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Silicon Photonics at Sandia National Laboratories: Flexible Onshore Foundry Service

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

What is Sandia National Lab?

1950s	1960s	1970s	1980s	1990s	2000s	2010s
NW production engineering & manufacturing engineering	Development engineering Vietnam conflict	Multiprogram laboratory Energy crisis	Missile defense work Cold War	Post–Cold War transition Stockpile stewardship	Expanded national security role post 9/11	LEPs New START Evolving national security challenges

"Exceptional service in the national interest""

- Commissioned initially to design and produce nuclear weapons and develop NW stockpile
- In 2010s, continue NW life extension programs while addressing diverse national security challenges through science and technology

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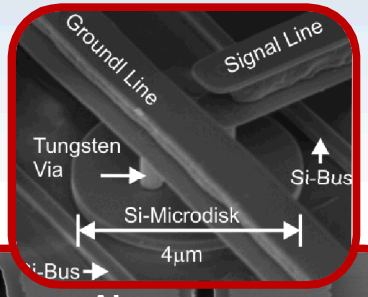
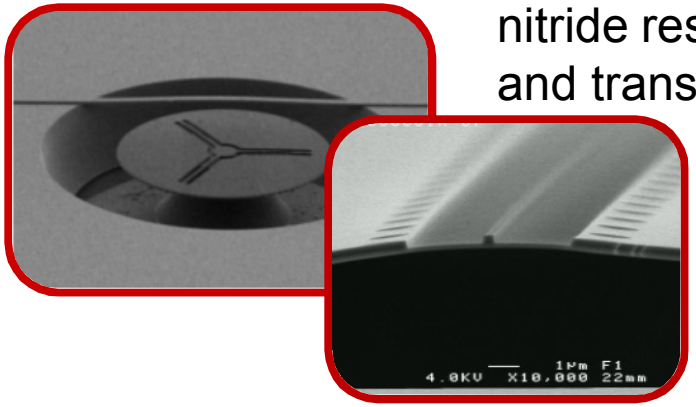
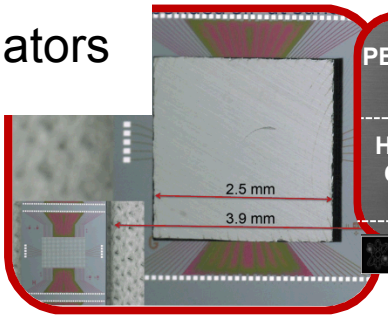
Silicon Photonics Defined?

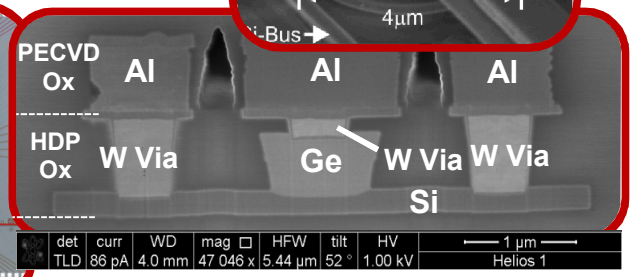
- Low energy modulators, detectors, low loss waveguides, SiN edge couplers, travelling wave Mach-Zehnder modulators, grating couplers, advanced CMOS flip chip bonding, direct CMOS



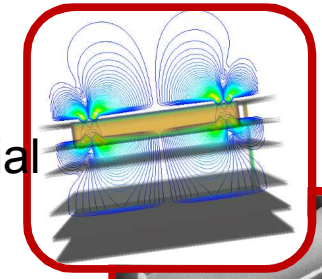
- Suspended Si/SiN waveguides/resonators phononic/photonic crystals, aluminum nitride resonators and transducers.



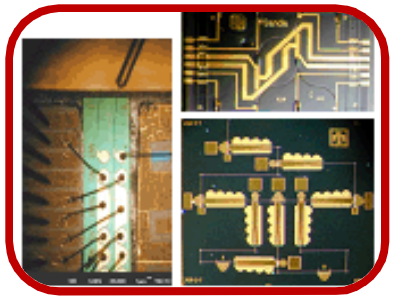


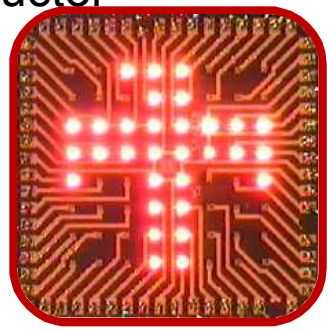


- Near to long wave IR plasmonics and metamaterial based devices.

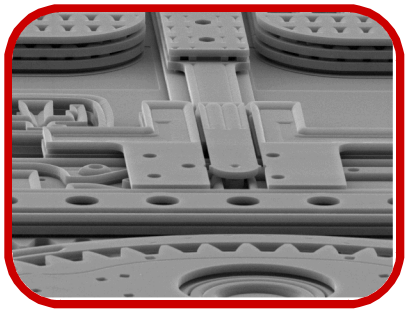


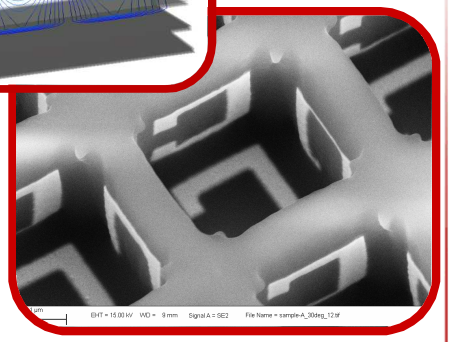
- Compound semiconductor devices and fabrication





- 5 layer poly silicon MEMS process





References:

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MESA Provides Top Facilities and Equipment For Microsystems Design, Fabrication and Test

- Trusted Digital, Analog, Mixed Signal & RF Integrated Circuits Design & Fabrication
- Micromachining
- RAD Effects and Assurance
- Failure Analysis,
- Reliability Physics
- Test & Validation
- 3-D Integration

- Compound Semiconductor Epitaxial Growth
- Photonics, Optoelectronics
- MEMS, VCSELs
- Specialized Sensors
- Materials Science
- Nanotechnology, Chem/Bio
- Mixed-Technology Integration & Processing

- Advanced Computation
- Modeling & Simulation
- COTS Qualification
- Custom Electronic Components
- Advanced Packaging
- System Design & Test

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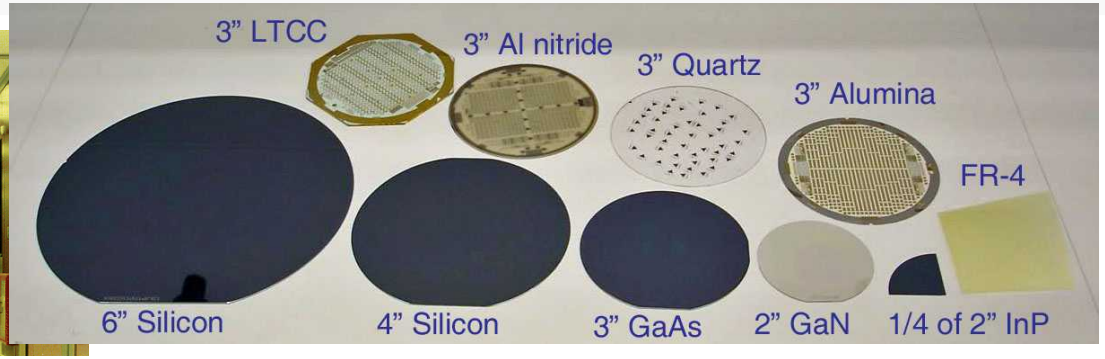
Microsystems and Engineering Sciences Applications (MESA)



- **Here today, here tomorrow.**
  - → **Scheduled IC deliveries to NW customer 10 years out.**
- **Silicon photonics processes are rooted in manufacturing.**
  - → **High yield, low variance in 'standard' processes.**
- **Located inside a limited area.**
  - → **Capable of top secret processing should the need arise.**
- **Can handle a wide variety of materials processing**
  - → **Can adapt to changing research needs**

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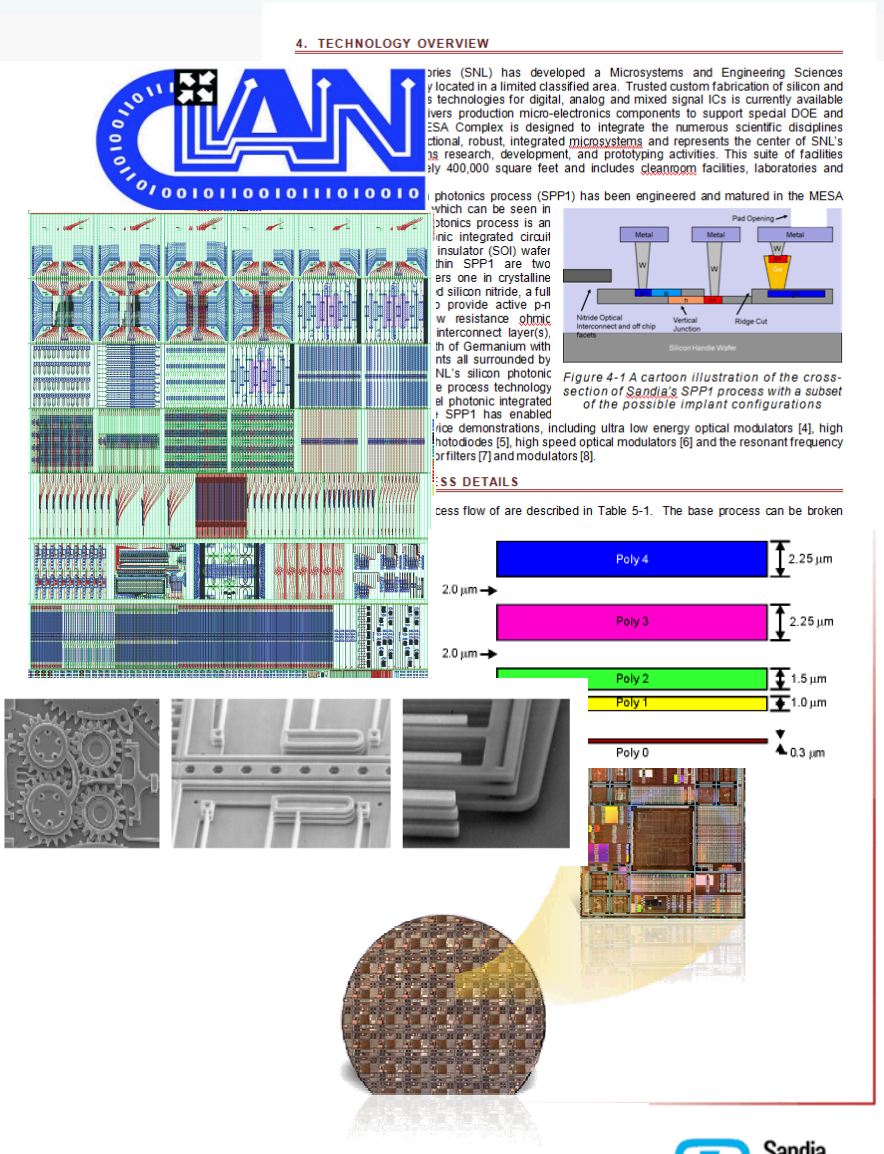
Sandia and MPW

- **SPP1 silicon photonics process**
  - **Developed design manual, DRC, pilot MPW in process.**
- **SUMMIT V 5 layer polysilicon MEMS process**
  - **Developed design manual, DRC supported multiple MPWs over the last decade**
- **CMOS7 Rad-hard, mixed-signal CMOS technology**
  - **0.35um, 3.3V core, 3.3V I/O**



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Next Steps

Current Funding:

- LDRD - Internal research investment
- BAA/Proposals - Sandia as PI or team partners
- CRADA - Sandia as collaborator for industry or universities
- WFO - Sandia as unique service provider

Increased and long-term sustained investments necessary for:

- Continued activities with CIAN-like customers.
  - Lowest cost but decreased priority as majority of run costs are taken on by existing programs at SNL.
- Partner to develop PDK for base process
  - Increased priority, with regularly scheduled research-flow shuttle runs.
- Partner with aggregator (e.g. MOSIS or KCP).
  - High priority, with regularly scheduled fixed-flow shuttle runs.
- Technology transfer to a high-volume manufacturing partner.
  - Increased cost required to persuade partner to implement flow and ensure high yield as driven by customer demand