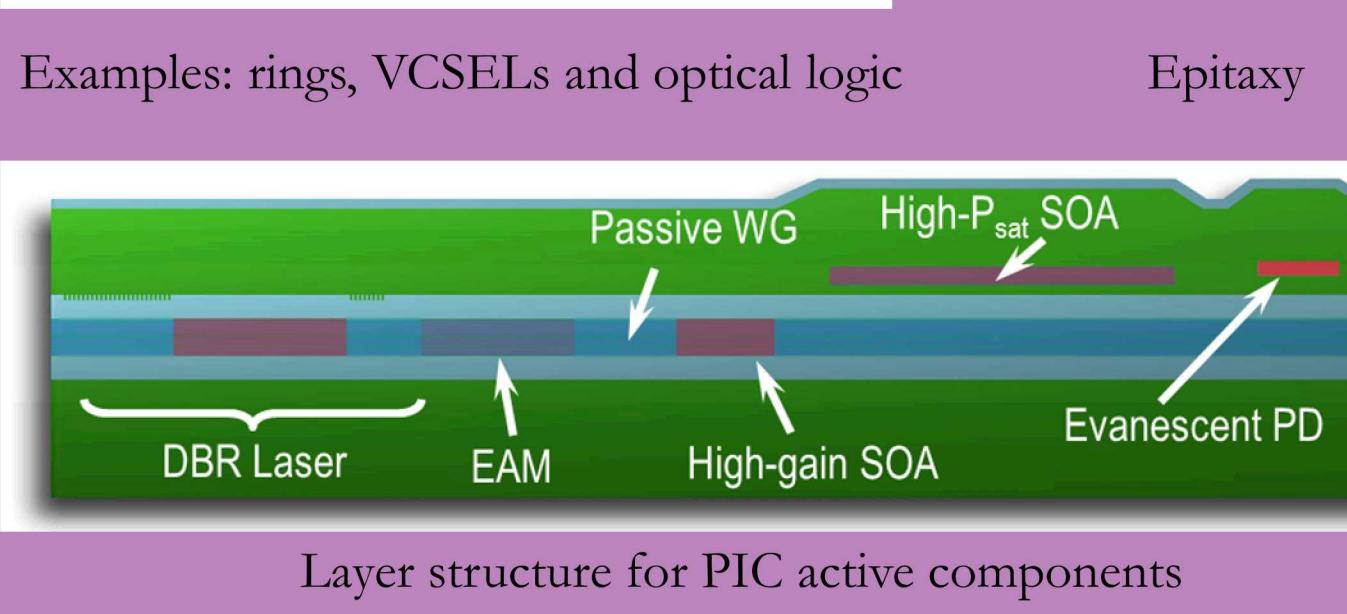
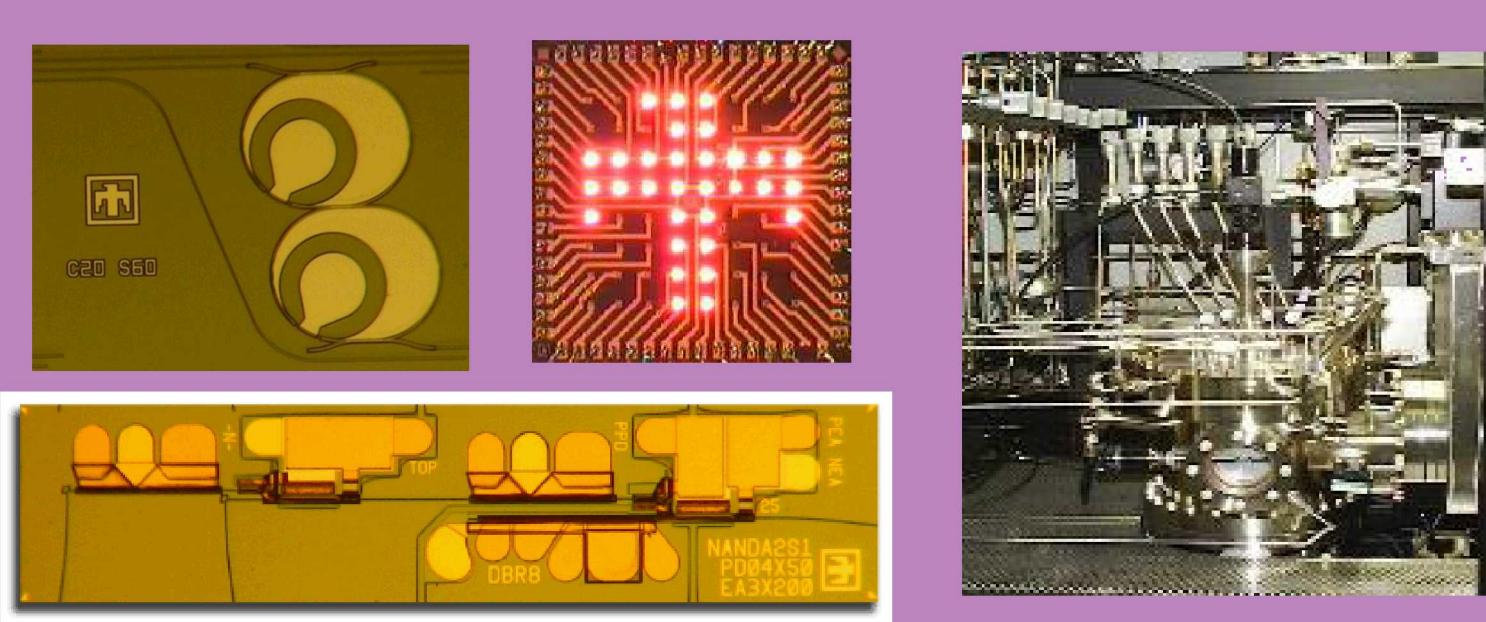
Why Silicon Photonics?

- Leverage existing CMOS infrastructure
- Close integration with CMOS electronics
- Low power, high speed devices
- Low loss waveguides (<0.1 dB/cm possible)



Optoelectronics and PICs

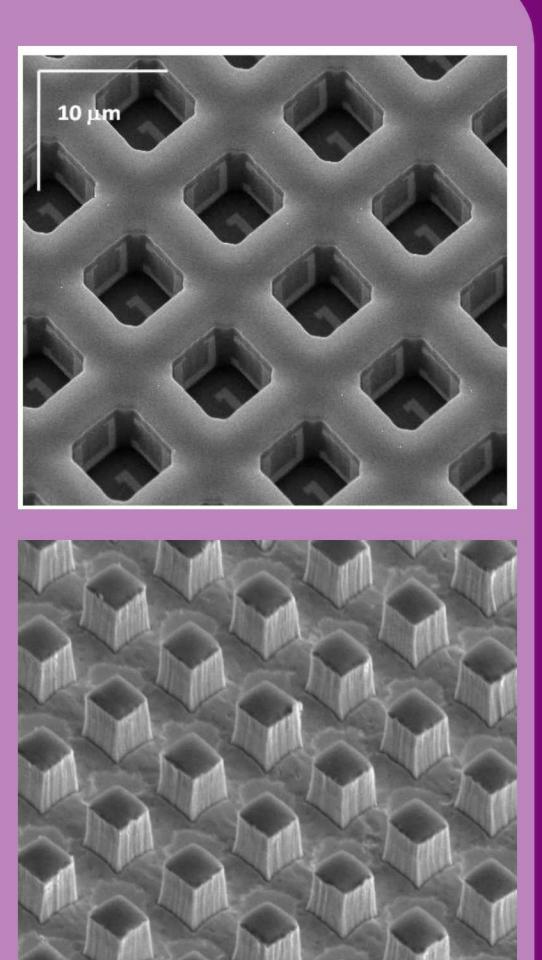
- InP PICs provide efficient, high speed generation, modulation and detection at 1550 nm
- Sandia's PIC toolkit includes:
 - Lasers
 - Modulators
 - Optical Amplifiers
 - Detectors
- Demonstrated circuits:
 - Transmitters
 - Receivers
 - Optical logic gates
 - Optical RF channelizers
 - Coupled-cavity lasers



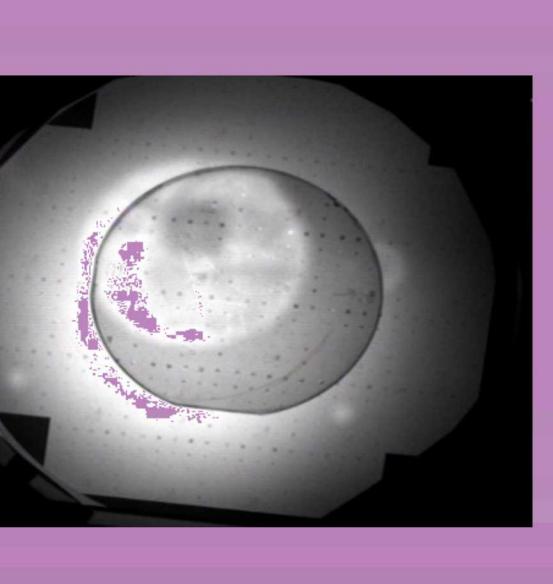
Metamaterials and Photonic Crystals



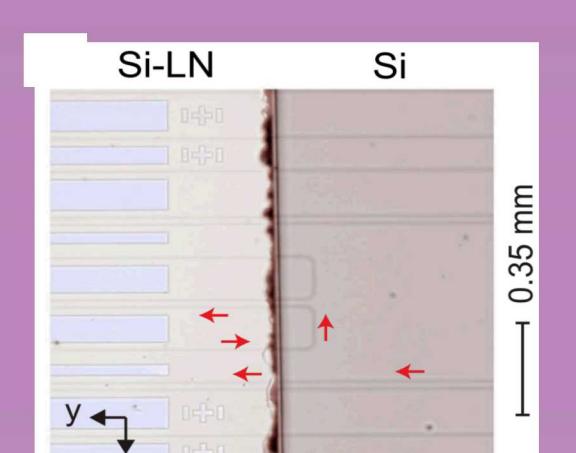
Metal and dielectric metamaterials in 2D and 3D. Photonic crystals from the visible to LWIR made from traditional and esoteric materials. Integration directly with LWIR detectors leading to increased QE and reduced dark current.



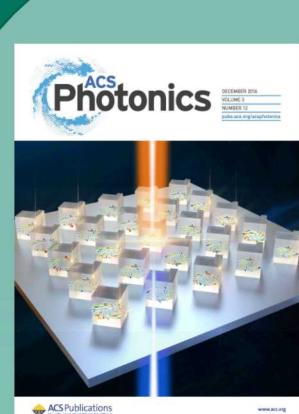
III-V materials
• Wafer bonding of III-V directly to silicon photonics
• Integrated lasers and amplifiers at 1550 nm



Thin Film LiNbO₃
• Second harmonic generation
• Parametric down conversion
• Low voltage, high frequency modulators
• Large spur-free dynamic range



R&D Leadership & Recognition



Journal covers in FY2017



Ultralow-power
Silicon
Microphotonic
Communication
Platform

Microsystems
Enabled
Photovoltaics

T-QUAKE
Transceiver for
Quantum Keys and
Encryption

Patents and Tech Transfer

Over 100 issued patents issued,
22 patents issued in 2017
Silicon Photonics: 34 patents issued,
~10 pending
Compound Semiconductor Photonics:
~ 70 Issued active patents, many
pending
Licensing & Technology Transfer
VCSEL laser technology to a broad list
of companies
Beam Steering
Atomic Clock Integrated VCSELs to
Microsemi
Microsystem photovoltaics to mPower