



nano@stanford

https://nanolabs.stanford.edu/

@nanostanford

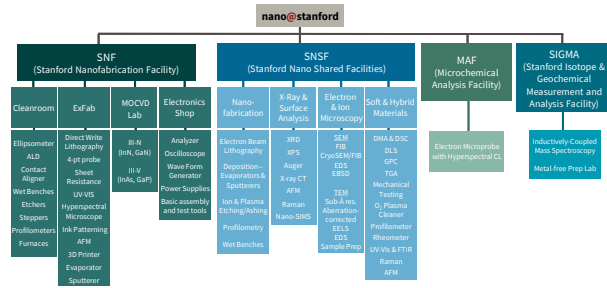
Debbie Senesky, PI, Director; Yuri Suzuki, Co-PI; H.S. Philip Wong, Co-PI; Kate Maher, Co-PI
Sara Ostrowski; Daniella Duran; Mary Tang; Tobi Beetz; Karrie Weaver; Dale Burns

Overview

- nano@stanford is four, open-access nanotechnology facilities at Stanford University
 - 30 technical staff members
 - ~16,000 ft² of fully equipped cleanroom facilities
 - ~15,000 ft² of characterization facilities



- Our Mission:
 - Provide **access** to world-leading facilities and expertise in nanoscale science & engineering for internal users and for external users (academic, industrial, government).
 - Develop and propagate a national model for **educational practices** that will help students and visitors become knowledgeable and proficient users of the facilities.

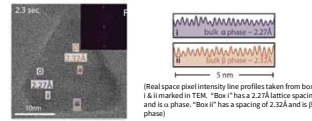


Recent Research Highlights

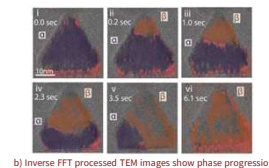
Hydrogenation-induced lattice expansion within a AgPd nanoparticle

PI: Prof. Jennifer Dionne, Stanford University
Tool: FEI Titan environmental TEM

An improved understanding of hydrogen diffusion in AgPd at an atomic scale is important for the advancement of hydrogen-based technologies.



a) Lattice spacings in TEM image reveal two phases: α & β



b) Inverse FFT processed TEM images show phase progression

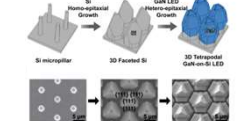
Angeli, D. K., Bourgeois, B., Vadai, M., & Dionne, J.A., ACS Nano, 2022, 16(2), 1781. DOI: https://doi.org/10.1021/acsnano.1c04602

The work also was supported by DOE DE-AC02-76SF00515, NSF award ECCS-1933624, and the NSF GRFP.

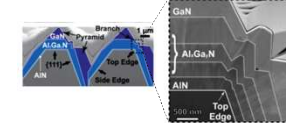
GaN-on-Si LED Fabrication (3D tetrapodal over 3D faceted Si)

PI: Prof. Dong Rip Kim, Hanyang University
Tool: MOCVD GaN deposition system

Overcoming the stress/strain interface issues of GaN on Si will enable a more cost-effective substrate for LEDs.



a) Deposition schematic and top-down SEM images: growing GaN on 3D faceted Si reduced threading dislocation densities, resulting in better performance



b) Cross-section SEM & TEM images show a AlN nucleation layer, a Al_xGa_{1-x}N buffer layer, & growth contours in the formation of branch GaN structures

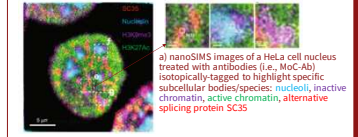
Yongsik, C., Jeon, M.S., Jang, H., Lee, H.S., Kim, D.R. Appl. Surf. Sci., 2021, 565(1), 150584. DOI: https://doi.org/10.1016/j.apsusc.2021.150584

This research also was supported by Basic Science Research Program (NRF2018R1A1A1A1A01003700) through the National Research Foundation of Korea (NRF).

Subcellular chemical imaging of biomolecules and drugs

PI: Prof. Garry Nolan, Stanford University
Tool: Cameca nanoSIMS

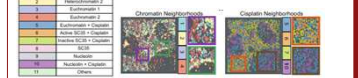
Chemical imaging of biomolecules will provide an improved understanding of biological processes and drug mechanisms.



a) nanoSIMS images of a HeLa cell nucleus treated with antibodies (i.e., Msc-Ab) isotopically tagged to highlight specific subcellular bodies/species: nucleoli, inactive chromatin, active chromatin, alternative splicing protein SC35

b) nanoSIMS images of a TYK-nu cell nucleus additionally treated with cisplatin (cancer drug) and isotopically tagged DNA.

After denoising and extensive data processing, "nuclear neighborhoods" with cisplatin-protein interactions (e.g., 5, 6, 7, 10) were identified.



Rovira-Clave, X., et al., Nature Comm., 2021, 12, 4628. DOI: https://doi.org/10.1038/s41467-021-24822-1

The work also was supported by the National Institutes of Health (NIH) SRO1HG085330-04, S45CA140148-05, S01HG006767-03, S02CA180930-04, SRO1HG083604, SRO1CA184960-04, SRO1GM1099360A, S100D00204, NIH/NIDDK P30DK116074, Department of the Army W81XWH-12-1-0591 and W81XWH-14-1-0180, Bill & Melinda Gates Foundation OPP1113692

External Lab Members

Raxium Acquired by Google for \$1B

A start-up company success story

Raxium, a five-year-old start-up company located in Silicon Valley, specializes in micro-LED technology. Shortly after launching their company, Raxium contacted the team at the Stanford Nanofabrication Facility (SNF) to use the open-access lab for product development. During the next three years, twenty-one Raxium process engineers joined SNF, were trained on many pieces of equipment, and became experienced with the specific tools in the facility. As Raxium ramped up and likely was poised for success, it began building its own lab while continuing to use SNF during the transition. A lot of the equipment choices for the new lab were based on the engineers' experiences at SNF.

"It's display tech is five times more efficient than the current world record holder."
- Richard Lawler (The Verge)

The micro-LED devices developed by Raxium boasted an impressively small pixel pitch of 3.5µm; whereas the industry standard for Super AMOLED screens on phones has a pitch of 50µm. This advancement in pixel pitch, coupled with the claim of an "unprecedented efficiency of five times better than any world record", caught the attention of Google. Google acquired Raxium for \$1B in May 2022. Experts speculate that Google Labs may use this newly acquired technology in an AR headset being developed in "Project Iris".



raxium

Raxium's micro-LED technology may pave the way for future augmented, virtual, and mixed reality devices



(representative list from 2021 - 2022)

Education & Outreach

NanoSIMST

- Nanoscience workshop for middle school teachers
 - in-person: four full days
 - Virtual: five ½ days

- Features tours + talks from staff focusing on hands-on activities & pedagogy

- 1 teacher can impact ~150 students/year



NanoSIMST Class of 2022



Getting up for a lab tour

- Program has expanded to 9 other NNCI sites
- Virtual nanoSIMST aims to reach low resource communities

71% virtual 2022

Title I Schools

48% 2021

39% 2016-2020 in-person



Community College Internships

- Hands-on, **paid** experience in nanotechnology

- Our interns

- **Learn** deposition, etching, lithography, laser cutting, SEM, ellipsometry, ICP-MS, etc.



- **Create** Instagram content, training videos

- **Support** staff with process control, facility tours, outreach

- **Share** their experiences with each other and inspire younger students through outreach



- Previous interns are all at 4-year universities now

- In 2022, we ~doubled the number of interns to 9



@internsnanostanford

Outreach Activities

- Nanoscience Outreach Group
 - A community of 126 lab members that creates a sense of belonging through STEM-focused volunteerism



- DEI focused outreach

- Partnership with Foothill College's Science Learning Institute (SLI)
 - supports students from underrepresented groups in their academic and career pathways in STEM at Foothill College
 - 177 students/faculty reached



- Oakland Promise partnership
 - K-12 classroom visits reaching >200 students



- Grad student DEI projects
 - educational videos + K-12 classroom projects inspired by famous scientists from minority groups

- Stanford Summer Engineering Academy (SSEA)
 - Supports 70 1st generation & underrepresented students interested in engineering