

# SHYNE

Soft and Hybrid Nanotechnology  
Experimental Resource

*ILLUMINATE YOUR RESEARCH*

Professor Vinayak P. Dravid - Director  
Professor Andrew Cleland - Co-Director

NNCI Annual Meeting, October 16, 2017

# SHYNE Resource – Site Overview

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**

***Vinayak P. Dravid***  
*Director - Northwestern*

***Andrew Cleland***  
*Co-Director – U Chicago*

***Ben Myers***  
*Director of Operations*

***Chad Goeser***  
*Business Manager*

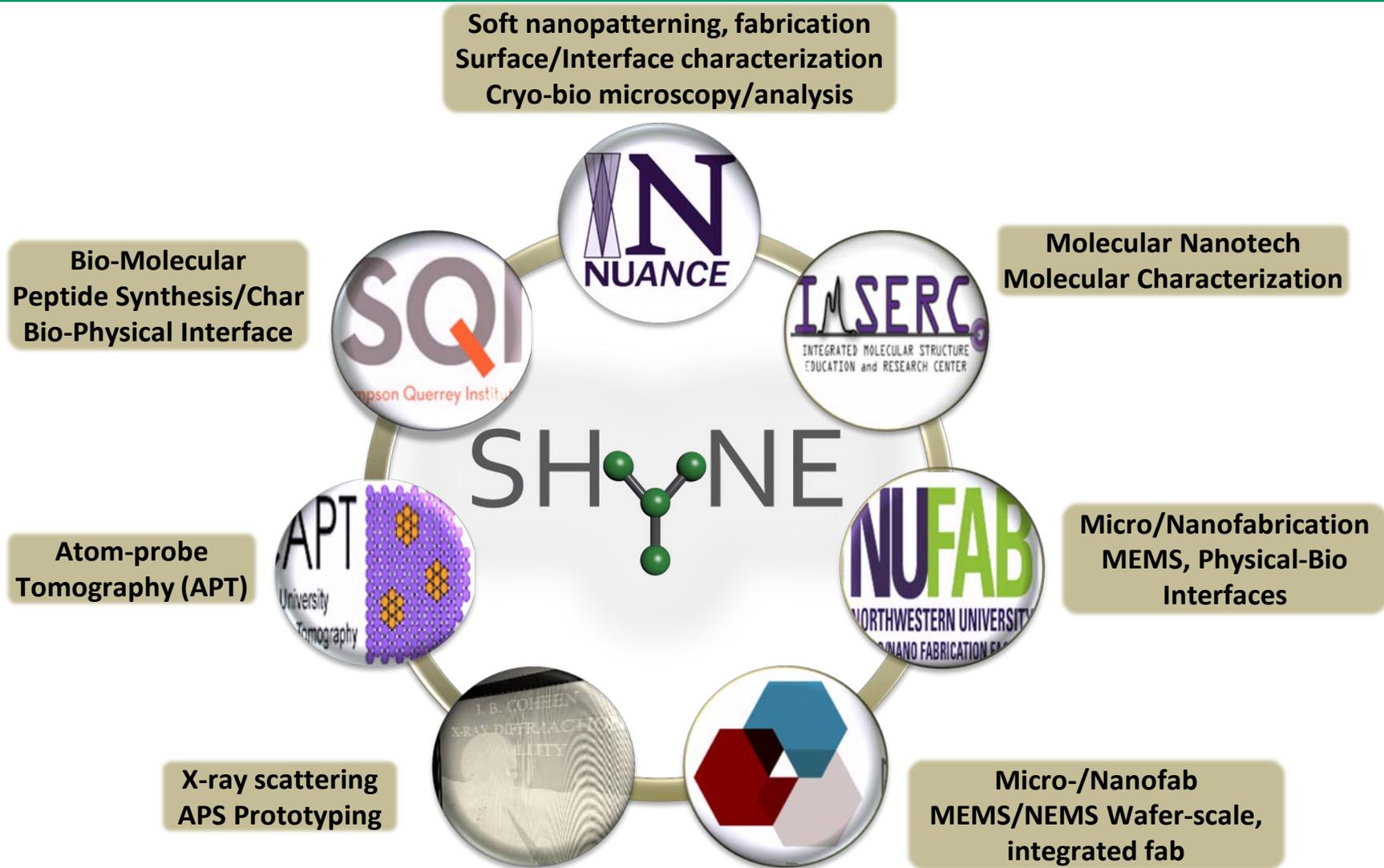
***Amy Morgan***  
*Program Administrator*



**SHYNE**

Soft Hybrid Nanotechnology  
Experimental Resource

# SHYNE Resource – Site Overview

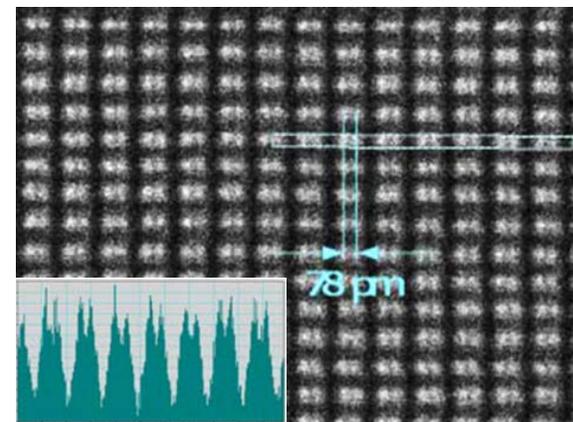


# New Capabilities

## JEOL JEM-ARM200CF S/TEM

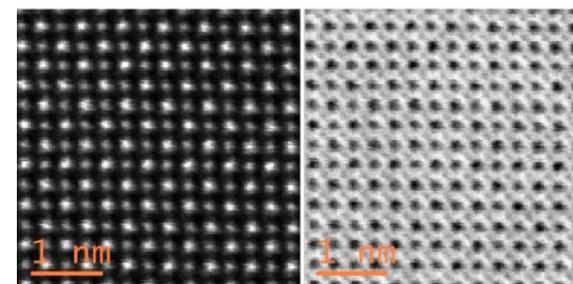


- 200 kV Cold FEG – Flash & Go
- Aberration corrected (probe)
- 0.08 nm STEM/0.23 nm TEM Resolution
- 0.35 eV energy resolution
- Dual SDD EDS detector (1.7sr!)
- Simultaneous HAADF/BF/ABF
- Gatan Quantum Dual EELS
- Atomic resolution at 60-200kV
- Gatan OneView CMOS camera

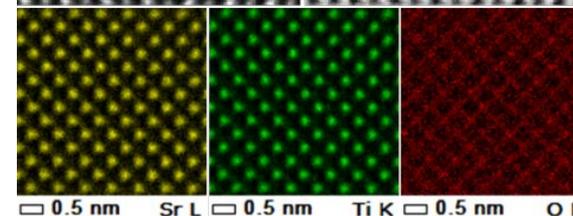


Si [112] Zone Axis

**Upper row:** simultaneously acquired high angle annular dark-field (HAADF) and annular bright-field (ABF) STEM images of SrTiO<sub>3</sub>



**Lower row:** EDS maps of Sr, Ti and O from the same sample



# New Capabilities

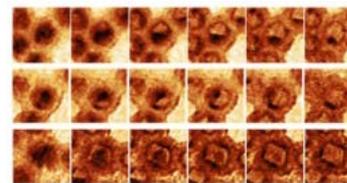
## JEOL JEM-ARM300CF S/TEM



- 300 kV Cold FEG – Flash & Go
- 0.19 nm STEM/0.22 nm TEM resolution
- Wide gap pole-piece for *in situ* expts.
- HAADF/BF/ABF & Diffractive STEM imaging
- SDD EDS detector
- Gatan OneView-IS camera for fast imaging (300 fps (1k x 1k) with automated drift correction)
- Hummingbird gas holder & delivery system
- Compatible with other *in situ* holders (heating, fluidic, biasing, mechanical straining...)



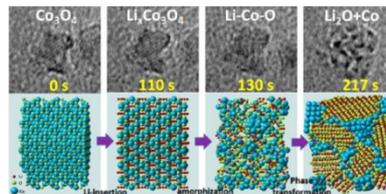
Gas-flow TEM holder can deliver up to 8 pressure-controlled gases (from  $\leq 10^{-7}$  Torr to 1 atm), with local specimen heating



Tomography TEM holder - accommodates TEM grids, FIB, and atom probe samples.



Nanofactory nano-manipulation and electric biasing holder

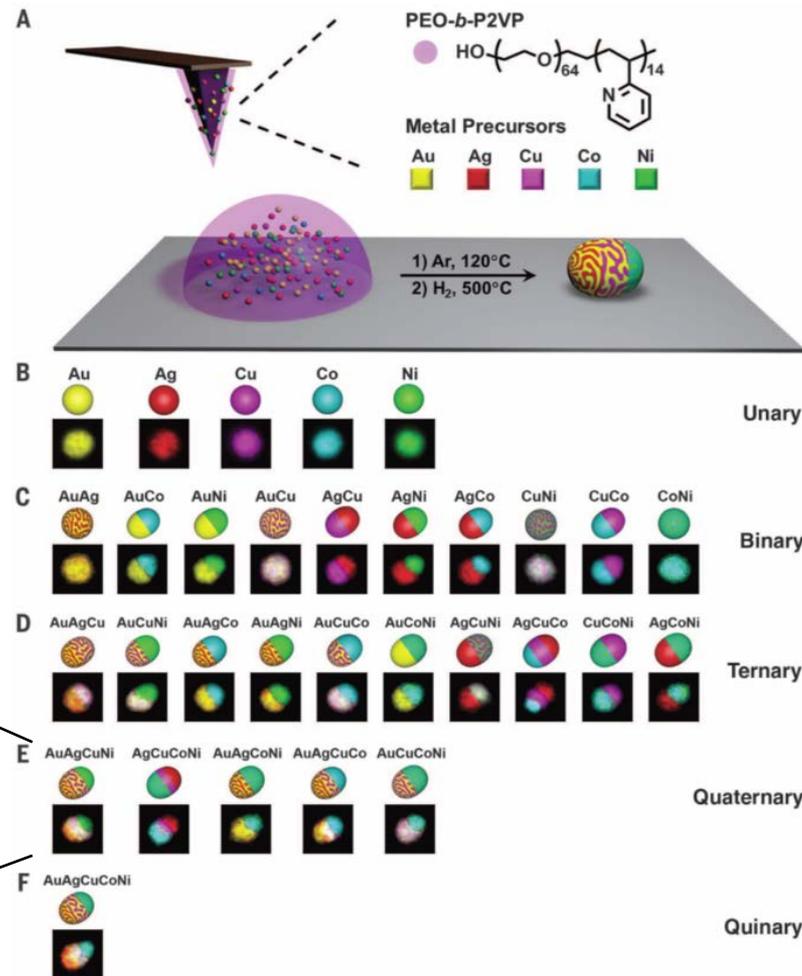
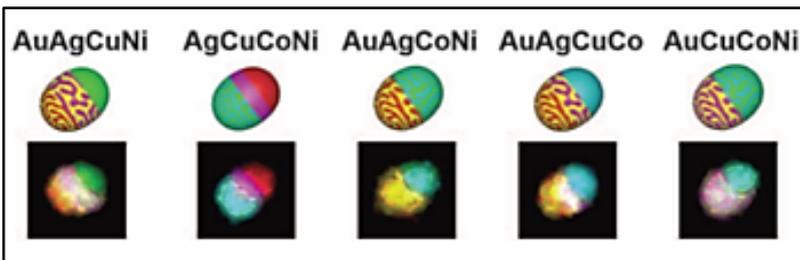


Ref: L. Luo, J. Wu, *et al.* ACS Nano, 8, 11560 (2014).

# SHYNE Research Highlight (Internal)

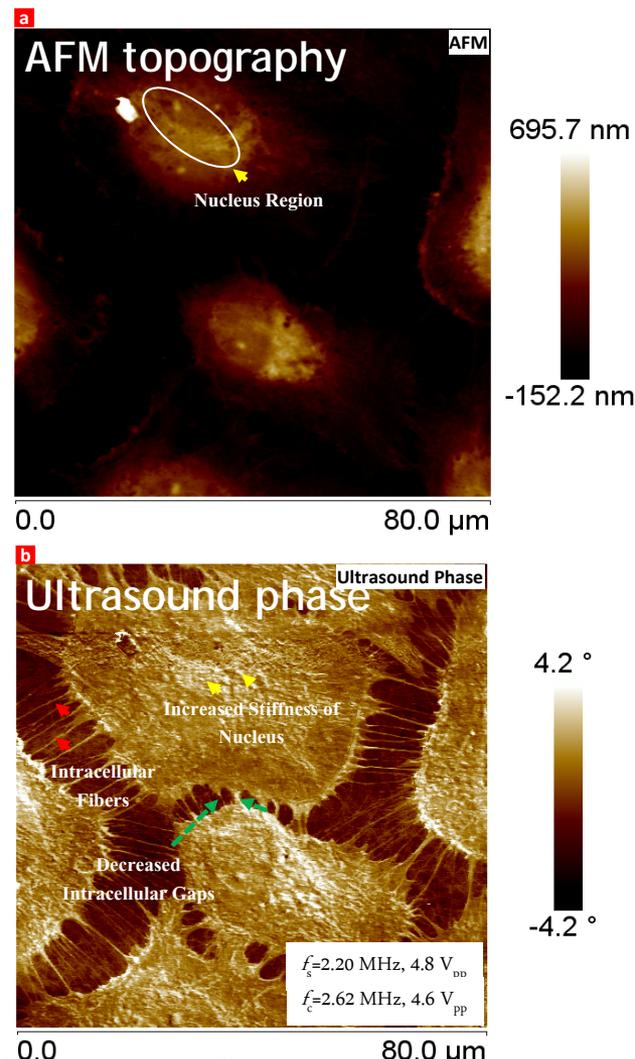
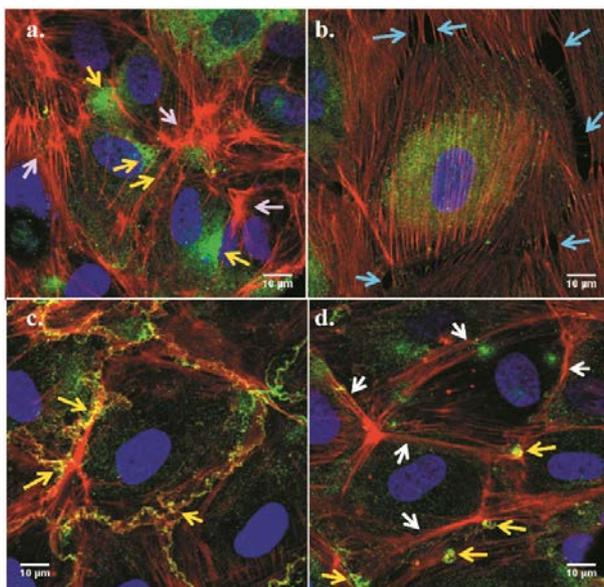
- **Polyelemental nanoparticle libraries**
- Rapid screening of millions of different compositions
- STEM-EDS mapping in SHYNE Facilities

Chen, P. C., et al. Polyelemental Nanoparticle Libraries. *Science* **352**, 1565-1569, (2016).



# SHYNE Research Highlight (External)

- **School of Medicine** – (Univ. Illinois, Chicago)
- Correlative AFM/confocal microscopy
- Modulus mapping and ultrasound imaging in SHYNE Facilities

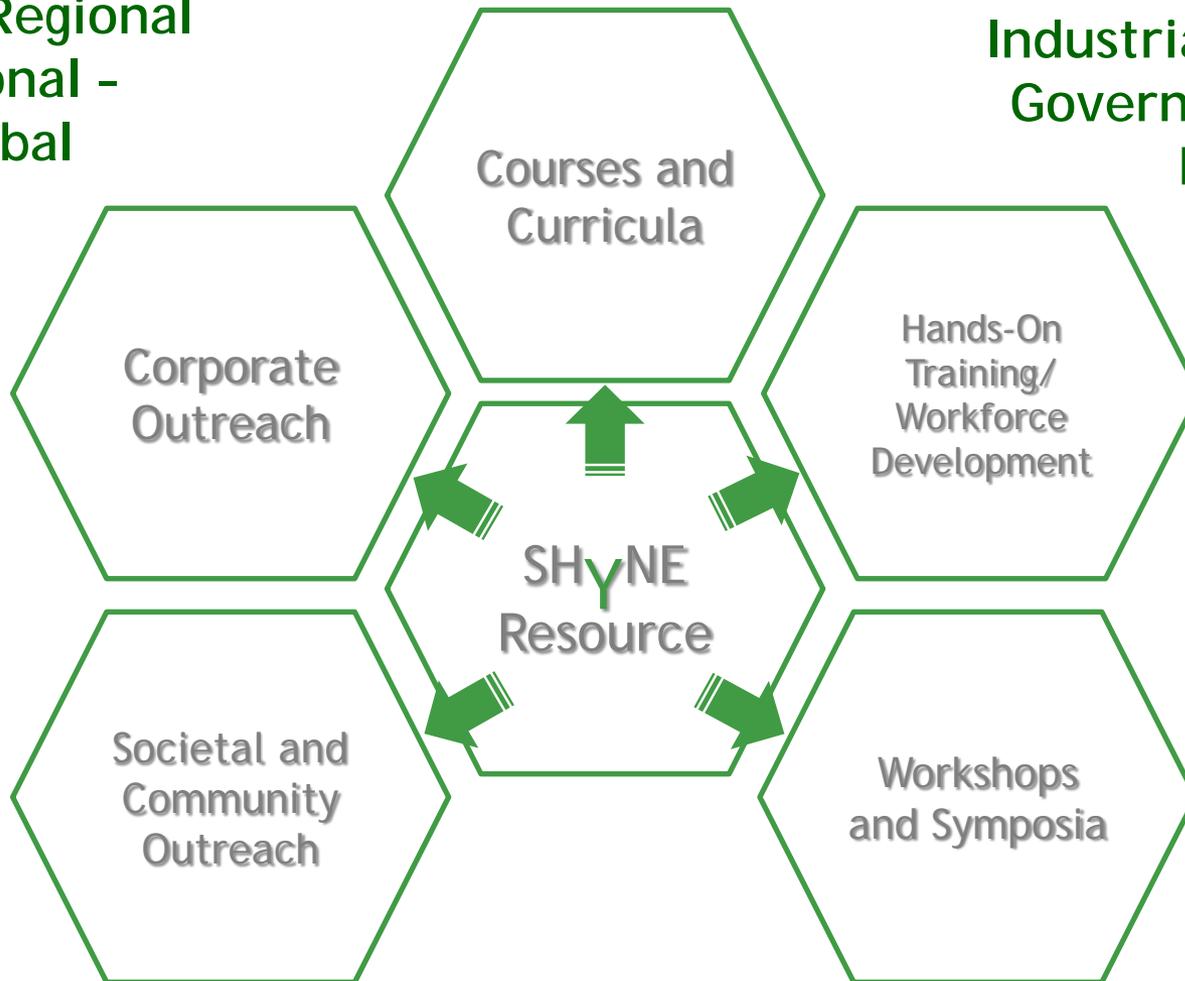


Ultrasound Bioprobe for In-Vitro Molecular Imaging, ACS Nano, *Manuscript Under Review*

# SHYNE Education & Outreach

Local - Regional  
National -  
Global

Industrial - Academic  
Government - Non-  
Profit



# SHYNE Corporate Outreach

## On-site Presentations:

*Baxter, Cabot Microelectronics, Engis, Shure, Exicure*

## SHYNE Tours/Meetings:

*Abbott Laboratories, Shure, Hydranautics, Nano Gas Technologies, IIT, UIC, Hospira, MilliporeSigma, Huawei, Hydranautics, Bioenergy Corp, Dura-Bar*

## Professional Conferences:

*Midwest Microscopy & Microanalysis Society*

*- Annual Meeting at Northwestern (spring '16)*

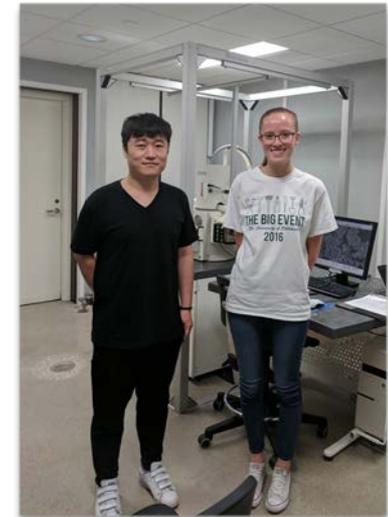
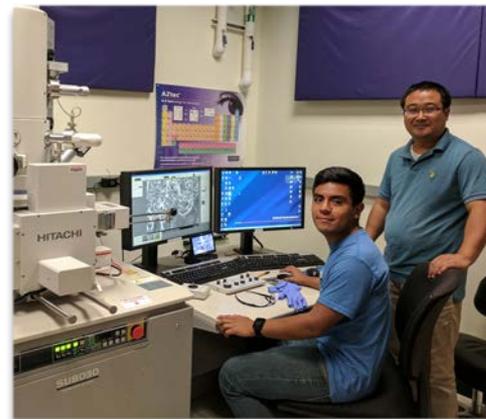
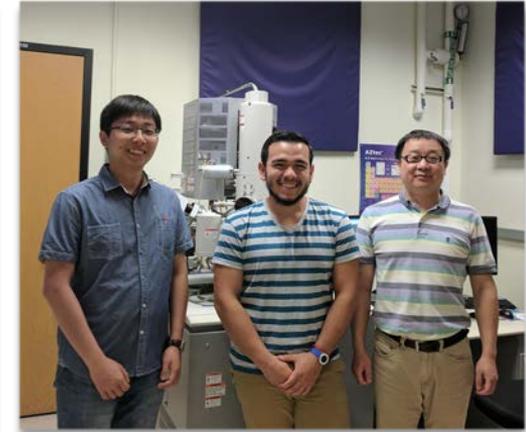
*Institute of Food Technologists - IFT2016 (summer '16)*

*Pittcon 2016 (spring '17)*



# SHYNE REU Program

- Facilities-focused REU program
  - Faculty Advisor
  - **Facility Staff Mentor**
  - Post doc/graduate student Mentor
- **2017 Projects**
  - Graphene for liquid-cell electron microscopy
  - Fabrication of microtip arrays for atom probe tomography
  - 2D materials for water splitting reactions
  - Novel lithium ion battery electrodes
- **2017 Students**
  - Juan Diego Marin (Georgia State U.)
  - Steven Ochoa (California State Polytechnic University, Pomona)
  - Robin Peter (The University of Chicago)
  - Olivia Baird (The University of Kansas)



# SHyNE Network Activity

- 2016 NSE Grantees Conference
  - ✓ *SHyNE hosted in Arlington*
- NNCI Referrals:
  - ✓ *Akhan Semiconductor was referred to Nano@Stanford*
  - ✓ *Purdue University was referred to MANTH*
- 2017 NNCI ALD/MOCVD Symposium at Stanford
  - ✓ *John Ciraldo (NUFAB) attended*
- Regional assistance:
  - ✓ *SHyNE assisted University of Michigan cleanroom during flood, 2016*
- 2017 NSF Cyberinfrastructure for Facilities workshop
  - ✓ *Joe Paris (NU Research Computing) to attend*
- Global and Regional Interactions (GRI)
  - ✓ *SHyNE Director, Vinayak Dravid, subcommittee chair*



# Nano-Journalism



- Prof. Abigail Foerstner - Medill Science Journalism
  - Faculty advisor of Nano-Journalism Program
  - Highlight top journal articles acknowledging SHyNE Resource
  - Host science writing workshop for researchers



- Puja Bhattacharjee, 2017 Nano-Journalism Intern
  - Developing in-depth pieces for national audience
  - Covering cross-facility projects



**Taking Command of  
Science Communications  
Seminar**

**October 24th, 2017**  
6:00 - 9:00 PM

- Gain coaching skills for compelling explainers, press releases, interviews and online presentations about your research.
- Gain practical knowledge about communicating your scientific message to society.

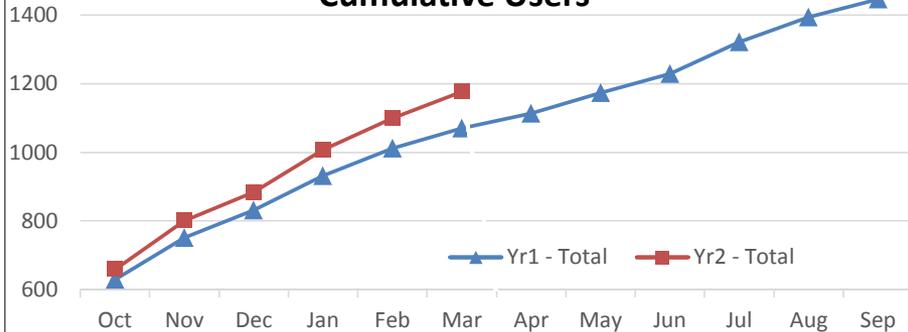


# Site User Data

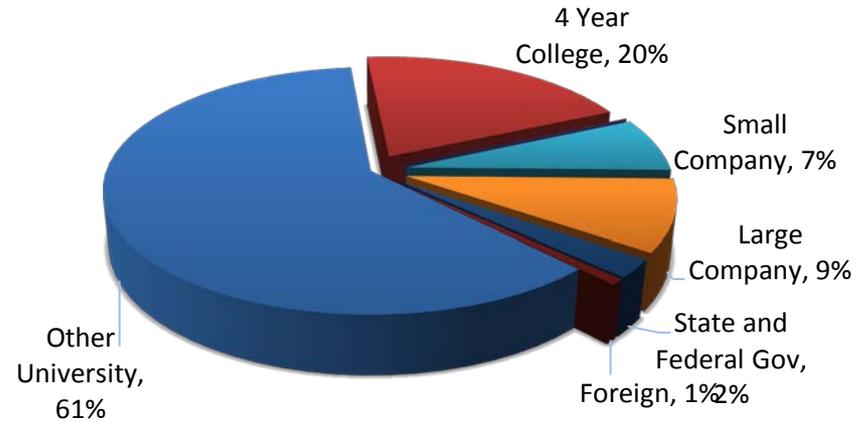
Yearly User Data Comparison

	Year 1 (12 months)		Year 2 (6 months)	
<b>Total Users</b>	1446		1176	
<b>Internal Users</b>	1230		726	
<b>External Users</b>	216	15%	150	13%
<b>Total Hours</b>	138,000		58,752	
<b>Internal Hours</b>	128,838		55,204	
<b>External Hours</b>	9162	7%	3,548	6%
<b>Avg. Monthly Users</b>	679		711	
<b>Avg. External Monthly Users</b>	54	8%	51	7%
<b>New Users</b>	699		316	
<b>New External Users</b>	152	22%	70	22%

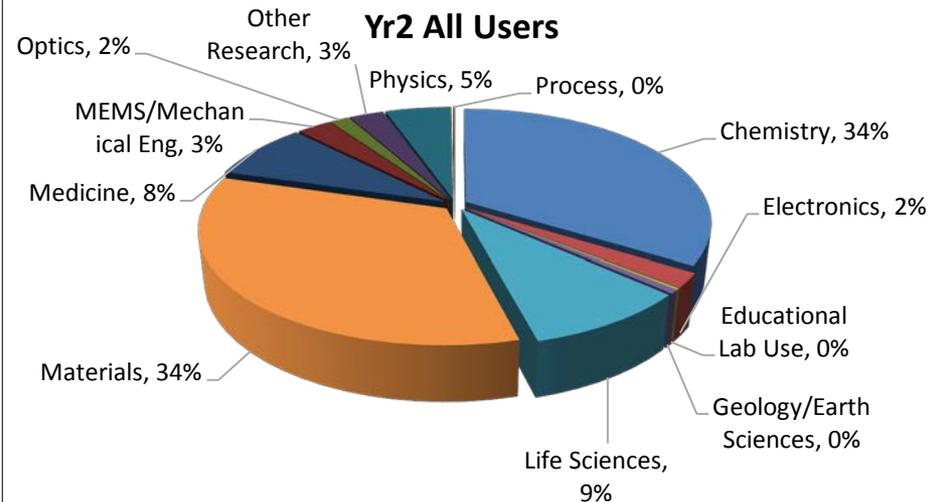
Cumulative Users



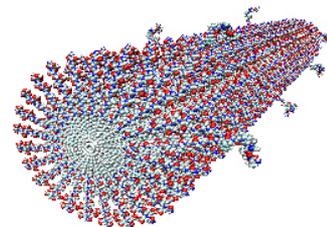
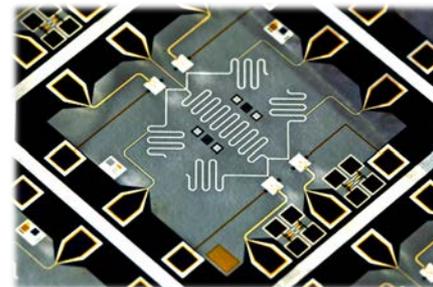
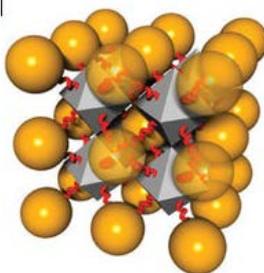
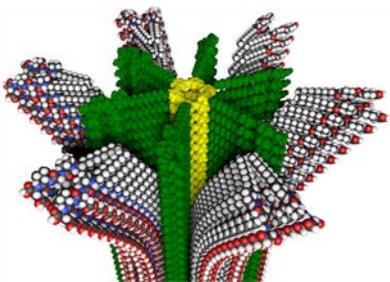
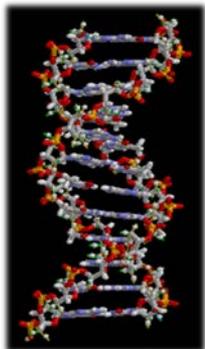
Yr2 External Users



Yr2 All Users

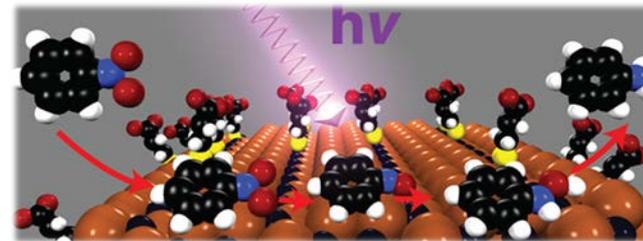
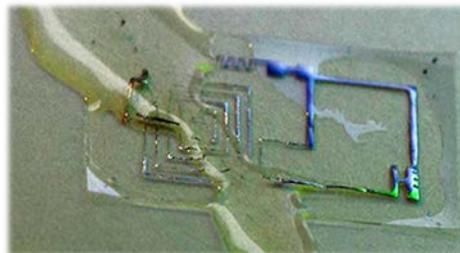
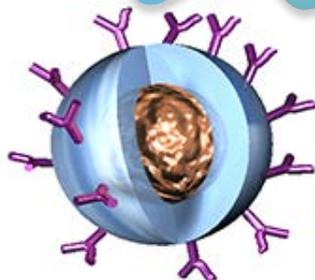
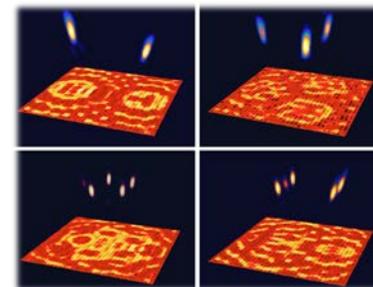


# Soft and Hybrid Nanotechnology



Soft

HARD



# Redefining Traditional Users

- Traditional (trə-'dish-nəl): adhering to past practices or established conventions
- Adaptation and flexibility are key:
  - Automotive industry as example
  - 1913 Henry Ford's assembly line was “advanced manufacturing”
  - By 1970's considered “traditional manufacturing”
  - Now auto makers have embraced modern methodologies
- Nano is no more about silicon and MEMS than Tesla is about sheet metal and the assembly line
- The new Nano infrastructure needs to support and foster the divergence of techniques and convergence of disciplines that define nanotechnology today