



National Nanotechnology
Coordinated Infrastructure

SH₂NE

Soft and Hybrid Nanotechnology
Experimental Resource

2018 NNCI Annual Conference

ILLUMINATE YOUR RESEARCH



Northwestern
University

SHyNE Resource

Northwestern



INTERNATIONAL INSTITUTE FOR
NANOTECHNOLOGY



THE UNIVERSITY OF
CHICAGO



Institute for
Molecular
Engineering



NU Center for
Nanofabrication
and Molecular Self-
Assembly



Simpson Querrey
Institute



Argonne National Laboratory
Center for Nanoscale Materials



Pritzker Nanofabrication Facility

Uniting over \$800 million in nanotechnology research,
education, infrastructure & facilities

Regional Coordination
Global Partnerships

Prof Vinayak P. Dravid (PI) – Northwestern

Prof Andrew Cleland (Co-PI) – U Chicago

*Ben Myers, PhD
Director of Operations*

*Chad Goeser
Business Manager*

*Joyce Park
Financial Administrator*

*Marcela Gallegos
Outreach Coordinator*

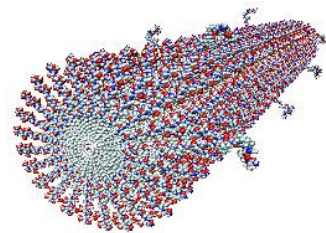
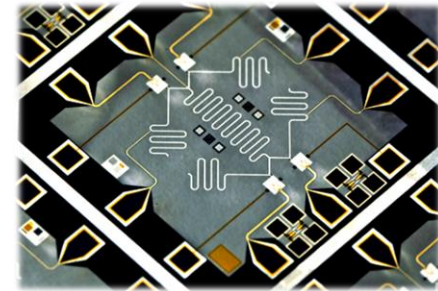
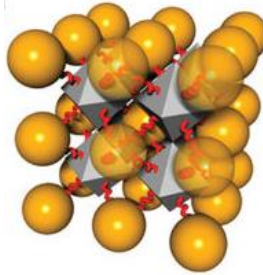
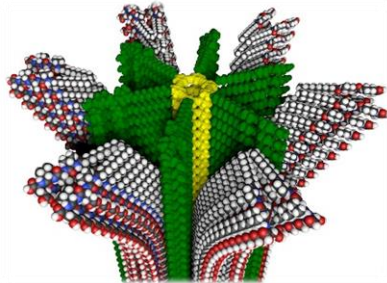
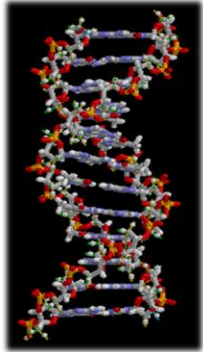
*Amy Morgan
Program Administrator*

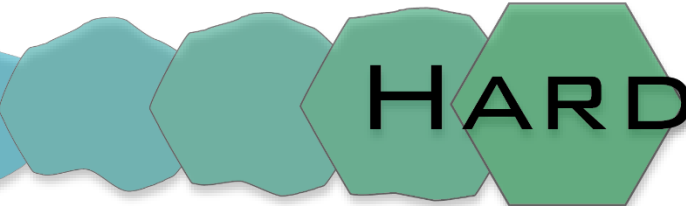


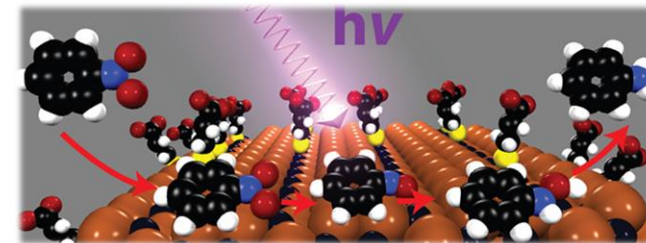
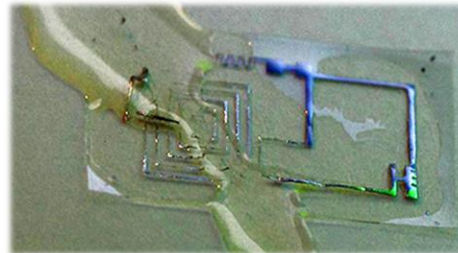
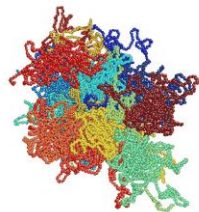
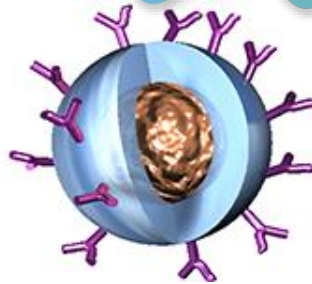
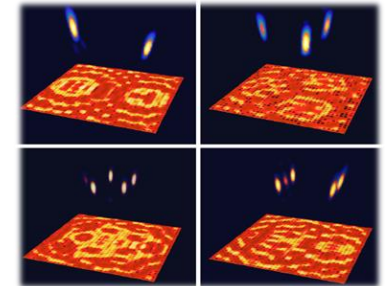
SHyNE

Soft Hybrid Nanotechnology
Experimental Resource

Soft and Hybrid Nanotechnology



Soft  HARD



SHyNE Resource Facilities

Soft nanopatterning, fabrication
Surface/Interface characterization
Cryo-bio microscopy/analysis

Bio-Molecular
Peptide Synthesis/Char
Bio-Physical Interface

Molecular Nanotech
Molecular Characterization

Atom-probe
Tomography (APT)

X-ray scattering
APS Prototyping

Micro-/Nanofab
MEMS/NEMS Wafer-scale,
integrated fab

Micro/Nanofabrication
MEMS, Physical-Bio
Interfaces

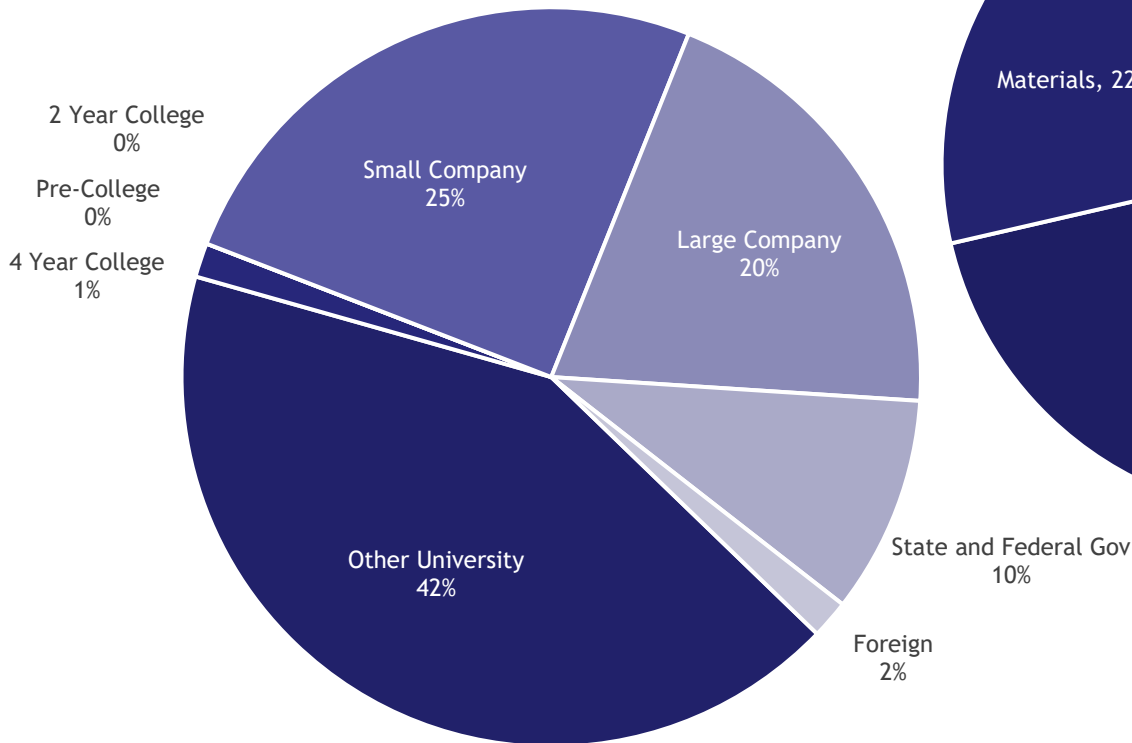


SHyNE User Data

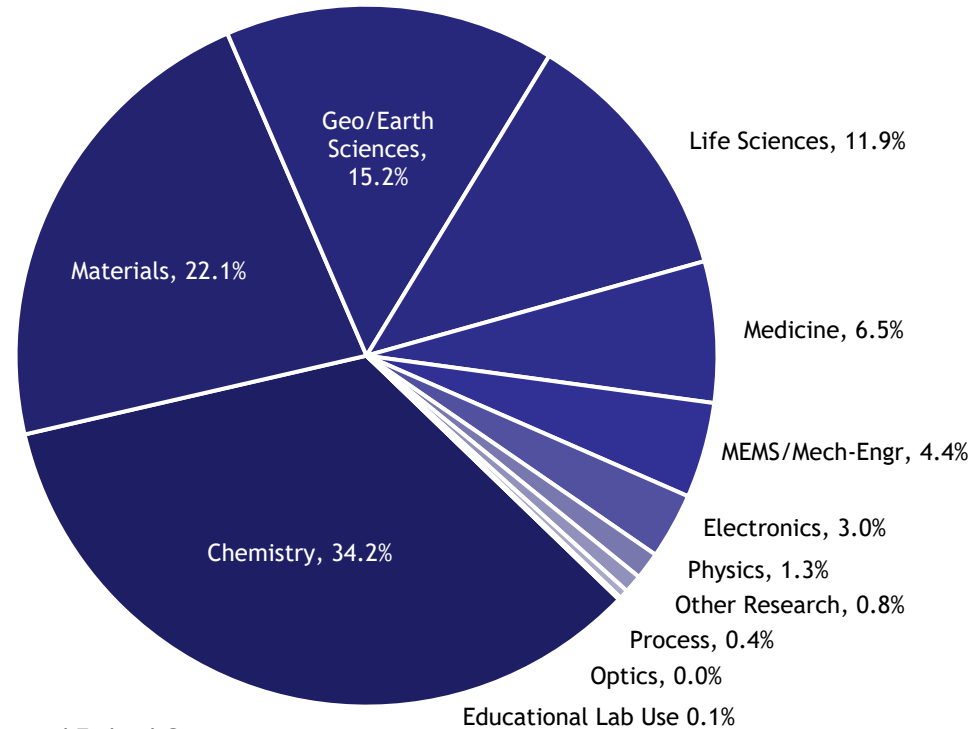
Yearly User Data Comparison			
	Year 1	Year 2	Year 3 (6 months)
Total Users	1,384	1,627	1,273
Internal Users	1,205	1,392	1,164
External Users	179 (13%)	234 (14%)	135 (11%)
External Academic	75	97	57
External Industry	88	115	61
External Government	15	17	15
External Foreign	1	5	2
Total Hours	85,490	111,259	58,623
Internal Hours	81,722	108,387	56,250
External Hours	3,768 (4%)	3,943 (4%)	2,373 (4%)
Average Monthly Users	657	740	780
Average Ext. Monthly Users	43 (7%)	48 (7%)	51 (7%)
New Users Trained	651	703	341
New External Users Trained	122 (19%)	146 (21%)	78 (23%)

SHyNE User Data

External User Affiliations



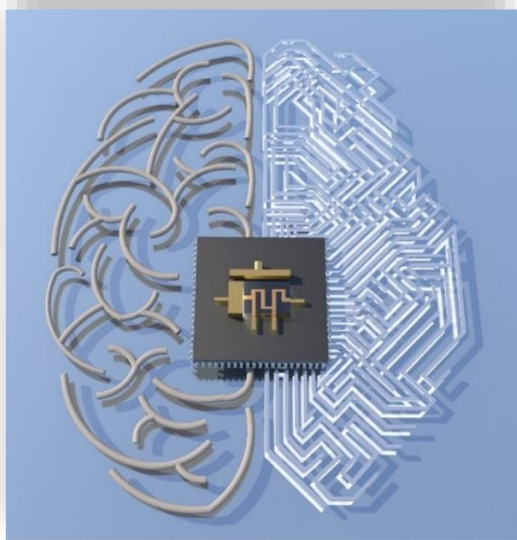
All User Disciplines



Facility Upgrades and New Tools

- New BioCryo Facility within NUANCE
- 1000 Sq Ft Expansion of NUFAB
- 8 new synthesis/fabrication tools including:
 - Wedge bonder, ebeam evaporator, thermal evaporator, plasma cleaner, picoliter deposition robot, phosphorus doping furnace
- 17 new characterization tools/upgrades including:
 - Aberration correction S/TEM, *in situ* S/TEM, atom probe upgrade, NMR, mass spec, XRD, ellipsometer
- Successful MRI for ebeam lithography system

SHyNE Research Highlights



Memtransistors for brain-like computing (Hersam Group)

Polycrystalline MoS₂-based devices combining memristor and transistor behavior

Fabrication and characterization performed in SH_YNE facilities

Sangawan, *et al*, Nature, **554** (2018)

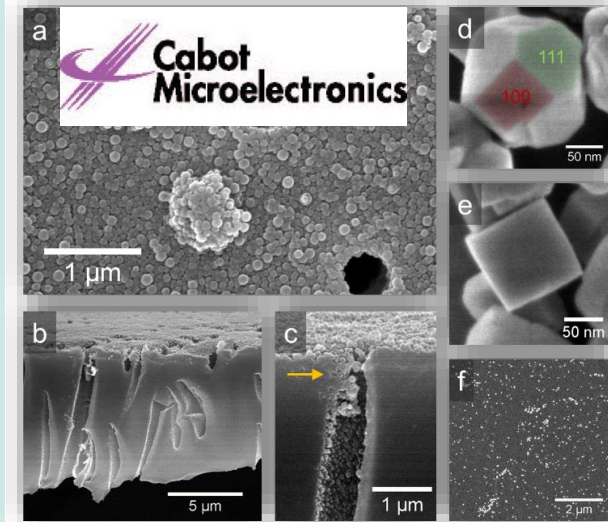
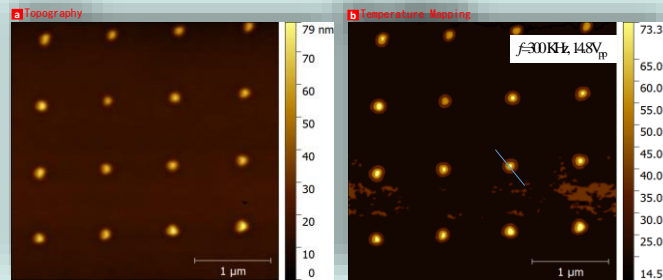
Single-particle temperature mapping

Collaboration between AppNano and SHyNE staff

Development of nanoscale thermal imaging probes for high resolution temperature mapping

Evaluation of temperature rise in magnetic nanoparticles for use in theranostic applications

Application development in SH_YNE Facilities



Slurry development for CMP processes

Cabot Microelectronics characterization of nanoparticle dispersions used in CMP processes – investigation of sieving through membrane filters.

Morphology and composition analyzed in SH_YNE Facilities

New User Engagement

- **Corporate Outreach**
 - On-site Presentations
 - Facility tours
 - Trade show exhibitions
 - Collaboration with internal corporate relations groups
 - Project consulting
- **Interaction with regional partners**
 - Professional societies
 - DOE labs (ANL, Fermilab)
 - Museums and cultural institutions
- **SEED (SHyNE External Experiment Development)**
 - Up to \$2500 funding for high-risk, high-reward projects
 - Three awards for 2018:
 - Biomesense - UChicago startup
 - Dr. H Chris Fry - ANL
 - Dr. Mohammad Asasi - IIT



Education and Outreach

19 Courses use SHyNE facilities
5 Major workshops, 24 Seminars
3 REU Projects
Facility tours for over 1000 visitors

Annual “Take Our Children to Work Day”

Biotechnology Day

Carthage College

DePaul University

Undergraduate Research Showcase

Elmwood Park District 401 Enrichment Program

Evanston Middle School

Evanston High School

Francis W. Parker School

Homewood Flossmoor High School

IIN All Scout Nano Day

Lenart Elementary Chicago Public School

Mundelein High School

National Student Leadership Conference (NSLC)

Northwestern Academy for Chicago Public Schools

NU Center for Talent Development at the School of Education and Social Policy

Parkway South High School AP Physics

SMART High School Outreach Program

Speers Academy High School



Workshops, Short Courses and Symposia



NUANCE Northwestern
Soft Hybrid Nanotechnology Coordinated Infrastructure Experimental Center

Zeiss Amplified Materials Imaging Workshop
January 25, 2018 | 9:30 am - 2:00 pm
Chambers Hall, Ruan Conference Center

9:30 am Coffee social and opening remarks
Hosted by Karl Probst, NUANCE ZEM manager. Light refreshments served.

10:00 am Laser Scanning Microscopy for Materials Research
This talk will address different imaging challenges faced by materials research practitioners, as well as better visualization of a material's microstructure. The goal of materials research sometimes hinges on the development and refinement of measurement systems that are practical and better understood during various stages of design, fabrication, and testing. Such goals are conveyed within a wide variety of materials-related disciplines. Join us as we discuss an interesting variety of applications and techniques for advanced light microscopy.

11:00 am Advances in Ion Beam Technology
This presentation will focus on the latest applications existing and new developments in focused ion beam (FIB) technology. We will discuss a complete microscopy workflow that allows you to move your data and sample seamlessly from one mode of operation to the next. We will also discuss the most recent high resolution 3D electron using evanescent wave optics and ion beam milling techniques. We will also explore considerations on large scale versus ultra high resolution electron on beam ion lenses and how this affects structures created with focused ion beam focused ion lenses.

12:00 pm Lunch - pizza and kebabs

1:00 pm Materials 3D Analysis Via X-Ray Microscopy
In this session we'll explore the emerging research applications, along with underlying technology and capabilities, inherent from 3D X-ray microscopy (XRM). As a non-destructive alternative to methods SEM allows us to analyze materials, the inherent structure of an sample and capabilities of X-ray microscopy, covering multiple contrast mechanisms and length scales. Moreover, 4D visualization of structures can be used to understand the evolution of materials over opportunities for uncoated materials evolution (degradation) processes, and combine resolution with 3D resolution capabilities such as 4D XRM offer the chance to study over a wide range of length scales. Several examples will be presented, with an emphasis on the future developments and an outlook toward the future.

Register HERE or via NUANCE website

Sponsoring Partners:
SHYNE
MRSEC
BIOLOGICAL IMAGING
Jerome B. Cohen X-Ray Diffraction Facility

www.nuance.northwestern.edu



- Zeiss Amplified Materials Imaging Workshop - January 25, 2018 (50 attendees)
- X-ray Photoelectron Spectroscopy Workshop - May 25, 2017 (80 attendees)
- Midwest Microscopy and Microanalysis (M3S) Meeting - March 30, 2018 (96 attendees)
- American Crystallography Association Summer School - June/July 2017 (25 attendees)
- Beamer Basic Training - April 11, 2017 (12 attendees)
- Plasma-Therm Workshop - May 25, 2017 (39 attendees)
- SEM Short Courses - June 8 and Sept 9, 2017 (25 attendees)



Midwest Microscopy and Microanalysis Society

Electron Microscopy for Materials Research: Recent Developments and Future Opportunities

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NSF

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iNANO 2018 - Sensors


2018 iNANO Spring Workshop
SENSORS
May 22, 2018 - Northwestern University

Keynote Speakers:
Supratik Guha
Argonne National Laboratory and University of Chicago
Tom Meade
Northwestern University
Phillipe Guyot-Sionnest
University of Chicago

Panel Discussions:
Future Sensor Research Directions
New Tools For Sensor Development

The greater Chicago area has one of the highest concentrations of nanoscale fabrication and characterization research infrastructure in the world. This iNANO workshop series is designed to bring together users and staff from the regional nano centers to enhance cooperation and collaboration. The theme of this first workshop is "Sensors" and will cover new research areas and tools related to optical/mechanical, biological and environmental sensing.

Register Here: <https://goo.gl/forms/14103wmyewnJb8Rh2>



Argonne NATIONAL LABORATORY
THE UNIVERSITY OF CHICAGO
Northwestern University
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Center for Nanoscale Materials

- Illinois Nano Centers Consortium (iNANO)
- Joint ANL-NU-UChicago initiative to bring together staff and users of regional nano facilities
- A series of thematic workshops was kicked off at NU in May



NNCI Cooperative Network Activities

Network-Wide

- NNCI Annual Meeting
 - Five SHyNE staff participated
- Subcommittee participation
 - Global and Regional Interactions (GRI) - Vinayak Dravid, chair
 - Equipment Subcommittee
- Working group participation
 - Vendor Relations, Education and Outreach, Environmental Health and Safety (Basit, co-lead), Electron Beam Lithography, XPS, ALD

Multi-Site

- 2nd Annual Mid-Atlantic Electron Beam Lithography (MAEBL)
 - Two SHyNE staff participated (Duda, Butun)
- Research Proposal with ASU Peptide Array Core
 - SHyNE SQI Core facilitated connection for joint proposal
- 2017 NNCI ALD/MOCVD Symposium
 - SHyNE staff (Ciraldo) presented

On Behalf of the Network

- MRSEC Shared Facilities Workshop
 - SHyNE (Dravid and Myers) represented NNCI
- American Vacuum Society Conference
 - SHyNE (Duda) represented NNCI
- USA Science & Engineering Festival
 - Two SHyNE staff supported NNCI (Morgan, Park)



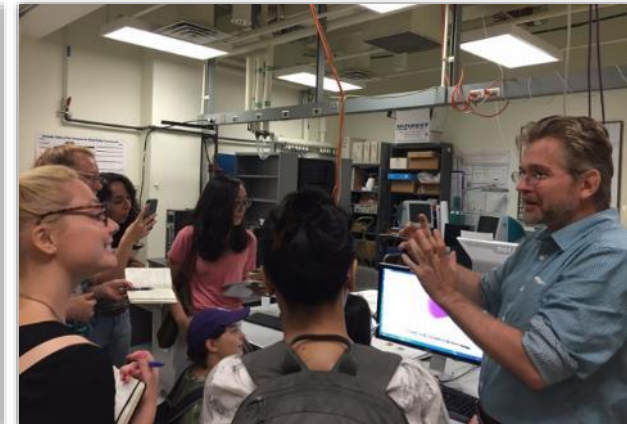
SHyNE Nano-Journalism

- Experiential learning for journalism students
 - Interact with nanoscience researchers
 - Visit and embed with facility staff
- Communications training for scientists
 - Science Writing Workshops
- Nano-Journalism Interns
 - Sir Fraser Stoddart: The Man Behind the Celebrity
 - Highlight research in SHyNE Facilities



Abigail Foerstner

Northwestern | MEDILL



Future Research Directions

- Hybrid Systems: Soft-Hard Interfaces and Assemblies
- Quantum Structures and Phenomena (Quantum Foundry?)
- Convergence