

# Midwest Nano Infrastructure Corridor (MiNIC)

Steven J. Koester, Director

**MiNIC**

Midwest Nano  
Infrastructure Corridor



National  
Nanotechnology  
Coordinated  
Infrastructure

**NNCI Annual Meeting**  
**October 25-27, 2023**



# Midwest Nano Infrastructure Corridor (MiNIC)

- Located at the University of Minnesota, Minneapolis, MN. Two main user hubs:
- Minnesota Nano Center (MNC)
  - Two cleanrooms + NanoBio / NanoMaterials labs
- Characterization Facility (CharFac)
  - Four facilities for hard, soft, and biomaterials located in related buildings



Minnesota Nano Center (MNC)



Characterization Facility (Charfac)



Steve Koester



Kristina Pearson



Nate Lynch



Javier Garcia Barriocanal



Brian Olmsted



Jim Marti



Greg Haugstad



Theresa Reinecke

# Our Prompt(s)

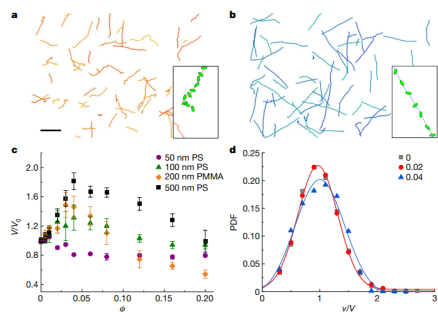
- Examples of programs, activities and relationships that could be expanded upon in a future network.
- How Can NNCI Support National Research Priorities in the Next 5-10 Years?

# Support for Leading Basic Research

- The NNCI remains the only national nanotechnology network that supports basic research, in all its various forms. **Below is a summary for MiNIC:**

## Scientific impact

CY 2022 = 212 journals, 44 conferences  
 FY 2023 = supported \$138M+ in external projects

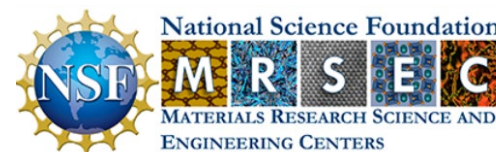


*The colloidal nature of complex fluids enhances bacterial motility.*

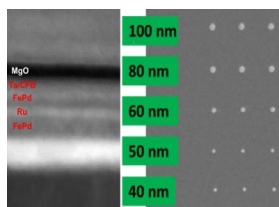
Nature, 2022.

## Center-Level Support

Spintronic Materials for Advanced Information Technologies (SMART)

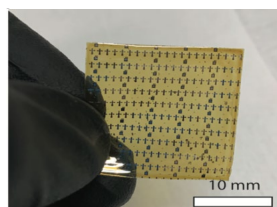


### Spintronics



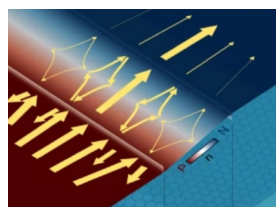
Nano Lett., 2022

### Flexible Electronics



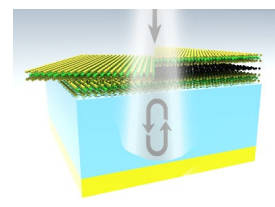
NPJ Flex. Electron., 2022

### Quantum Physics



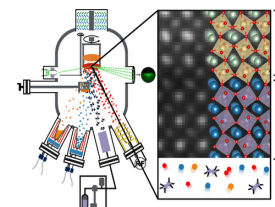
Nature Commun, 2022

### Nano-Optics



Nature Commun., 2023

### Smart Materials



ACS Nano, 2023

# Semiconductor Workforce Development

- Minnesota Semiconductor Manufacturing Consortium:
  - **MiNIC is helping to lead a major new initiative to support workforce development in microelectronics industry.**
  - Working with leading microelectronics and MEMS companies, University professional training groups, and a major regional economic development organization to develop a 10-week training course for new and incumbent workers in microelectronics. **Upscaling semiconductor workforce.**
  - Supported by a grant from the Minnesota Department of Employment and Economic Development.

**Honeywell**

 skywater

**GREATER MSP**  
Minneapolis Saint Paul Regional Economic Development Partnership



**Collins Aerospace**  
An RTX Business

**m** EMPLOYMENT AND  
ECONOMIC DEVELOPMENT

College of Science and Engineering

Technological Leadership Institute



**POLAR**  
semiconductor

 National Nanotechnology  
Coordinated Infrastructure



**MiNIC**  
Midwest Nano  
Infrastructure Corridor



Round table with Sen. Amy Klobuchar

# Research Experience for Teachers

- MiNIC is working with SHyNE (Northwestern), NNF (U Nebraska-Lincoln) and SENIC (Georgia Tech) to offer an **RET experience** for up to 5 teachers at each site.
- RET teachers spend 5 weeks in summer working with faculty research groups. The participants:
  - develop a classroom activity related to nanoscience or STEM,
  - attend annual meeting of the National Science Teachers Association (NSTA).



Teachers staffing the NNCI booth and presenting their new lessons at the NSTA annual meeting.



- **Very important for future infrastructure since it is our best opportunity to engage with students at an early stage → motivate nano careers before it's too late.**

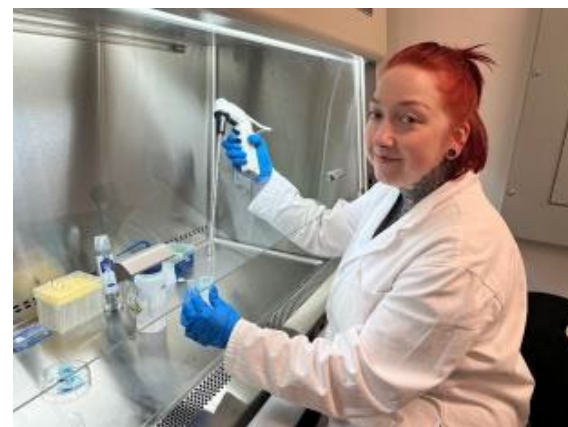


# Internship Programs

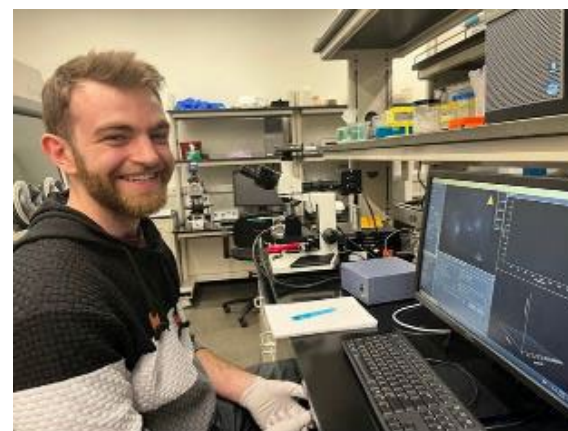
- MiNIC's laboratory internship program (MiNSPIRE) offers students from two-year colleges the chance to work in a nanoscience lab:



- 9 students supported from fall 2021 to spring 2023.
- Projects studied included:
  - synthesis of fluorescent nanoparticles.
  - genetically modifying cells.
- The students used our NanoBio labs and tools to characterize nanoparticle dispersions and culture human cell lines.
- **Current year interns also working on microelectronics projects.**



- **Community college engagement importance emphasized by Sec. Raimondo / Sen. Klobuchar visit to Normandale Community college in July.**



# Early-Stage Student Bootcamps

- MiNIC hosted a 10-day program in the summer of 2023 designed for **early-stage undergraduate students** to introduce them to key topics in quantum phenomena and their computing devices.
- Guest speakers from Intel, Google, Seagate, other companies.
- Combined US students and students from Kyung Hee University.
- **Emphasizing early stage students...before REU eligible.** Goal is to get them involved in nano/quantum before moving into another area.

<https://sites.google.com/umn.edu/quantum/home>

## Quantum + Chips



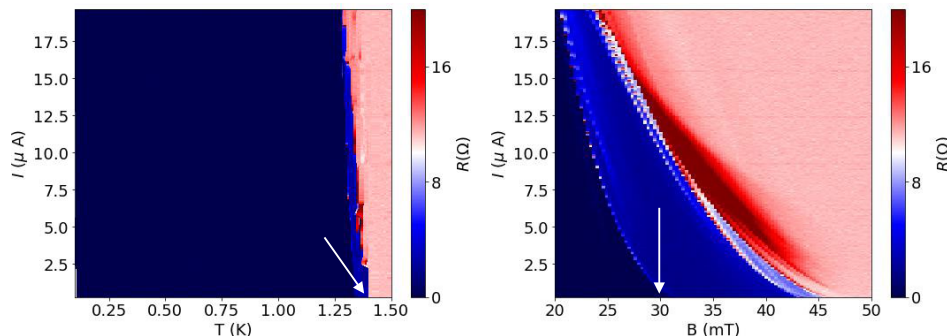


# Support for Key Focus Areas: Quantum

- MiNIC has a focus on developing infrastructure for quantum devices and materials:

- AJAATC 1800-HY UHV tool:

- System is now supporting quantum device research by enabling fabrication of superconducting Al thin films and Josephson Junctions.

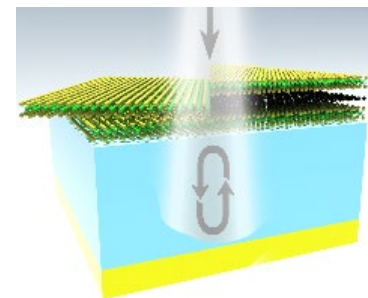


**Superconducting properties of a 13-nm Al thin film, deposited using MNC's ultra-high vacuum AJA ATC 1800-HY.**

- Ultra-high-purity 2D material assembly system:



**Twisted TMD layers for “perfect absorbers”.**



# Support for Key Focus Areas: Quantum

- MiNIC co-leads TransformQuantum research community, and leading on studying quantum infrastructure:



Time (EDT)	DAY 1 Tuesday, 4/13	DAY 2 Wednesday, 4/14	DAY 3 Thursday, 4/15
12:00 PM	Welcome, <b>Steven Koester</b> <i>U Minnesota</i>	Welcome, <b>Steven Koester</b> <i>U Minnesota</i>	Welcome, <b>Steven Koester</b> <i>U Minnesota</i>
12:05 PM	Welcome, <b>Dawn Tilbury</b> , <i>NSF</i>	Intro to NQCO, <b>Alex Cronin</b> , <i>NQCO</i>	NNCI node presentations: <i>Minnesota, Cornell, Harvard, and Nebraska</i>
12:10 PM	Intro to NNCI program, <b>Lawrence Goldberg</b> , <i>NSF</i>	NNCI node presentations: <i>Stanford, U Washington, NC State, and Montana State</i>	
12:15 PM	Overview of NNCI program, <b>Oliver Brand</b> , <i>Ga Tech</i>		
12:35 PM	NSF Center for Quantum Networks, <b>Saikat Guha</b> , <i>U Arizona</i>	NSF Quantum Foundry, <b>Ania Bleszynski Jayich</b> , <i>UCSB</i>	DOE Quantum Science Center, <b>David Dean</b> , <i>ORNL</i> (starting at 12:30 PM)
1:05 PM	Break	Break	Break (starting at 1:00 PM)
1:15 PM	Superconducting Qubits 1, <b>David Schuster</b> , <i>U Chicago</i>	Color Centers & Optics 1, <b>Jelena Vuckovic</b> , <i>Stanford U</i>	Topological Qubits 1, <b>Chris Palmstrom</b> , <i>UCSB</i>
1:45 PM	Superconducting Qubits 2, <b>Will Oliver</b> , <i>MIT-LL</i>	Color Centers & Optics 2, <b>Kai- Mei Fu</b> , <i>U Washington</i>	Topological Qubits 2, <b>Amir Yacoby</b> , <i>Harvard U</i>
2:15 PM	Break	Break	Break
2:30 PM	Trapped Ions 1, <b>Kenneth Brown</b> , <i>Duke U</i>	Color Centers & Optics 3, <b>Dirk Englund</b> , <i>MIT</i>	Spin Qubits 1, <b>Mark Eriksson</b> , <i>UW-Madison</i>
3:00 PM	Trapped Ions 2, <b>Susan Clark</b> , <i>Sandia National Labs</i>	Color Centers & Optics 4, <b>Marko Loncar</b> , <i>Harvard U</i>	Spin Qubits 2, <b>Jason Petta</b> , <i>Princeton U</i>
3:30 PM	Breakout 1, SC Qubit Infrastructure	Breakout 2, Trapped Ion Infrastructure	Breakout 1, Topological Infrastructure
		Breakout 2, Spin Qubit Infrastructure	
4:30 PM	Breakout Summary Reports		Breakout Summary Reports
5:00 PM	Adjourn		Adjourn

# Support for Key Focus Areas: Rules of Life

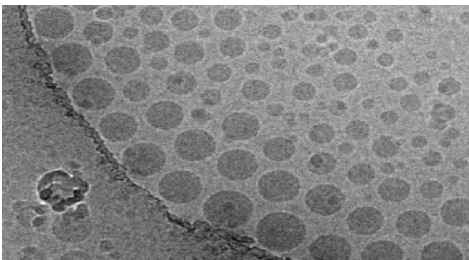
- MiNIC is a critical resource for local start-up companies to develop initial prototypes and to scale-up new nano-scale **bio-medical technology**:



**Zeptolife** uses GMR sensors and a microfluidic environment with magnetic particles to create a fully-automated, extremely high sensitivity assay.



**Grip Molecular** develops next generation graphene biosensors for lab quality diagnostics at home.



**Superior Nano** uses MNC's NanoBio labs to develop lipid-based nano-particles for improved transdermal drug delivery.

# Supporting Tech Transfer

- MiNIC supports numerous early-stage start-ups. Minnesota recently was awarded a Department of Commerce Tech Hub → **direct links to NNCI supported projects!**

## Minnesota MedTech Hub 3.0

Lead Agency: Minneapolis Saint Paul Economic Development Partnership

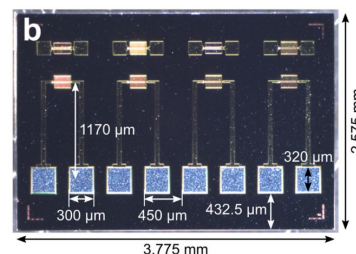
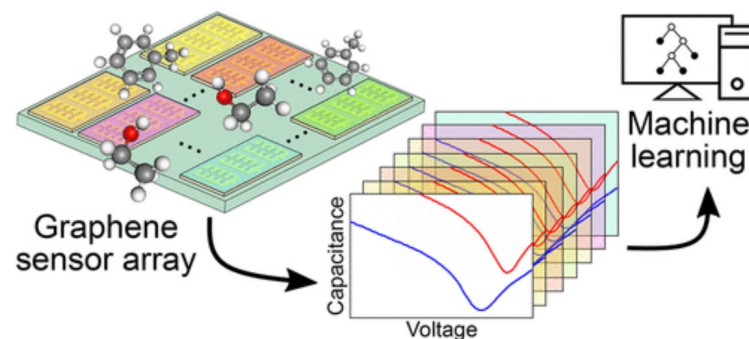
State Served: Minnesota

Applicant-Defined Region: Minneapolis-Saint Paul-Bloomington MSA

Core Technology Area: smart medical technologies

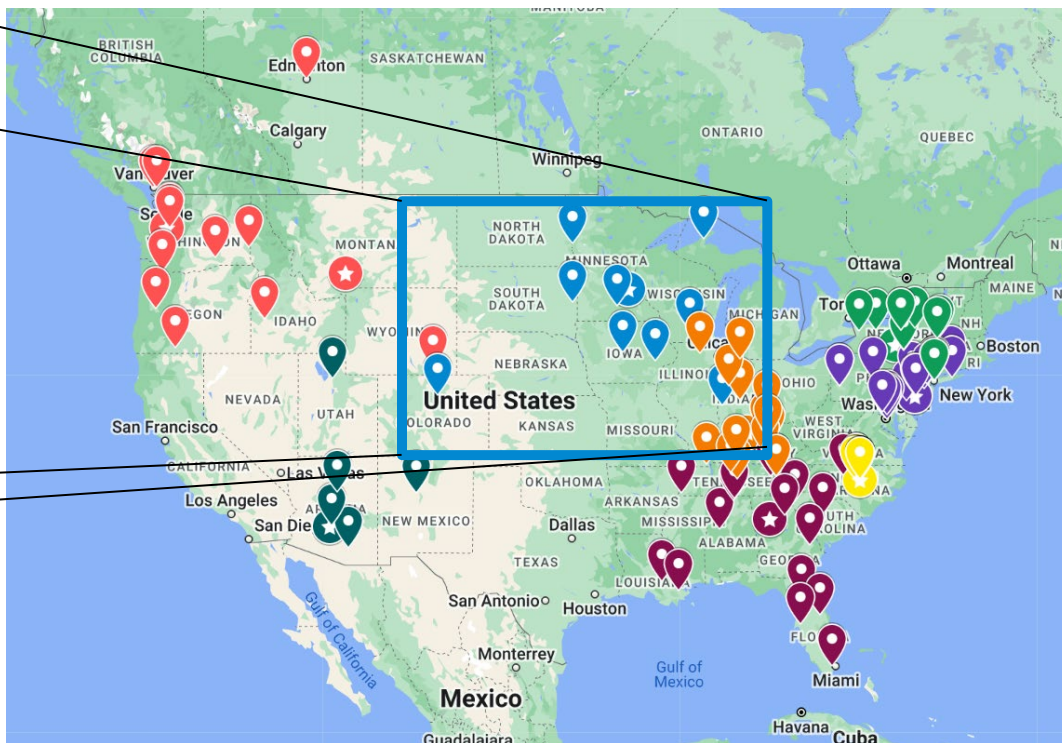
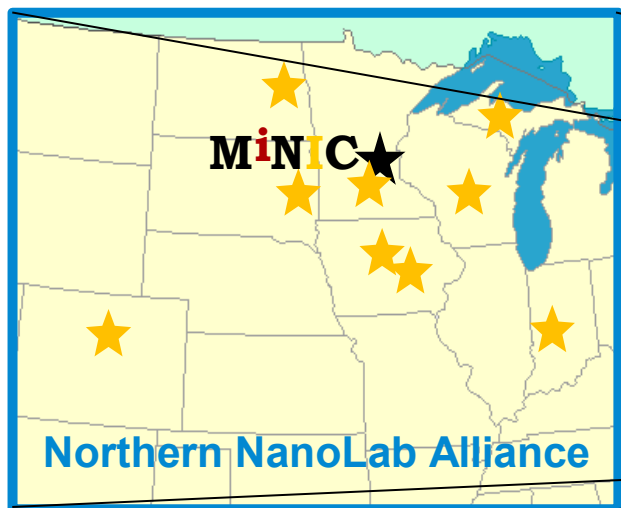


**E-nose developed through MiNIC and licensed to new spin-out VOCxi Health.**



# Regional Networks

- NNCI nodes have spurred the formation of local networks to ensure that every institution can benefit from NNCI know-how. **MiNIC was a leader in developing this model:**



- Sharing ways to reduce operating costs, promoting best practices, sharing experiences.

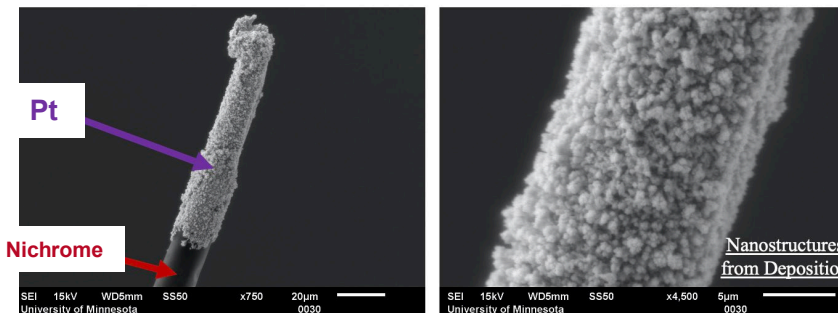
- **One of the best ways to democratize access to nano in a future network.**

# User Incentive Programs

- *Explore Nano*: Incentive program to attract new external/industrial users to MiNIC's facilities:
  - The program offers a \$2000 subsidy to new users of either MNC or CharFac facilities to offset user fees.
  - Nearly 20 new users supported in since restarting during pandemic.
  - Spawned new scientific collaborations between external users (with unique materials problems) and MiNIC staff scientists (with unique analytical expertise).

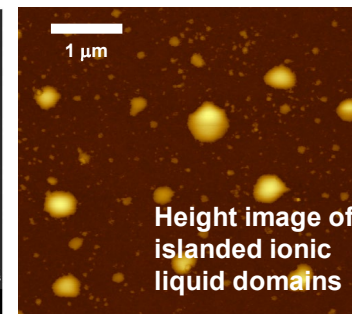
## Example 1:

**Fasikl Inc.** created a peripheral neural interface system which enables new levels of neural communication with prosthetic limbs.



## Example 2:

**University of Mississippi** used the AFM in attractive-regime AC mode to image ionic-liquid domain morphology.



# How Can NNCI Support National Research Priorities in the Next 5-10 Years?

- Basic research:
  - Retain strong emphasis on basic science. Make sure our equipment is on the cutting edge of capabilities for new science (e.g. quantum, bio). Provide some direct support for infrastructure → coordinate MRI program. Provide support for permanent staff for institutional memory.
- Focus areas (CHIPS / Quantum / Bio):
  - Emphasize education / training greatly, both for early stage researchers and retraining. Support basic research side of these areas (e.g. NSF FuSe). Make sure new network can develop a pipeline of technology into development (e.g Commons, NSTC, Tech Hubs).
- Access to Nano:
  - Strong emphasis on regional networks. Maintain central facilities, but have more “spokes.” Develop master access documents or fast access template to make using other sites easier. Be the first introduction to nano for K-12.