

UCSB Nanofabrication Facility

College of Engineering

**A Regional and National Resource
Enabling Research for Academia and
Industry**

www.nanotech.ucsb.edu

Mission

To serve UCSB and the greater community in their micro-nanofabrication research and development endeavors.

- Provide the best physical resources and technical expertise/support
- Provide easy access for new users – remote or on-site
- Provide a safe and user-friendly laboratory environment

Organization

- **Director** : Prof. Mark Rodwell, Electrical and Computer Engineering
- **Management** : Tom Reynolds, Brian Thibeault
- **Facility Staff**
 - ◆ 9 Facility/Tool Support – Industry Experienced engineers and technicians.
 - Tool use training
 - System installation, maintenance, modification
 - **Over 130 person-years experience on semiconductor/thin film tool support – RF, vacuum, electronic, etc.**
 - ◆ 5 Research/Process support staff – PhD and MS level.
 - Free process consultation support
 - Remote processing
 - Expertise in Lithography (EBL, DUV, i-Line), ICP and RIE etching, Sputtering, ALD, PECVD, Evaporation, AFM, FESEM, etc.
 - **Over 80 person-years experience in industrial, start-up, and academic fabrication environments.**

Facility

- ~13000 ft² of total clean space - Class 1000 (5 bays), 100 (2 bays)
- Full set of nano-micro-scale fabrication – **top university facility**
- Very few materials restrictions to encourage research diversity
- **Easy 24/7 Access for External / Industrial Users**



*Main Corridor
7 Bays*

*Class 100 – Litho1
Bay 6*



*Class 1,000 – Deposition
Bay 3*

Equipment - Overview

- **Lithography**– Steppers (i-line(2) and **DUV**), **EBL**, Contact, Nanoimprint
- **Etching** – **ICP**(4), **CAIBE**, RIE(3), SiDRIE, vaporHF, XeF₂, CMP
- **Deposition** – Evaporation(6), Sputtering(5) (RF,DC,reactive), IBD, ALD (dielectric, metal), PECVD (3) (ICP, low stress)
- **Characterization** – FESEM(2), AFM, VASE, 3DOptical, Stress, resistivity, failure (QFI)
- **Hybridization/Integration** – Dicing, Flip-chip, wafer bonding



ASML-DUV-248nm



JEOL 6300 EBL



Panasonic ICP Etcher/Asher



Oxford CAIBE, 2-ALD Cluster Tool



AJA 7-Target RF/DC Reactive Sputter

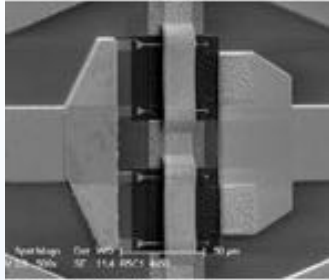


JEOL 7600 FESEM

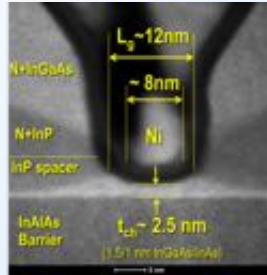
Project Sampling from UCSB Nanofab Users

Electronics, Photonics, MEMs, Microfluidics, Materials, Physics

GaN HEMTs



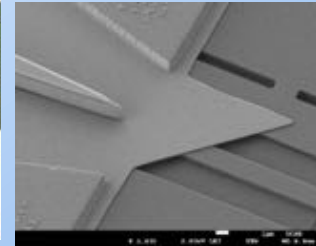
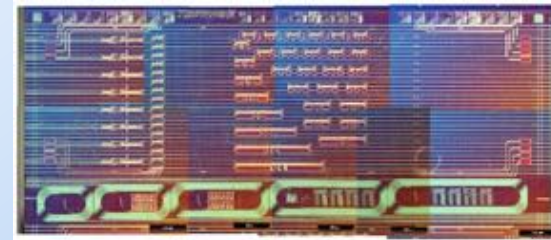
III-V MOS



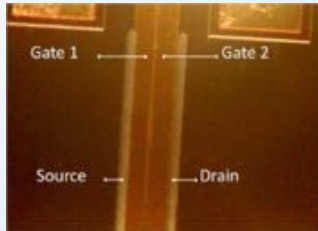
LEDs for Lighting



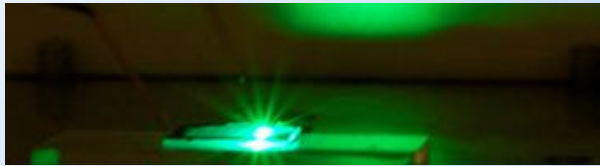
*Si photonics
Heterogeneous III-V Si Integration*



Organic FETs

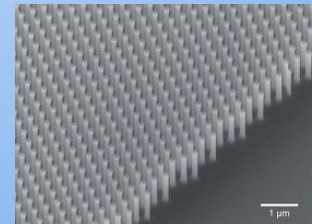
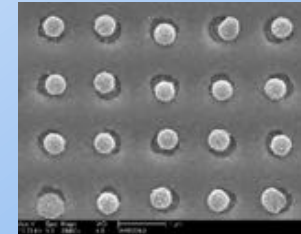


Green lasers



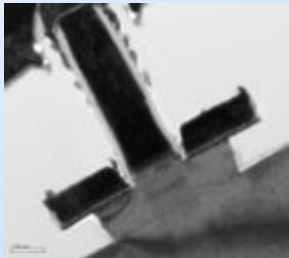
VCSELs

DNA Sequencing

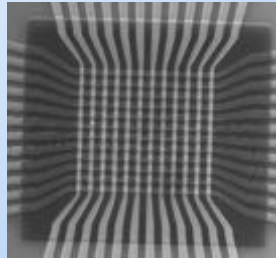


Chem Sensing

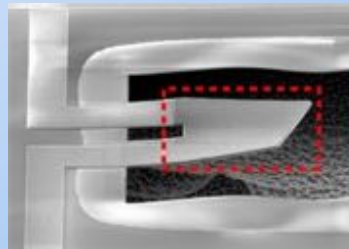
THz transistors



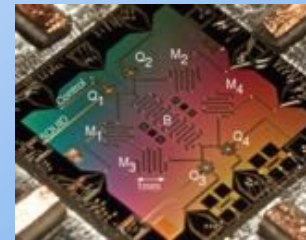
InP-Photonic ICs



*Phase-change
memory*

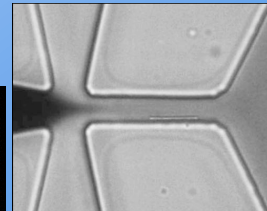
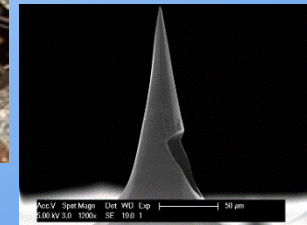


Quantum MEMs



Q-bits

Microneedles

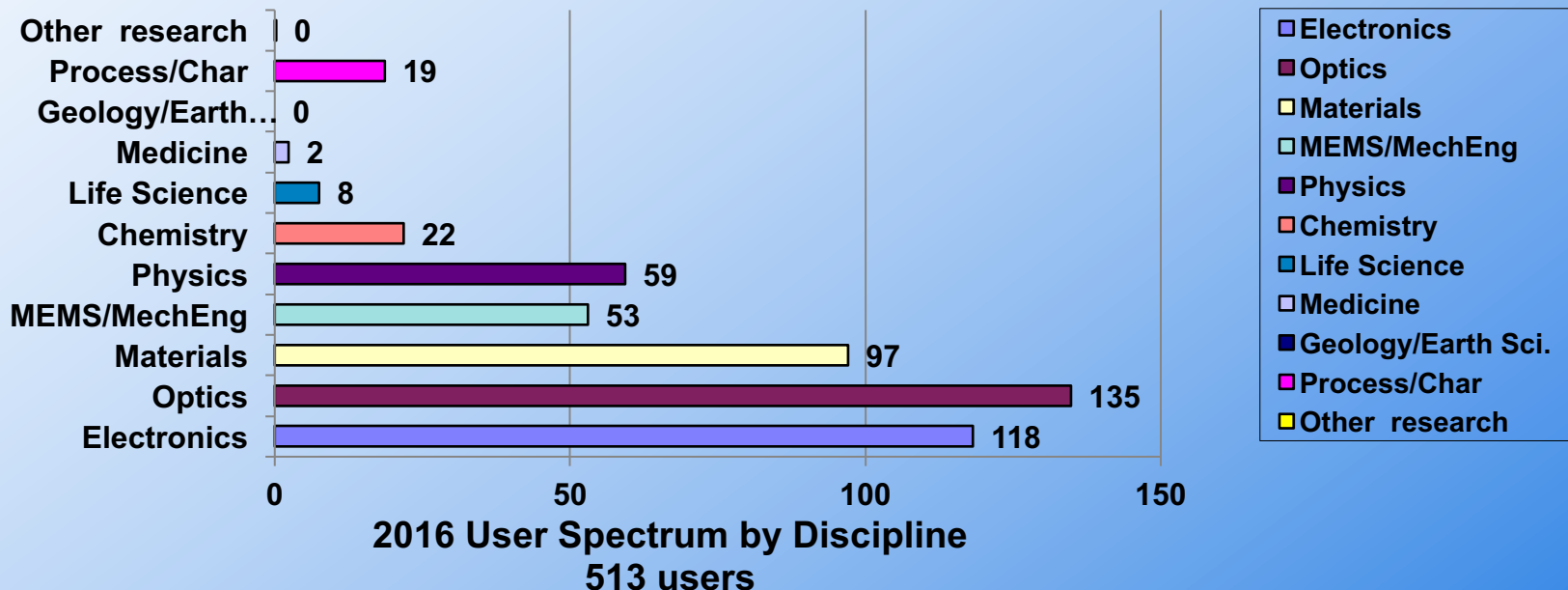


*Micro-
Nanofluidics*

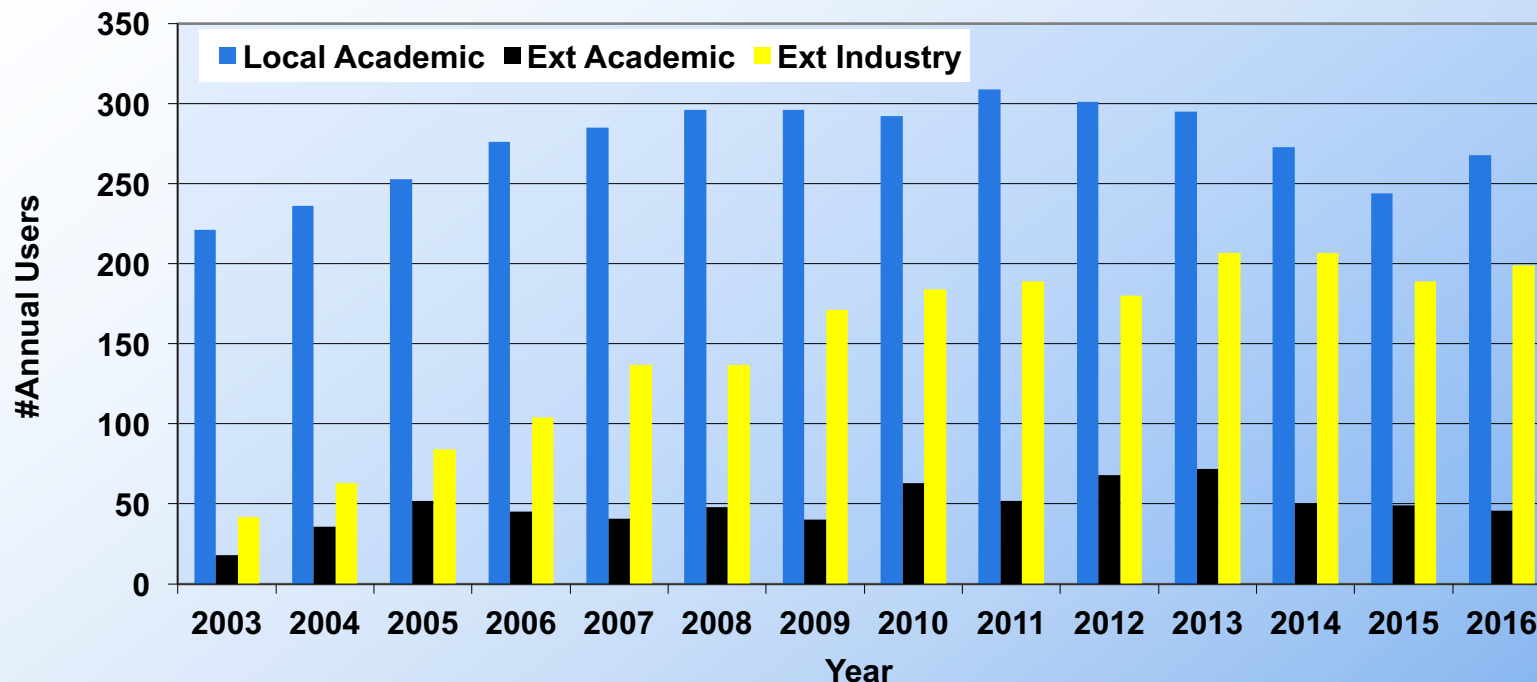
Solid-State Lighting, Photovoltaics, Thermoelectrics, Oxide Electronics

Research Diversity

- Committed to growth and stability for a diversity of research projects
 - Need to target a **wide range of research interests** (Chart below).
- ~ **\$50M in total equipment** (estimated new replacement cost)
 - **\$9M in Equipment added last 10 years:** ALD, PECVD, ICP-RIE, CAIBE, XeF2, VaporHF, Multi-Target Sputtering, FESEM, AFM, Flip-Chip, CMP, ASML DUV Stepper, SiDRIE



Annual User History



● Significant External User Increases since 2003

- Moved to new 13000ft² (3x increase) cleanroom in ESB – increased capacity
- Significant investment in new equipment.
- Successful projects and programs (reputation), new start-ups (tech transfer)
- Now stable at approximately 200 industrial and 50 external academic users/year.

● Maintaining high Academic Use at same time

- Academic mission critical to University

Facility Impact

● Campus Impact – Internal Academic Programs

- ◆ >35% of research contracts (by award \$) use the nanofab (2014-2015).
- ◆ Last 5 years: Served over 460 UCSB grad students/post docs.
- ◆ Key resource for prominent UCSB research centers.
 - 300 publications/year (journal and conference)

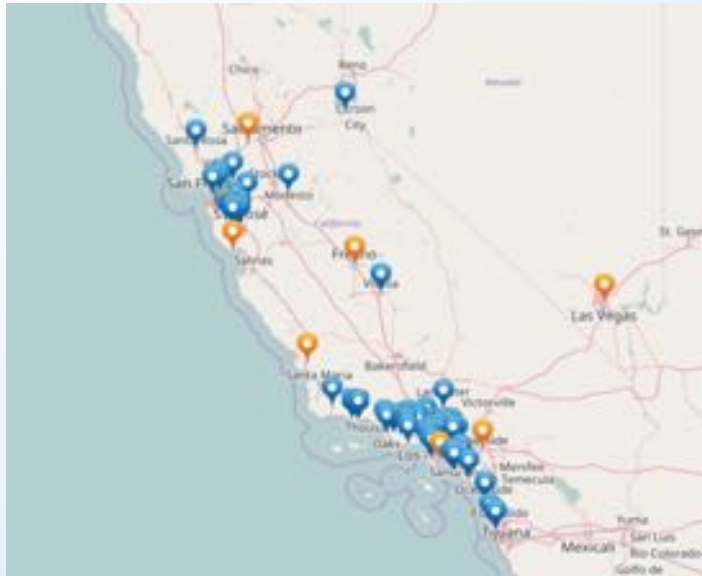
● External Impact outside the UCSB walls

- ◆ **Since January 2000** (in addition to formal collaborations):
 - **256 Industrial Institutions** (66 large, 190 small)
 - **177 external academic research groups** (65 Institutions)
- ◆ **Over 50% of users over last 5 yrs. are external.**
 - Among highest of all US university labs.
- ◆ Graduates going to large companies, academia, and many start-ups.

● Successful external user recharge model – over 15 years and running.

- Higher industrial recharge rate keeps cost of research down for academic users. Industry gets access to full research equipment set. Win-Win situation.
- **Stable recharge rates** for academic and industrial use - averaging about 1.5% rate increase/year over last 7 years.

A Proven State and National Resource: Map of Institutions Served 2006-2016



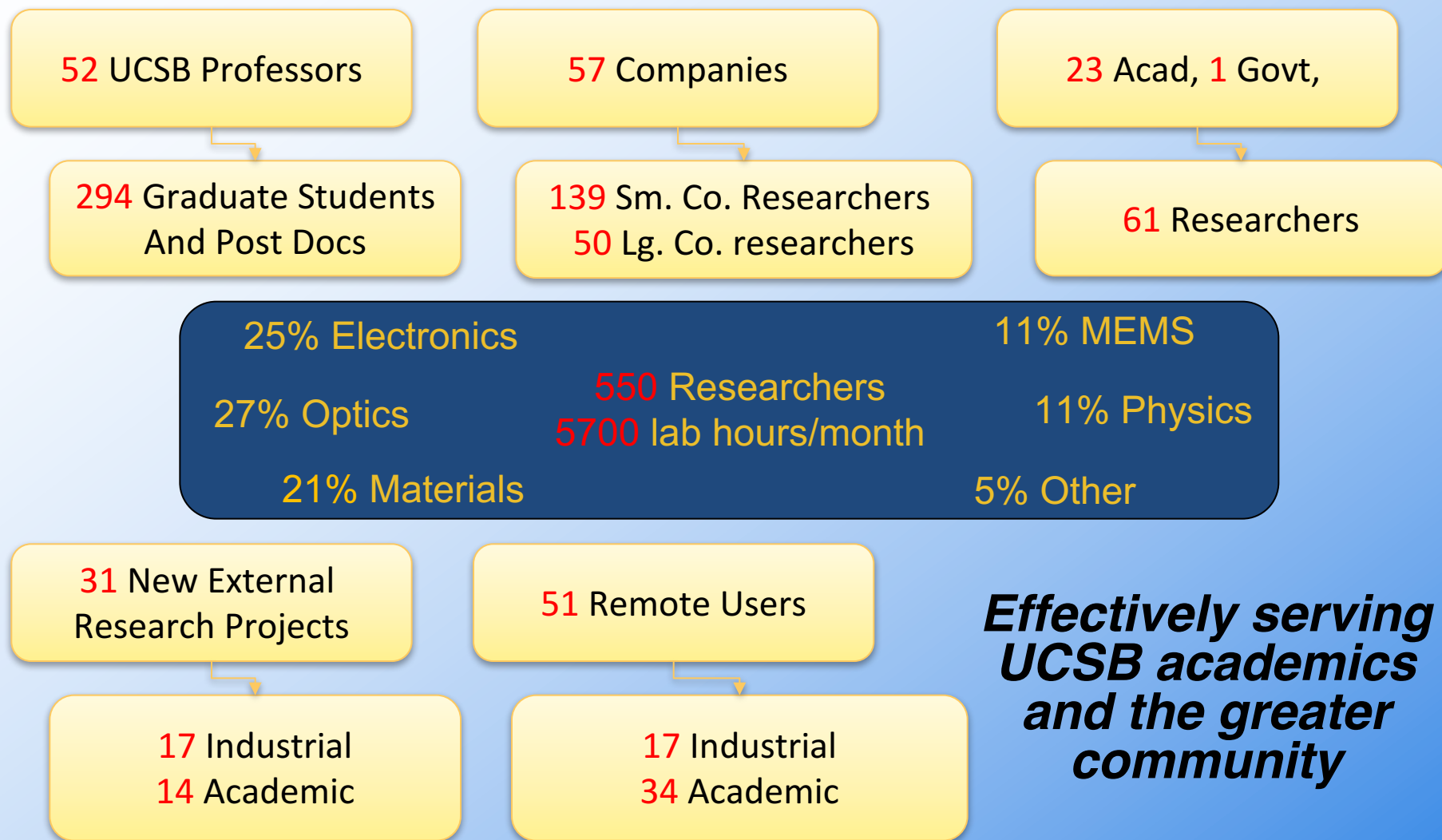
● Regional (CA) Reach

- ◆ 148 in state external industrial institutions (and 15 Academic)
- ◆ 61 local companies

● National Reach

- ◆ 48 out-of-state External Industrial Institutions out of state
- ◆ 49 External Academic Institutions out of state

Yearly Snapshot of Research Community



***Effectively serving
UCSB academics
and the greater
community***