

SHYNE

Soft and Hybrid Nanotechnology
Experimental Resource

ILLUMINATE YOUR RESEARCH



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Materials Science and
Engineering, Applied
Physics



Chad Mirkin
Materials Science,
Chemical and Biological
Engineering,
Biomedical
Engineering, Medicine



Jian Cao
Mechanical Engineering,
Civil and Environmental
Engineering, Materials
Science and Engineering



Andrew Cleland
Physics, Molecular
Engineering Innovation
and Enterprise

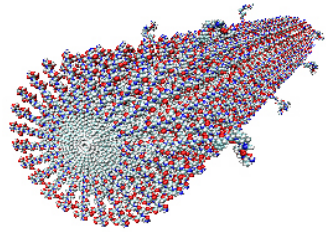
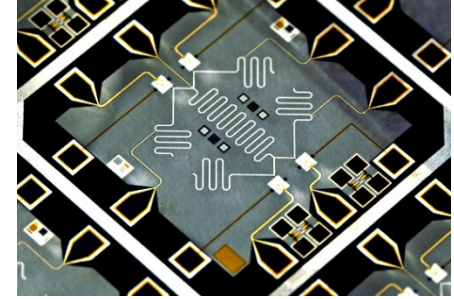
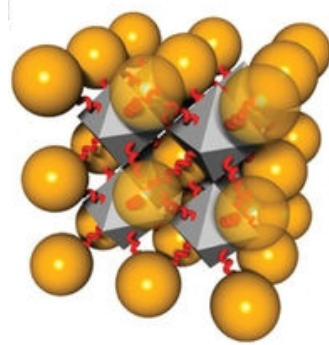
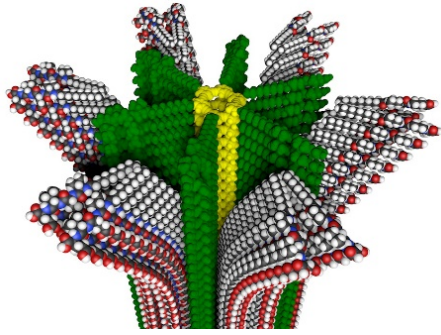
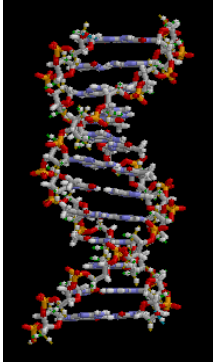


Vinayak Dravid
Materials Science and
Engineering



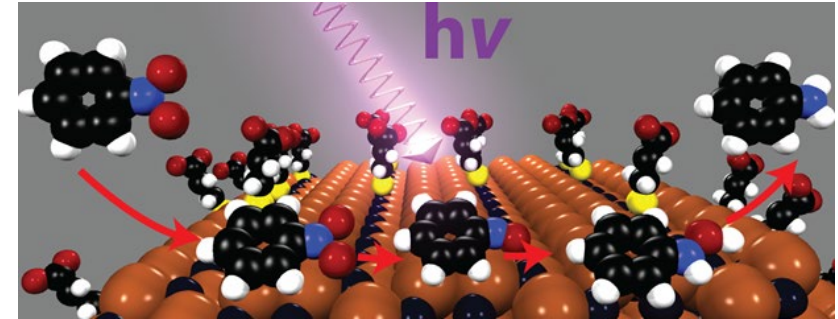
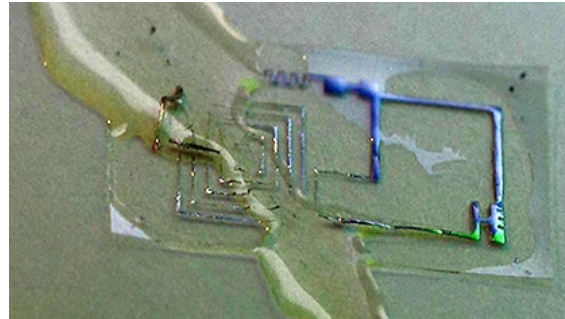
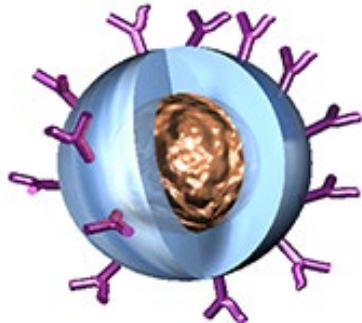
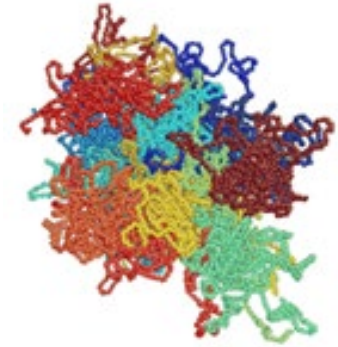
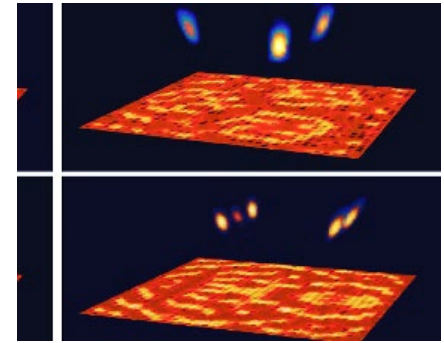
Site Review | NNCI Annual Meeting – November 3, 2021

SH_yNE - Soft & Hybrid (Soft-Hard) Nanotechnology Experimental (SHyNE) Resource



Soft

HARD



SH_YNE Facilities

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

16 Tech Staff -
14,000 sq ft

Molecular Nanotech
Molecular Characterization

10 Tech Staff -
12,300 sq ft

\$50M+
Tools

Bio-Molecular
Peptide Synthesis/Char
Bio-Physical Interface

5 Tech Staff -
3,400 sq ft



SH_YNE

Micro/Nanofabrication
MEMS, Physical-Bio
Interfaces

6 Tech Staff -
7,000 sq ft

65,000+ ft²
space

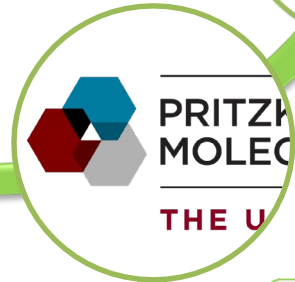
Atom-Probe
Tomography (APT)

2 Tech Staff -
900 sq ft



X-ray Scattering
APS Prototyping, Pulsed Laser
Deposition (PLD)

3 Tech Staff -
2,500 sq ft



Micro/Nanofab MEMS/NEMS
Wafer-scale, Integrated Fab

6 Tech Staff -
24,000 sq ft

60+
Staff

SH_yNE Impact - Intellectual Merit

SH_yNE Publications (per calendar year)

Users	2016	2017	2018	2019	2020	2021	Total: 2016-2021
Internal Users	230	279	358	367	362	360	1,956
External Users	26	30	43	30	39	tbd	168
Total	256	309	401	397	401	360	2,124

- ✓ **Soft & Hybrid** – unique theme
- ❑ **Total Users:** 1521 (during COVID-19)
- ❑ **Growth - External Users & Usage**
- ❑ **Publications:** 2,124 (...and counting)
- ❑ **Patents/Disclosures:** 250+
- ❑ **Process & Product Development**
- ❑ **Museums and Public Institutions**

- ✓ **\$50M+** in new equipment
- ✓ **State-of-the-Art Space:** J-, AB-Wings
- ✓ **SEED** funding - new user engagement



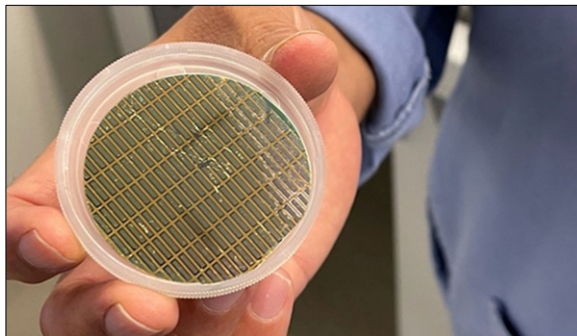
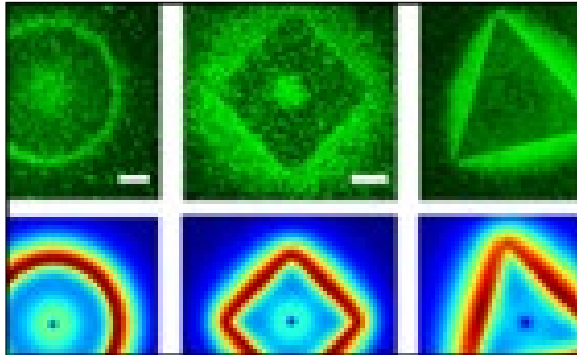
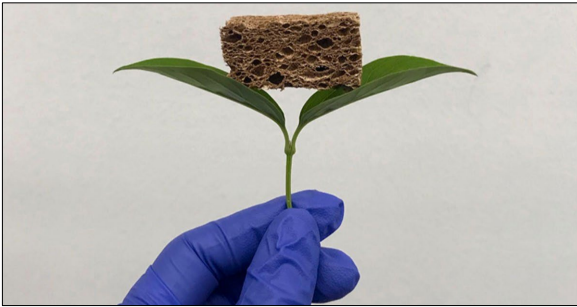
NSF MRI - Raith Voyager 100 eBL



- ✓ **Regional Coordination**
 - Women in Microscopy
 - Chicago State University
 - Oakton Community College
 - Northern Illinois University
 - iNano, CBC, M3S,
 - Chicago Quantum Exchange
- ✓ **NNCI Network Activities**
 - Global & Regional Interactions
 - Staff exchange
 - Machine Learning for Predictive Maintenance
 - ChiMaD, MFRN – MRSEC, SQMS
- ✓ **SME collaboration and development**
- ✓ **Start-ups enabled** - J2 Materials,



SH_YNE Impact – Over 360 Publications



SH_YNE Publications for Calendar Year 2020

Internal User Papers [362]

- Accardo, J. V.; McClure, E. R.; Mosquera, M. A.; Kalow, J. A., Using Visible Light to Tune Boronic Acid-ester Equilibria. *Journal of the American Chemical Society* 2020, 142 (47), 19969-19979.
- Akono, A.-T.; Nanostructure and fracture behavior of carbon nanofiber-reinforced cement using nanoscale depth-sensing methods. *Materials* 2020, 13 (17), 3837.
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- Akono, A.-T.; Dávila, G.; Druhan, J.; Shi, Z.; Jessen, K.; Frotts, T., Influence of geochemical reactions on the creep behavior of Mt. Simon sandstone. *International Journal of Greenhouse Gas Control* 2020, 105, 103183.
- Akono, A. T., Fracture behavior of metakaolin-based geopolimer reinforced with carbon nanofibers. *International Journal of Ceramic Engineering & Science* 2020, 2 (5), 234-242.
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- Amsterdam, S. H.; LaMountain, T.; Stanev, T. K.; Sangwan, V. K.; López-Arteaga, R.; Padgaonkar, S.; Watanabe, K.; Taniguchi, T.; Weiss, E. A.; Marks, T. J., Tailoring the Optical Response of Pentacene Thin Films via Templated Growth on Hexagonal Boron Nitride. *The Journal of Physical Chemistry Letters* 2020, 11, 26-31.
- An, D.; Baik, S.-I.; Ren, Q.; Jiang, M.; Zhu, M.; Isheim, D.; Krakauer, B. W.; Seidman, D. N., A transmission electron microscopy and atom-probe tomography study of martensite morphology and composition in a dual-phase steel. *Materials Characterization* 2020, 162, 110207.
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- Bae, Y. J.; Shimizu, D.; Schultz, J. D.; Kang, G.; Zhou, J.; Schatz, G. C.; Otsuka, A.; Wasielewski, M. R., Balancing Charge Transfer and Frenkel Exciton Coupling Leads to Excimer Formation in Molecular Dimers: Implications for Singlet Fission. *The Journal of Physical Chemistry A* 2020, 124 (41), 8478-8487.
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- Baik, S.-I.; Gupta, R. K.; Kumar, K. S.; Seidman, D. N., Temperature increases and thermoplastic microstructural evolution in adiabatic shear bands in a high-strength and high-toughness 10 wt% Ni steel. *Acta Materialia* 2020, 1169568.
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- Balch, H. B.; Evans, A. M.; Dasari, R. R.; Li, H.; Li, R.; Thomas, S.; Wang, D.; Bobey, R. P.; Slicker, K.; Castano, I., Electronically Coupled 2D Polymer/MoS₂ Heterostructures. *Journal of the American Chemical Society* 2020.
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- Battistella, C.; McCallum, N. C.; Vanthournout, B.; Forman, C. J.; Ni, D. Z.; La Clair, J. J.; Burkart, M. D.; Shawkey, M. D.; Gianneschi, N. C., Bioinspired Chemoenzymatic Route to Artificial Melanin for Hair Pigmentation. *Chemistry of Materials* 2020, 32 (21), 9201-9210.
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SH_YNE – Growth in External Users

Identify Users

Communicate

Consultation

Onboarding

External Users

- Academic
- Small Company
- Large Company
- Govt/Non-Profit

Identify PIs:

- Targeting **URM** Orgs
- Regional Institutions
- Start-ups & SMEs
- Large Companies
- Govt/non-Profits

Networking:

- Referrals, NNCI/Users
- Corporate Liaison Networks
- Innovation HUBs
- Govt. Economic Development Offices
- Regional Partners

Targeted Contact:

- Invited Seminars
- Workshops/Demos
- Direct Mail / Email
- Invited Webinars
- Hosted Conferences

Outreach:

- Website, Social Media
- Brochures
- Open Houses
- Conference Booth

URM inclusion statement

Technical Discussion

- CTO Project Mtgs
- Web Meetings

Statement of Work

SEED funding

- Trial Runs
- 50% **URM** Institutions

Contact Tracking:

- Follow-up
- Referrals

Efficiencies:

- Non-Disclosure Agreement
- Lab Services Agreement
- Purchase Orders

Satisfaction Survey:

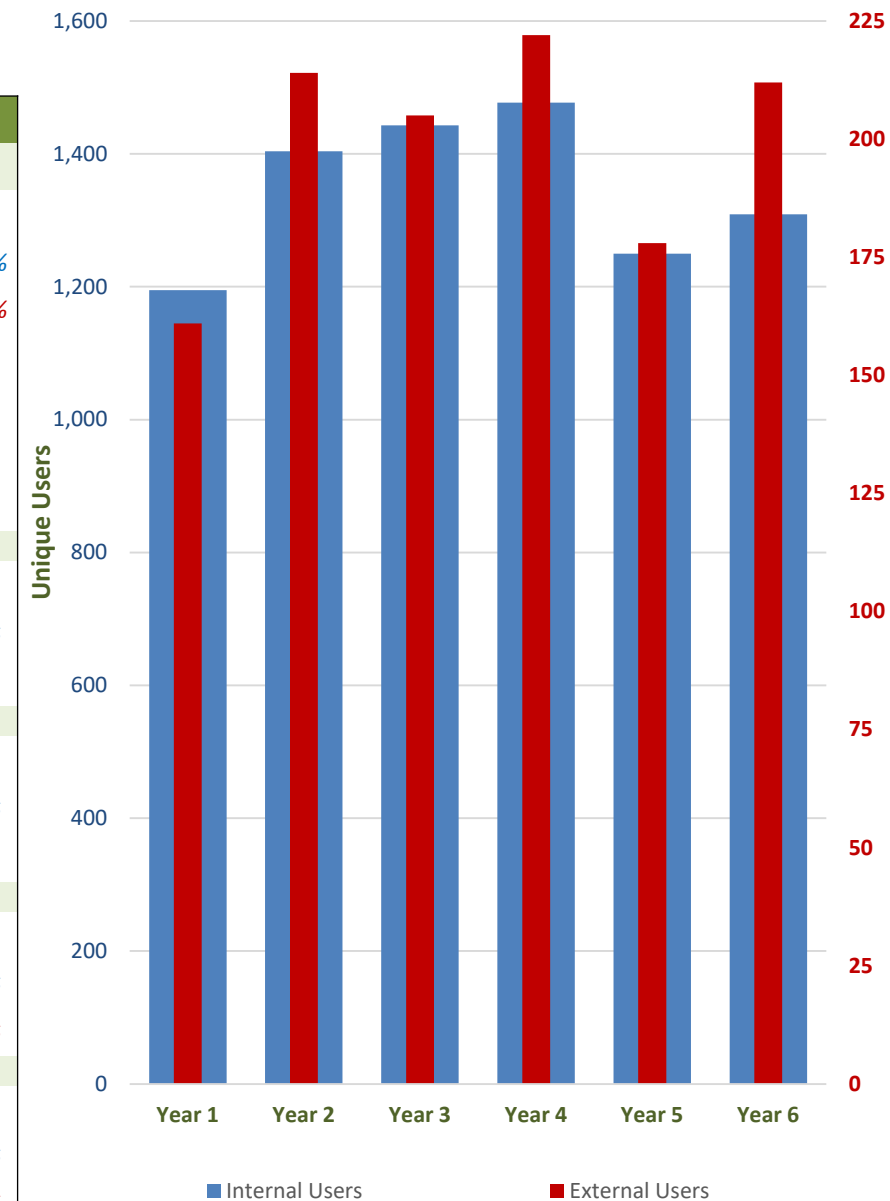
- Continual improvement
- Referral Forms
- User Demographics



SH_YNE - User Data | Year 6 (12 mos.)

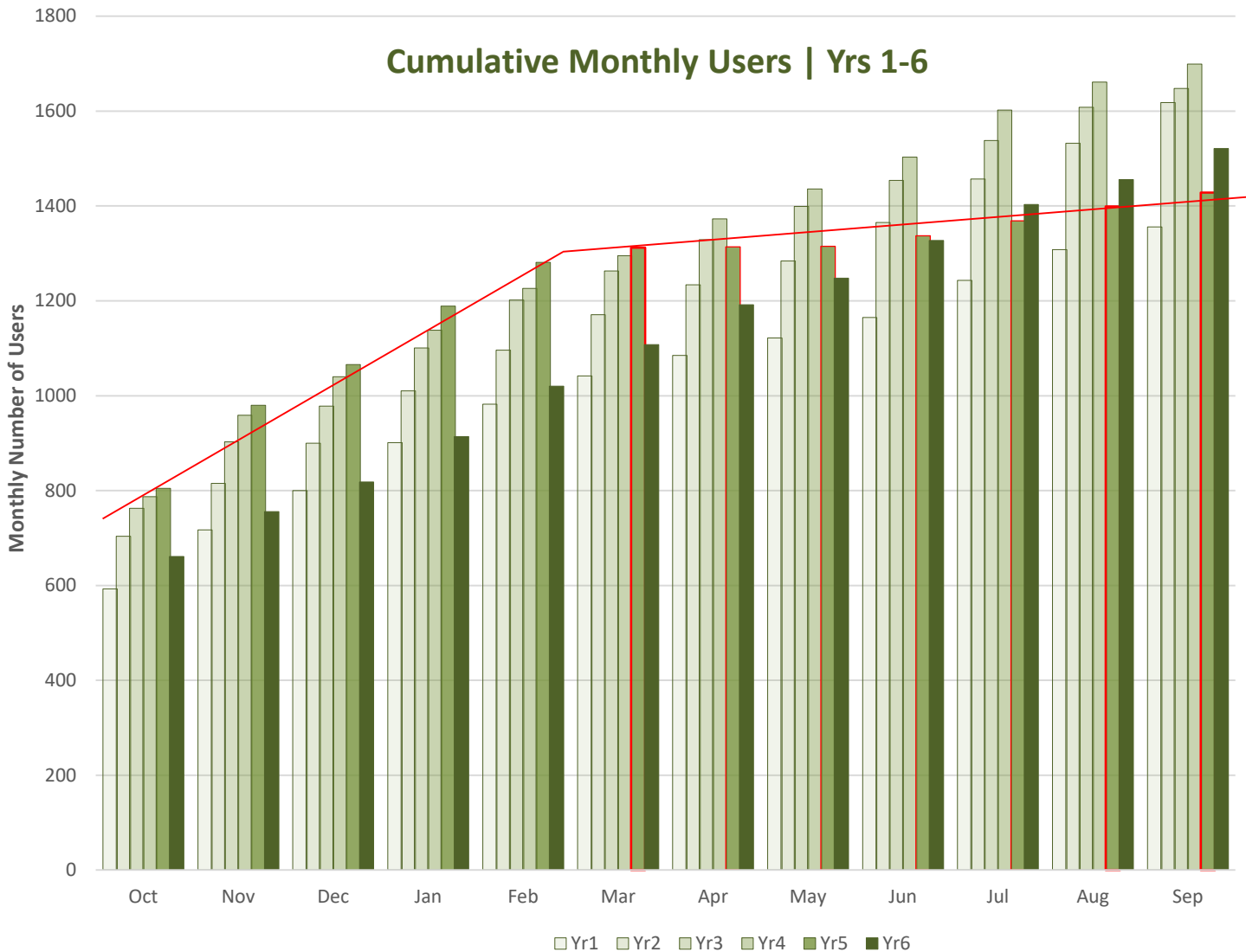
Yearly User Data Comparison						
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6 (12 mos)
Total Users	1356	1618	1648	1699	1428	1521
Internal Users	1,195 88%	1,404 87%	1,443 88%	1,477 87%	1,250 88%	1,309 86%
External Users	161 12%	214 13%	205 12%	222 13%	178 12%	212 14%
<i>External Academic</i>	70	94	98	113	101	106
<i>External Industry</i>	76	103	81	78	59	88
<i>External Government</i>	14	15	24	29	16	13
<i>External Foreign</i>	1	2	0	2	2	5
Total Hours	128,201	161,536	168,676	202,844	139,301	159,720
Internal Hours	123,537 96%	154,565 96%	161,391 96%	192,434 95%	132,303 95%	150,425 94%
External Hours	4,664 4%	6,971 4%	7,285 4%	10,410 5%	6,998 5%	9,294 6%
Avg. Monthly Users	644	743	795	778	606	653
Avg. Users (Internal)	610 95%	698 94%	744 94%	725 93%	565 93%	602 92%
Avg. Users (External)	35 5%	45 6%	51 7%	53 7%	41 7%	51 8%
Total Revenue	\$3,252,822	\$4,295,005	\$4,437,345	\$5,171,862	\$3,610,469	\$4,522,643
Internal User Revenue	\$2,941,710 90%	\$3,848,501 90%	\$3,952,249 89%	\$4,560,925 88%	\$3,248,978 89%	\$3,966,167 88%
External User Revenue	\$311,112 10%	\$446,504 10%	\$485,096 11%	\$610,937 12%	\$361,491 11%	\$556,477 13%
New Users Trained	570	619	605	649	340	597
New Internal Users	519 91%	554 89%	519 86%	529 82%	274 81%	476 80%
New External Users	51 9%	65 11%	86 14%	120 18%	66 19%	121 20%

Cumulative Users - Internal | External

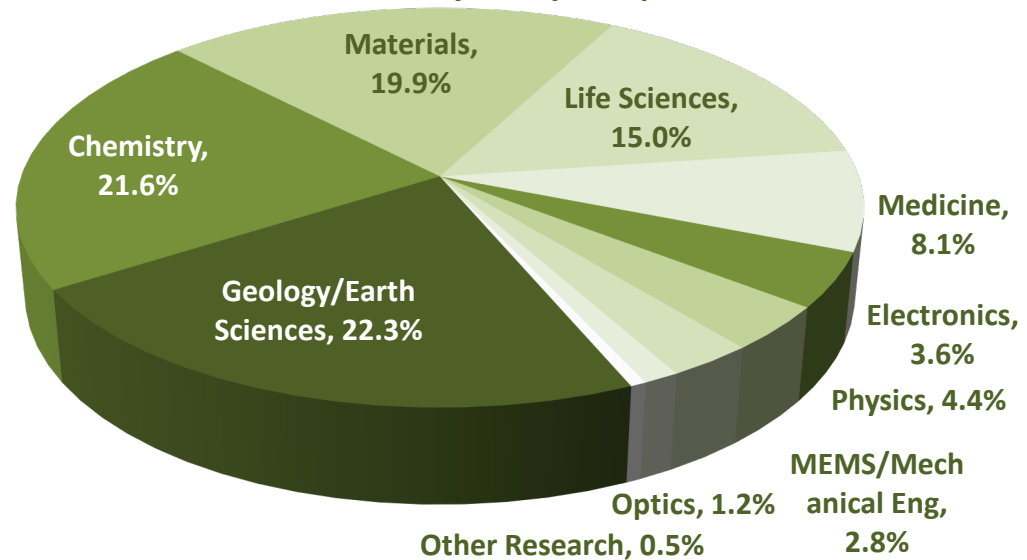


SH_YNE - Usage Details

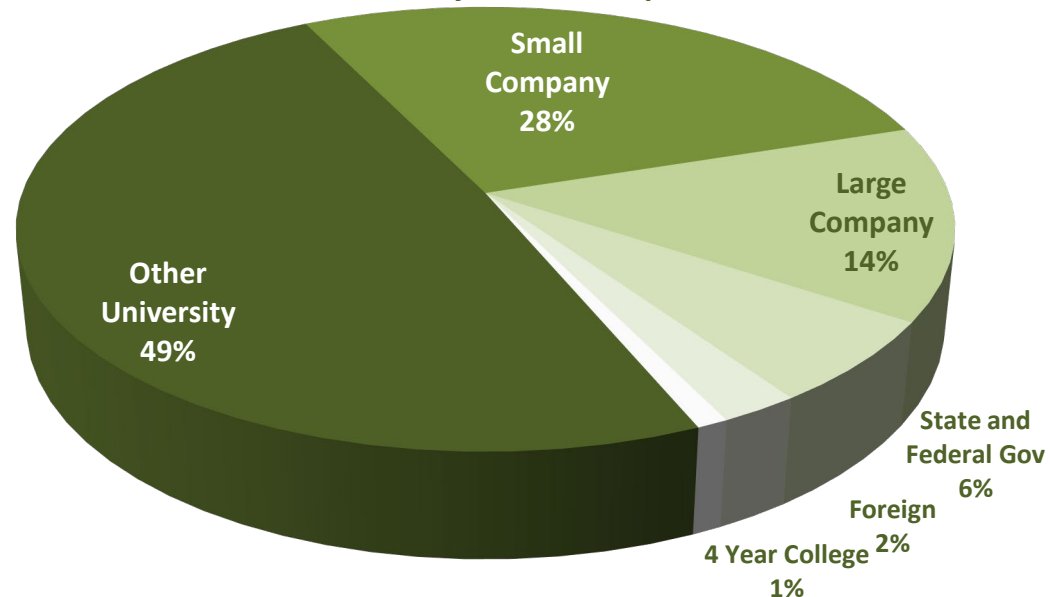
Cumulative Monthly Users | Yrs 1-6



Cumulative Users - by Discipline | Year 6 (12 mos.)



External Users - by Affiliation | Yr6 (12 mos.)



SH_yNE – Integrated & Comprehensive Approach

Outreach and Education



- Nano-Journalism, Social Media
- Nanotech Exhibits, Museums
- Lecture series, iNANO, M3S



- Industry Workshops, Demos
- Vendor Relations
- SEED Funding, Targeted Marketing



- Seminars, Courses, User meetings
- Technical Workgroups
- Proposal Development



- REU – Workforce Development
- CC Internship Program
- Open House, Image Contest



- RET - curriculum Development
- Science in Society (SiS) - camps, science clubs, Boys/Girls Clubs, URM
- Lab Tours, Demos, Remote Learning

Public, Community

Industry, Entrepreneurs

University, Faculty

Comm. College, Undergrad

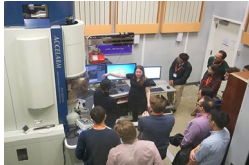
K-12

Diversity and Inclusion

- Science Chicago, Regional outreach
- Chicago Museums, URM community
- Women in Nano, SWE, SBE hiring



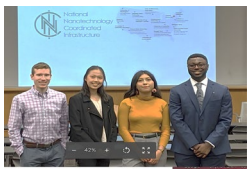
- Diversity Survey - demographics
- External user onboarding
- Improved tracking and metrics



- Targeting URM universities
- Diversity Survey – demographics
- Coordination: Dean Williams



- SHyNE REU - 100% Women/URM
- Community College interns
- MRSEC REUs



- RET 100% URM teachers
- SiS Targets Chicago schools,
- Diversity Survey – demographics
- Tracking outcomes

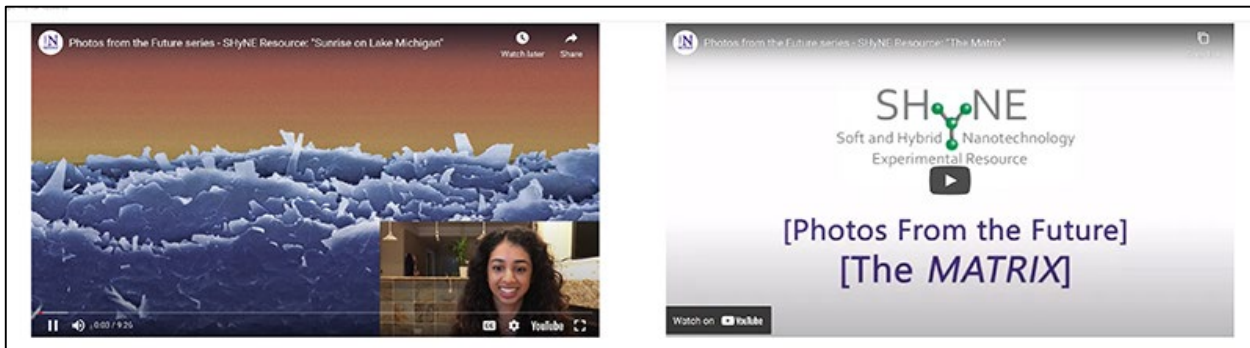


SEI - Nano-Journalism

- Experiential learning for journalism & communication students
- Communications training for scientists: *Workshops, Seminars, Training Events*

Nano-Journalism Intern: **Mohammad Behroozian**, Nanojournalism Intern

- Producing a video series aimed for international middle-school audience on nanoscience research that SHyNE makes possible.
- In line with the University-wide effort to advance inclusion and diversity; initiative strives to reach adolescents in underserved communities by increasing the exposure to nanoscience research and strengthens their sense of self-efficacy in pursuing STEM studies.



(Above) Screenshots from "Photos From the Future" - short video series on the science behind our science images taken with instruments at SHyNE facilities.

Diversity and Inclusion

- **Women in Microscopy Conference**
– Annual Conference focusing on women microscopists
- **Women in Nano**
– Women's History Month social media campaign



Karen DeRocher, Joester Group

- **REU & RET Program**
- **Science Chicago – Mayor's initiative**
- **UTSA & UIC: PREM Collaboration**
- **Chicago State and Roosevelt College**
- **Open house, Festivals, Townhalls**

NUANCE spearheaded #WomenInNano campaign, showcasing regional women STEM scholars and culminating in the annual Women in Microscopy Conference with Microscopy Society of America.

SH_yNE - Education & Outreach

- **Facilities-focused Short Courses, Exhibits, Events & Tours**
 - *SHyNE facilities conducts 20+ courses every year*
 - *Science In Society collaboration involving K-12*
 - *Vendor-workshops, seminars, training, and open-houses*
 - *Gatan Virtual Workshop on 4D STEM – over 480 attendees from 45 different countries*
- **Regional & Network Coordination**
 - *iNano – UC, ANL, NU initiative under SHyNE*
 - *Chicago Biomedical Consortium (CBC): UC, NU, UIC*
 - *Chicago Quantum Exchange, M3S (Midwest Microscopy)*
- **NNCI RET & REU Program**
 - *SHyNE is hosting 5 REU's & 5 RET's per year*
 - *Aligns with long-standing MRSEC RET program*
- **UC Innovation Exchange (CIE) and Illinois Science + Tech Park**
- **NU-MRSEC-PREM, MFRN Coordination**



SHyNE 2021 RET's



Boys & Girls Club summer activity including a video created by Tirzah Abbott on basics of SEM as additional learning materials for foldscopes.

SH_yNE - Education & Outreach

Women in Microscopy Conference March 8, 2021

NUANCE
Northwestern University Atomic and Nanoscale Characterization Experimental Center

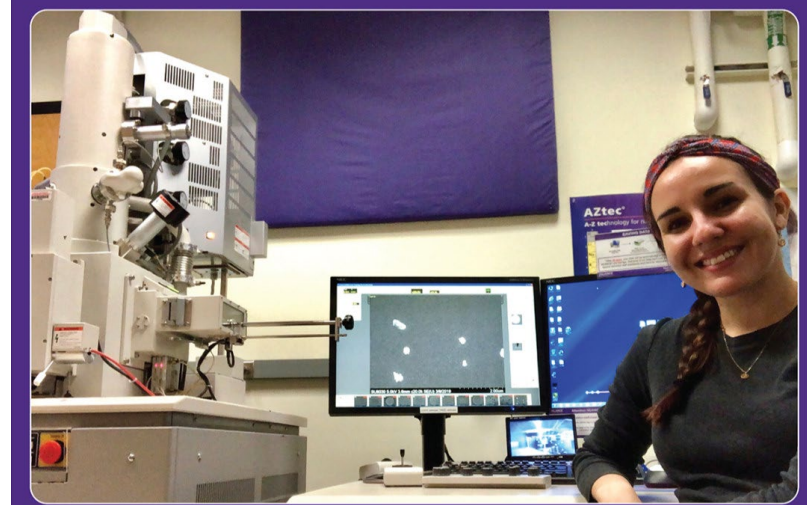
2021 "Art of Science" Image Contest

Get your Images Ready!

The 2021 Submission Portal opens **August 2, 2021**



"The Crystal Heart"
Image by Timur Islamoglu, Farha Group



Register Today!



NUANCE Tech Talks

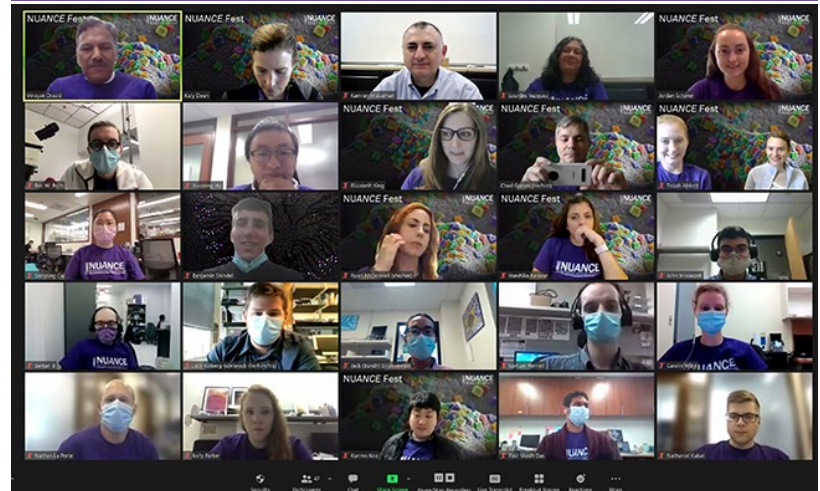
...explore with us

Please join us for monthly user meetings!

Tech staff will:

- showcase our state-of-the-art capabilities
- provide updates on the latest innovations
- discuss any topics you find interesting

Northwestern RESEARCH **SH_yNE**
Soft and Hybrid Nanotechnology Experimental Resource

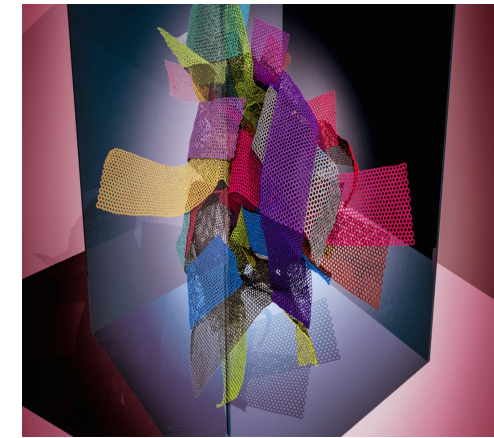
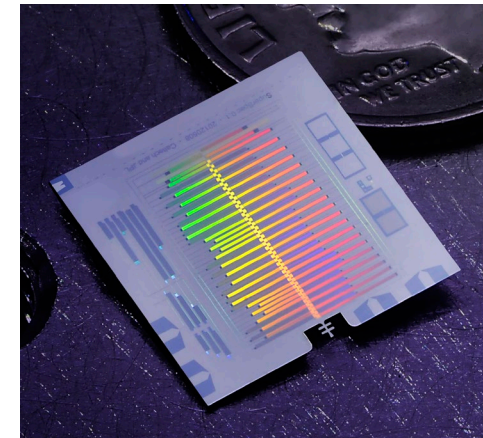
SH_yNE | Years 6-10 Plans

Intellectual Merit

- **Continued excellence - Soft & Hybrid Nanotechnology**
 - *Food, Ag products, Biomaterials and Nano-Bio interfaces*
 - *“Energy-Enviro-Water-Food” Nexus*
 - *Quantum Information Systems – leveraging Nano Infrastructure*
- **Collaborations within and beyond NNCI: Federal, Industry, Non-Profits, Foundations, Museums, and Public Institutions**
- **Growth of External Academic & Industry Users**
 - Multifaceted and Coordinated Approach
 - Expanding SHyNE SEED funding and Enhance TEG interactions
 - Open houses, short courses, webinars, and workshops
 - ➔ ***New A/B Space: One-stop-shop & problem solving***
- **Data Science Initiatives – CHiMaD and MRSEC collaborations**
 - Predictive Maintenance, Material Genome, Data mining...
- **New/Future Opportunities and Diversification**
 - Extra-Terrestrial Materials Analysis, Covid-19 aftermath

Broader Impacts:

- Integrated & Comprehensive Approach
- Regional Coordination:
 - iNANO, URM, Community colleges
 - Science Chicago, Nanotech exhibit at Chicago MSI
- Expanding REU and RET programs
- Local Museums: Art Institute of Chicago, Field Museum, and Botanical Garden





SHYNE

Soft and Hybrid Nanotechnology
Experimental Resource

ILLUMINATE YOUR RESEARCH



Sossina Haile
Materials Science and
Engineering, Applied
Physics



Chad Mirkin
Materials Science,
Chemical and Biological
Engineering,
Biomedical
Engineering, Medicine



Jian Cao
Mechanical Engineering,
Civil and Environmental
Engineering, Materials
Science and Engineering



Andrew Cleland
Physics, Molecular
Engineering Innovation
and Enterprise



Vinayak Dravid
Materials Science and
Engineering



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Q & A

Discussion