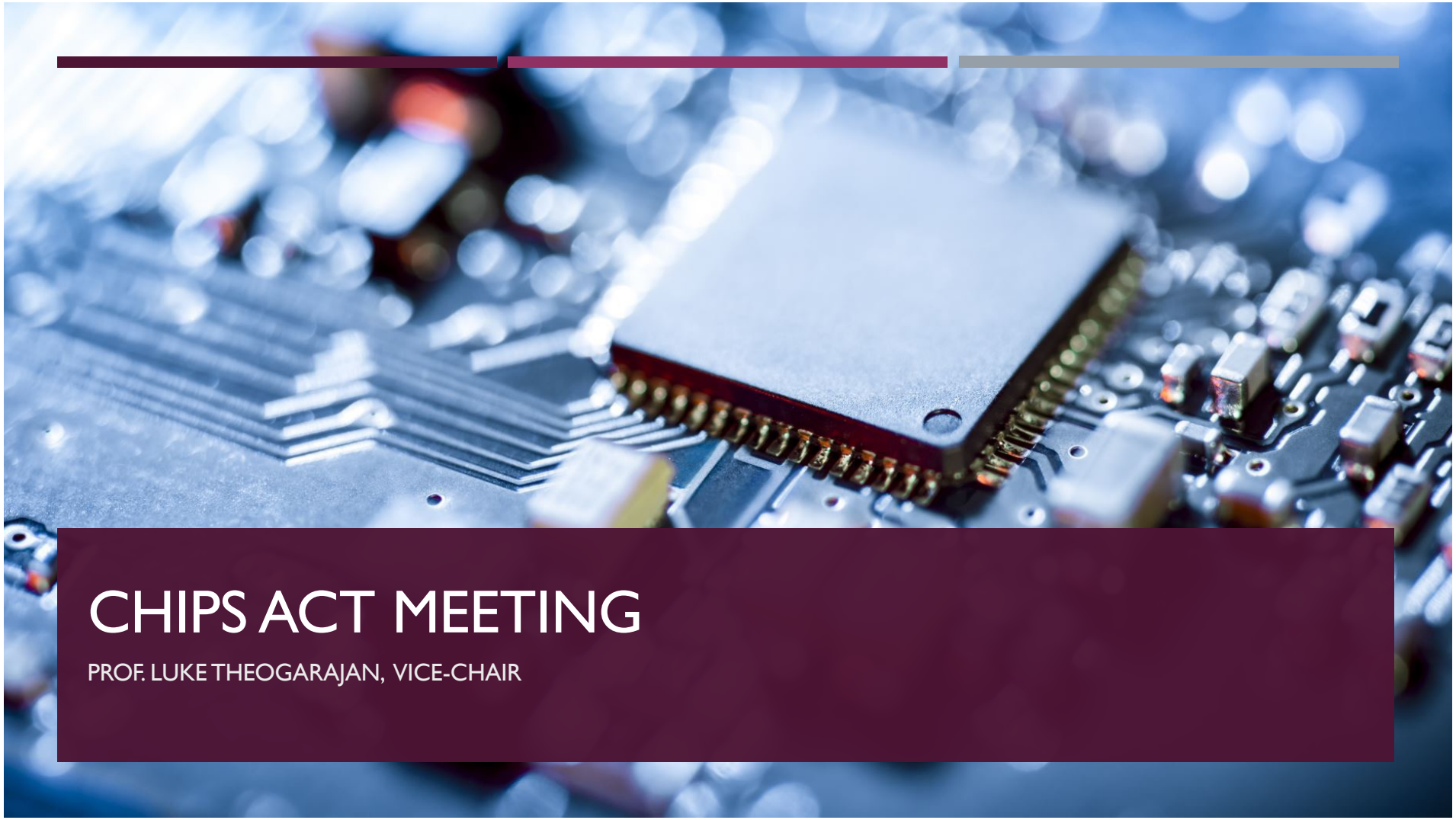


CHIPS ACT MEETING

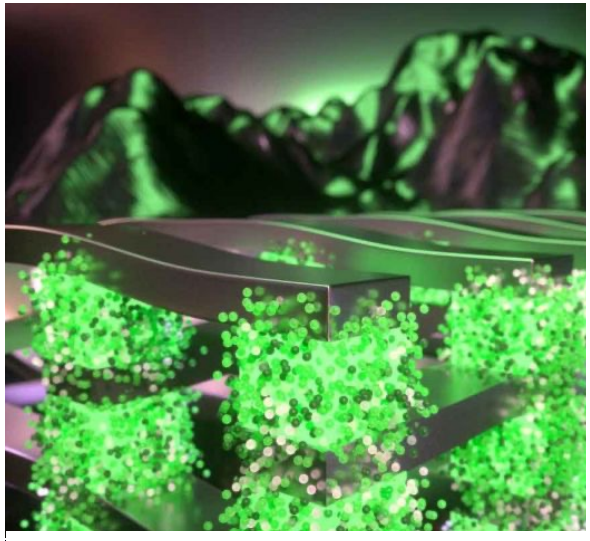
PROF. LUKE THEOGARAJAN, VICE-CHAIR

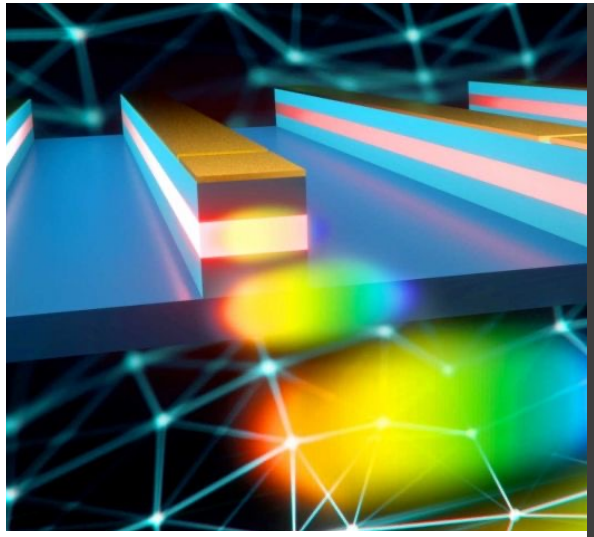
BRIEF OVERVIEW OF THE DEPARTMENT

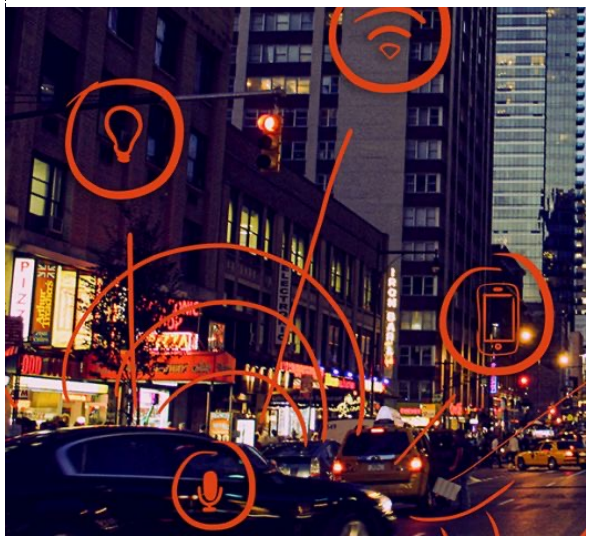
Faculty Size: 47	• 45 current tenured or tenure-track faculty • 2 Lecturers - 2 SOE Lecturers
Undergraduate Students:	• EE: 278 • CE: 275
Graduate Students: 228	• 55 Master's Degrees • 32 PhD Degrees
Degrees awarded 2020-2021	• EE: 65 • CE: 62

QUALITY

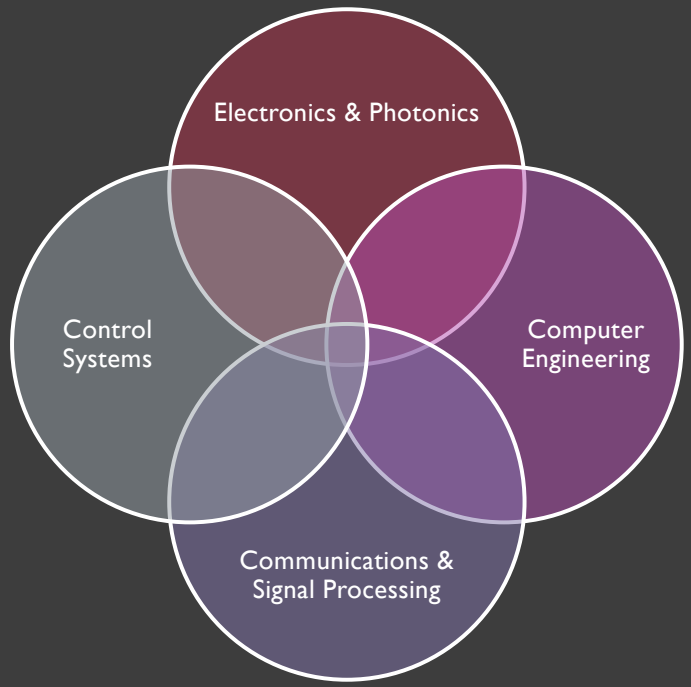
- Top Ranked Engineering Program
- 2 Nobel Prize Laureates
- 2 National Medal of Technology and Innovation
- 1 IEEE Medal of Honor
- 5 National Academy of Sciences members
- 15 National Academy of Engineering members
- 1 American Academy of Arts & Sciences Members
- 9 National Academy of Inventors Fellows
- 40 Institute of Electrical and Electronics Engineers Fellows
- 2 Association for Computing Machinery Fellows
- 8 American Association for the Advancement of Science Fellows
- 8 The Optical Society Fellows







ECE THRUST AREAS



COMMUNICATIONS & SIGNAL PROCESSING

Wireless and Communications
Signal Compression
Image and Video Processing
Computational Imaging
Computer Vision & Pattern Recognition
Machine Learning

COMPUTER ENGINEERING

Bioinspired Computing
Computer Architecture
Energy-efficient Computing
Machine Learning/AI
Network and Distributed Systems
Nanotechnology

CONTROL SYSTEMS

Nonlinear and Hybrid Systems
Robotics
Systems Biology
Scientific Computation
Sensor Networks

ELECTRONICS & PHOTONICS

Circuits and Electronics
Microwaves and Antennas
Optoelectronics/Photonics
Semiconductor devices and processing

ECE CENTERS RELEVANT TO THE CHIPS ACT

- UCSB NanoFabrication facility
- American Institute for Manufacturing of Photonics (AIM)
- California Nanosystems Institute (CNSI)
- Institute for Energy Efficiency (IEE)
- Center for Converged TeraHertz Communications & Sensing (ComSenTer)
- Optoelectronics Technology Center (OTC)
- Solid-State Lighting and Energy Electronics Center (SSLEEC)
- UCSB Quantum Foundry (UQF)

State-of-the-Art Cleanroom Facilities

12000 sqft. of class 100 and 1000 clean floor space

2 class 100 bays for optical and electron beam lithography and 5 class 1000 process bays

A spacious gowning room and supplies storage to accommodate up to 350 researchers

Equipment reservation via a web-based system

Extensive process and tool documentation accessible through the cleanroom wiki

Secure, 24-hour access to our facilities

UCSB NANOFABRICATION FACILITY

AMERICAN INSTITUTE FOR MANUFACTURING OF PHOTONICS (AIM) : KEY TECHNOLOGY MANUFACTURING AREAS

Telecom/Datacom

- Initiative focuses on the challenges for manufacturing high volume, low cost Terabit-scale photonic interconnectivity technology for advanced high performance embedded computing and data centers.

RF Analog Applications

- Initiative objective is to develop manufacturing technologies specifically targeted for producing high volume chip-scale microwave photonics for demanding applications requiring very high optical performance fidelity.

PIC Sensors

- Initiative addresses the manufacturing challenges of chemical and biochemical sensors realized in glass/silicon materials, and demonstrates how the proposed solutions can facilitate high-volume production of embedded sensors connecting to or integrated with mobile platforms.

PIC Array Technologies

- Initiative addresses the manufacturing challenges associated with PIC Phased Arrays. The primary focus of this effort will be on chip based LIDAR.

WEST COAST HEADQUARTERS OF

AIM PHOTONICS

AMERICAN INSTITUTE FOR MANUFACTURING INTEGRATED PHOTONICS

UC SANTA BARBARA

AIM: MANUFACTURING INNOVATION CENTERS OF EXCELLENCE

Electronic Photonic Design Automation

- Development of a set of integrated design tools for photonic and combined electronic-photonic components.
- Features: Models for Si and InP devices; Integrated electronic-photonic design environment; Design tools/PDK; and intellectual Property protection.

Multi Project Wafer / Assembly

- Provision of full MPWA services including Foundry Broker and Foundry Operations for both Si and InP based photonic devices & components
- Features: Availability of in-house 300 mmm Si and InP fabrication faciliites; III-V laser integration; Interposer 2.5D/3D integration; and Integrated inline and optical test

Inline Control & Test

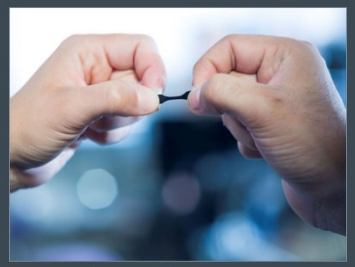
- Robust optical testing for photonics applications using inline and stand-alone approaches.
- Features: High-throughput, high-functionality wafer-scale optical probe test; on wafer photonic test cells for process control; and Multi-channel I/O fiber array test interfaces.

Test, Assembly & Optical Packaging

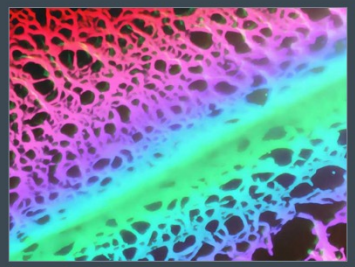
- Development of standardized advanced automated, no-touch and accessible processes for PIC test, assembly & optical packaging.
- Features suite of 2D, 2.5D and 3D automated optical element align on interposer, fiber/WG attach, and pick and place capabilities; Sub micron 3D inspection tools; and In-house prototype photonics optical packaging center.`

CALIFORNIA NANOSYSTEMS INSTITUTE (CNSI)

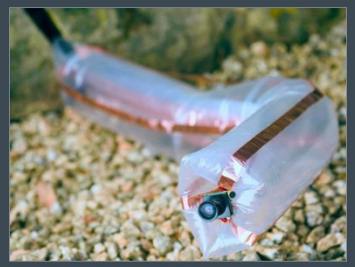
Focus Areas



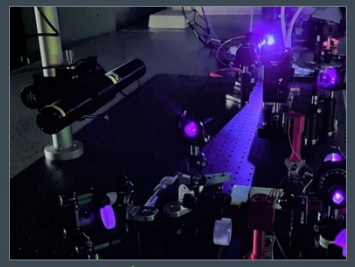
Advanced Materials
Materials for energy management, healthcare, and actuation.



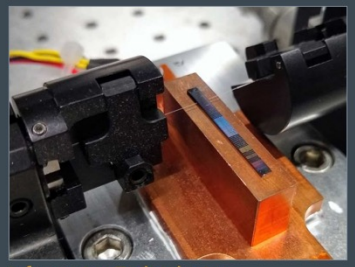
Biotechnology
Biomolecular discovery, systems biology, diagnostic devices and therapeutics.



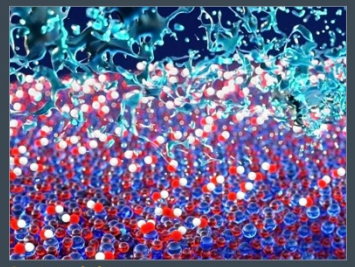
Complex Systems
From forests to microbes to robotics: how do complex systems work?



Discovery Tools
Developing next-generation characterization systems to advance discovery across fields.



Information Technologies
Next-generation platforms for information storage, transmission, and computation.

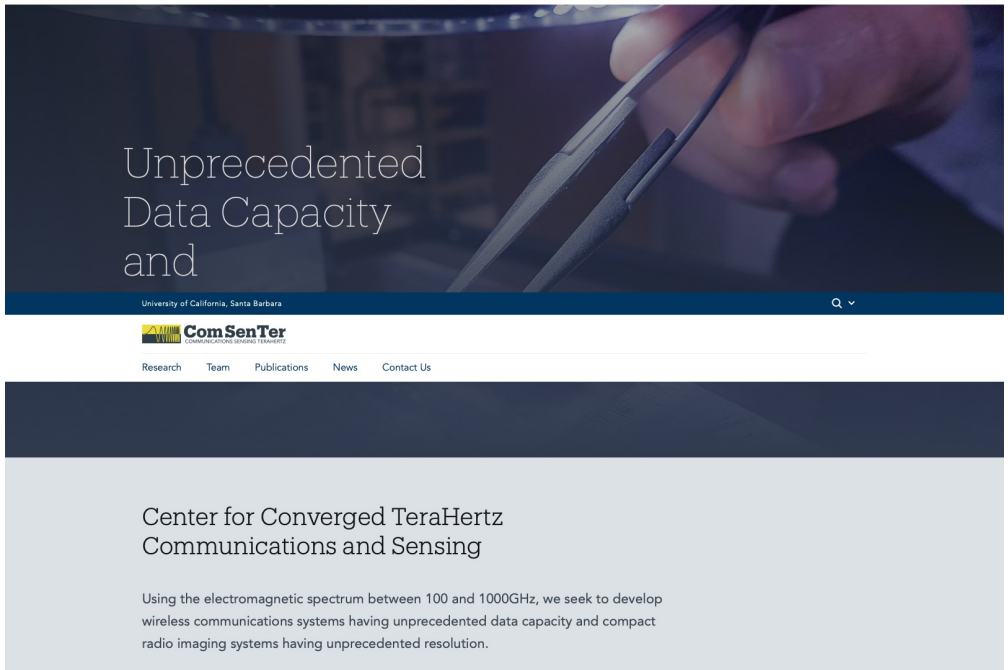


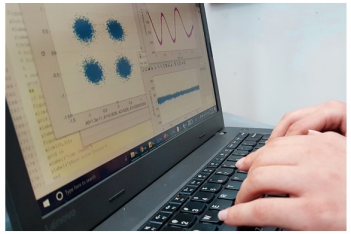
Sustainability
New technologies for efficient energy, clean water, and environmental protection.

INSTITUTE FOR ENERGY EFFICIENCY (IEE)

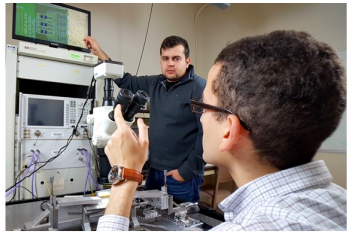
- RESEARCH THEMES
  - SOCIETAL INFRASTRUCTURE
  - COMPUTING & COMMS
  - FOOD ENERGY WATER
  - TECHNICAL FOUNDATIONS
  - ELECTRONICS PHOTONICS
  - QUANTUM
  - AI / MACHINE LEARNING
  - POLICY & SUSTAINABILITY

CENTER FOR CONVERGED TERAHERTZ COMMUNICATIONS & SENSING (COMSENTER)

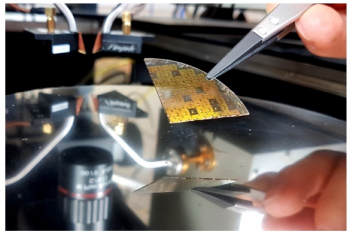




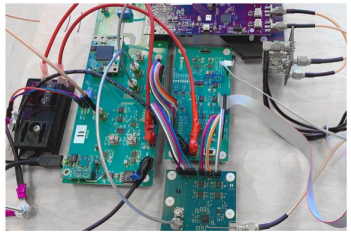
Systems



Integrated Circuits



Devices



Demonstrations

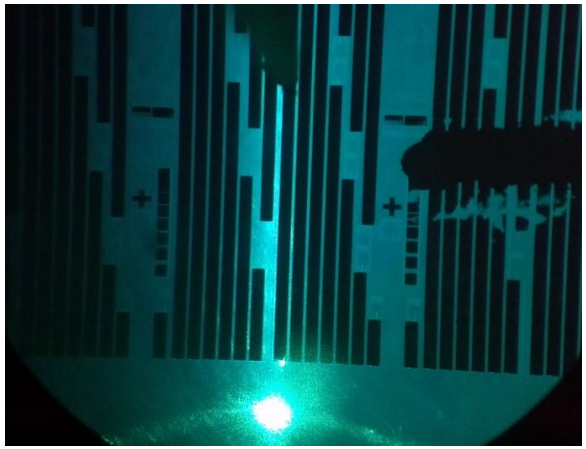
OPTOELECTRONICS TECHNOLOGY CENTER

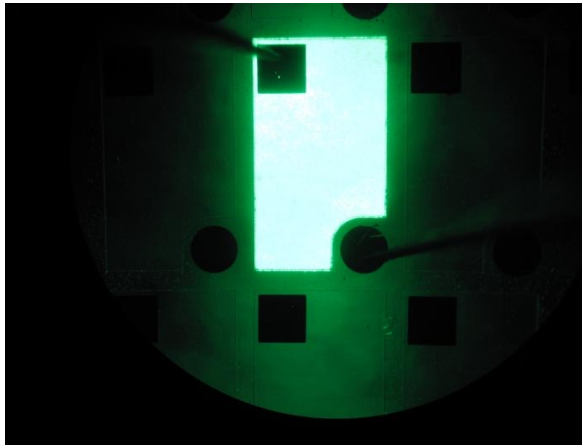
UC **SANTA BARBARA**

OTC

OPTOELECTRONICS TECHNOLOGY CENTER

The Optoelectronics Technology Center (OTC) was established to facilitate fundamental advances in photonics and optoelectronics by a team of faculty in the **Electrical and Computer Engineering (ECE)** and **Materials** Departments. It has been involved in various multicampus consortia funded by the **Defense Advanced Research Projects Agency (DARPA)** and other agencies since the early nineties. More recently **ARPA-E** has become a major supporter of some key efforts. The general goals have been to advance the state-of-the-art in chip-to-chip optical interconnects, data-center efficiency, optical fiber communications, and biosensors. A main aspect of the Center's charter is to encourage collaboration between academia and the U.S. industry in order to accelerate the realization of practical, manufacturable technologies.





SOLID-STATE LIGHTING AND ENERGY ELECTRONICS CENTER (SSLEEC)

UVC-LED Development for Disinfection

- Deep UV for safer disinfection
- Novel epitaxial process for AlGaN alloys
- UVA, UVB and UVC light emitters
- Advanced UV device design for high power and higher efficiency light;
- UV FAQ: https://media.ies.org/docs/standards/IES%20CR-2-20-V1a-20200507.pdf
- For UVC-LED details, go to: https://www.news.ucsb.edu/2020/019949/uv-lights-way.
- If interested in supporting the UVC-LED research, please click: https://gauchoboost.ucsb.edu/project/21466

Micro-LED Development for Mobile Displays

- Blue, green, yellow, and red
- Advanced MOCVD growth
- Low voltage tunnel junctions
- Advanced packaging for light extraction
- High Efficiency, High Power LEDs for Lighting (>280 lm/Watt)

Lasers for Lighting and Communication

- Blue (415-450 nm) and green (525 nm) high-power directional laser diodes
- DFB laser designs
- Novel phosphor materials and matrices for high-power applications

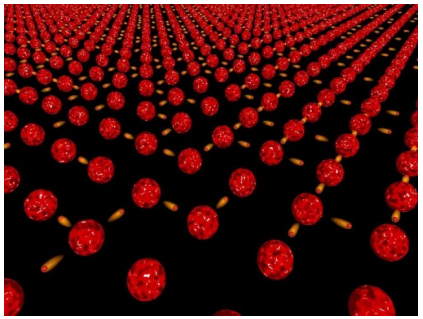
Vertical Cavity Surface Emitting Lasers (VCSELS), compact, hight-brightness, high-efficiency, directional sources

- 3D light sources
- Fully polarized arrays

Power Electronics using AlGaN/GaN (98% efficient >2kV)

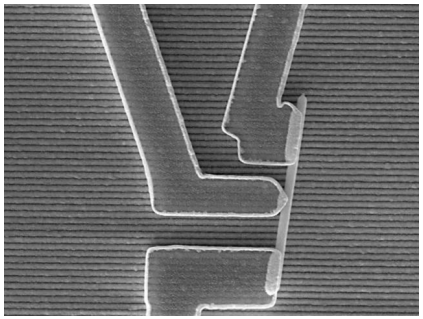
- High breakdown voltage
- Low on-resistance
- Vertical transistors

UCSB QUANTUM FOUNDRY



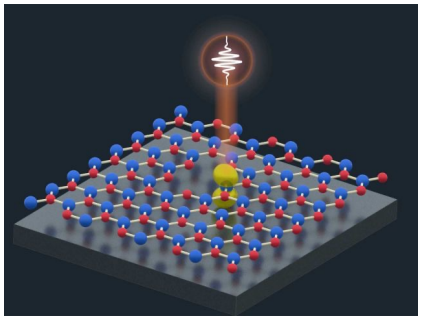
Thrust 1: Natively Entangled Materials

Materials with highly entangled many-body states and protected coherence.



Thrust 2: Interfaced Topological States

Create and control protected quantum states via the creation of hybrid (ie. interfaced) materials.

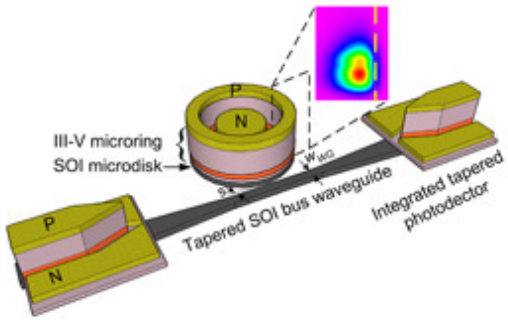


Thrust 3: Coherent Quantum Interfaces

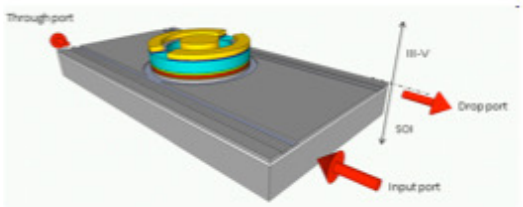
Engineer material platforms that host localized quantum states with robust coherence.

SILICON PHOTONICS

Lasers



Modulators



. Ongoing work on micro-ring based hybrid III-V on Si electro-absorption modulator.

Photodetectors

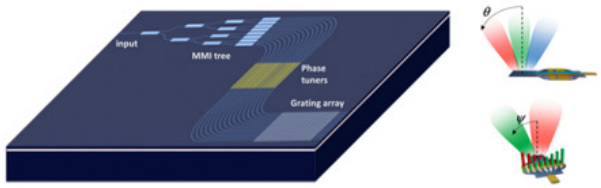


Fig. 1. Optical phased array in silicon for 2D beam sweeping. [1]

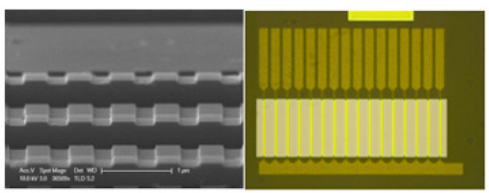
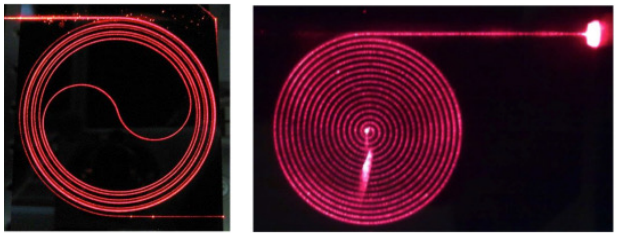


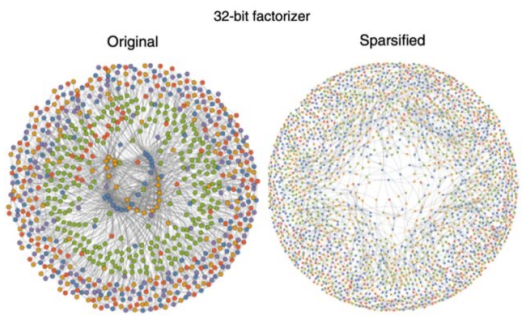
Fig. 2. Surface grating array (left) and thermo-optic phase tuners (right).

Phased Array

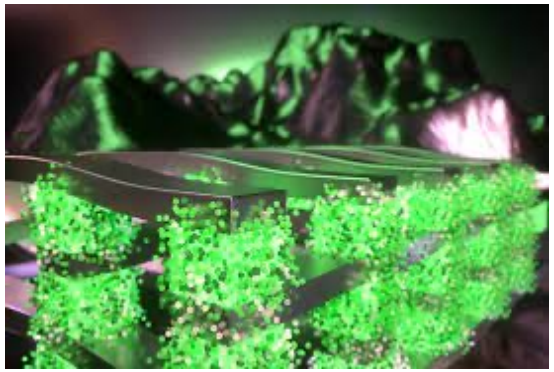


Ultra Low-loss Waveguides

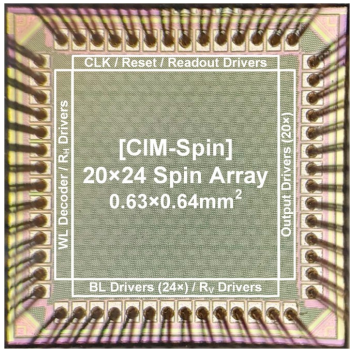
AI/ML



Probabilistic Computing



Memristor Based Neuromorphic Computing



In-memory Computing

COMPUTING INFRASTRUCTURE

- Center for Scientific Computing
- Computer Clusters
  - HP Intel (braid)
    - Infiniband based Sandy Bridge/Ivy Bridge/Broadwell condo cluster.
  - HP Nehalem (guild)
    - Infiniband based Intel Nehalem condo cluster.
  - Knot Cluster (knot)
    - Campus available Infiniband cluster.
  - Pod
    - Newer Campus available cluster with Omnipath interconnect with CPU, GPU, and 'fat' nodes.
  - Braid 2
    - Newest Condo partipant available Infiniband cluster, both CPU and GPU nodes.
- Faceboook Funded Datacenter at IEE