# The NanoFab

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NIST National Institute of Standards and Technology • U.S. Department of Commerce

# NanoFab Overview

Providing researchers world-wide customized processing tools for nanoscale fabrication and measurement on a shared-use, cost-reimbursable basis through a straightforward application process designed to get users into the facility in a few weeks.

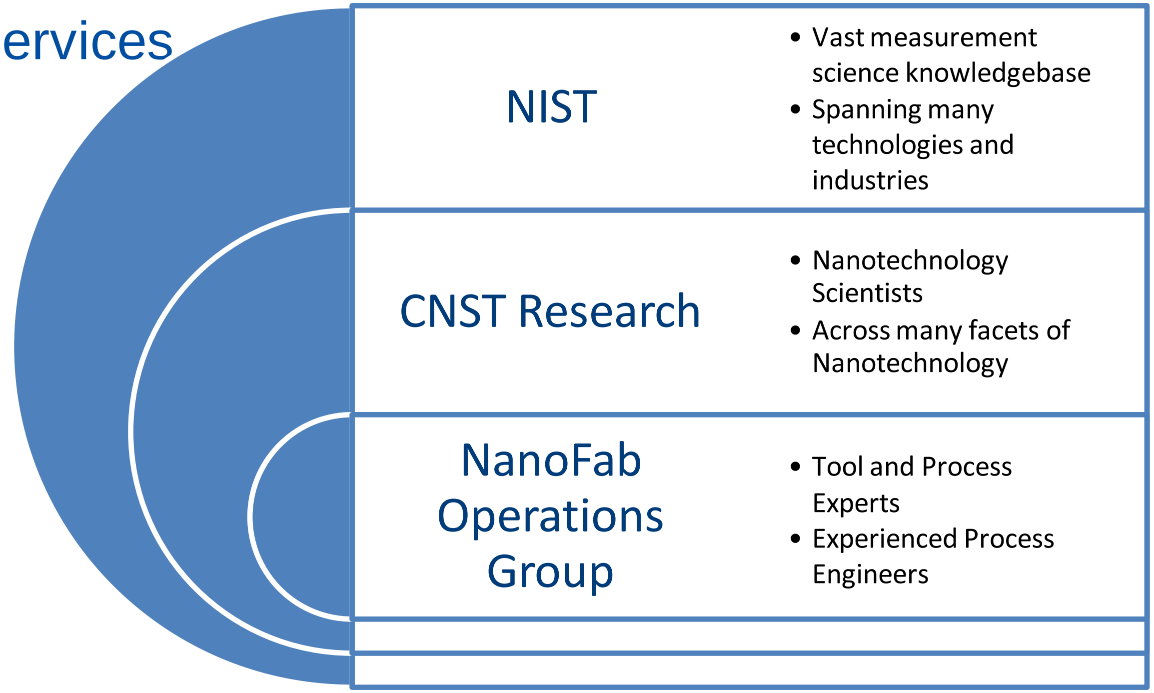
- NanoFab Staff: 12
  - Process Engineers: 7
  - Process Technicians: 1
  - Administrative Support: 2
  - Equipment Technicians: 2
- 19,000 ft$^2$ cleanroom; 8,000 ft$^2$ at class 100
- Advanced Nanofabrication and Metrology tools
- Additional shared-use tools outside the cleanroom

# Outline

- Expertise
- Environment
- Tools
- Processes
- Accessibility
- Continuous Improvement
- Outreach

# NanoFabrication Expertise

- Provide One-On-One Expert Training on Tools
- Ongoing Process Development Consulting to all users
  - Over 170 Years of Process Development Experience on Staff
- Process Development Services
  - Fee Based
- Vast Technical Resources to draw on as needed



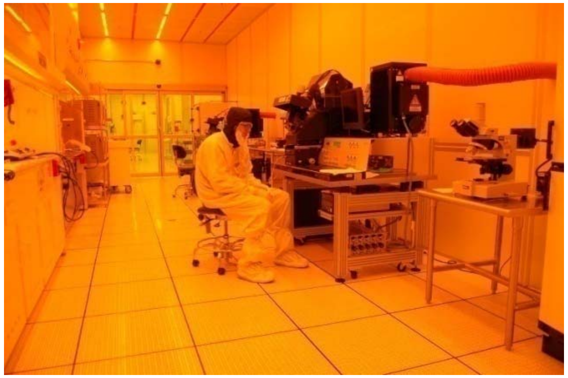
NIST
- Vast measurement science knowledgebase
- Spanning many technologies and industries

CNST Research
- Nanotechnology Scientists
- Across many facets of Nanotechnology

NanoFab Operations Group
- Tool and Process Experts
- Experienced Process Engineers

# The NanoFab Environment

- 19,000 ft Cleanroom;  8,000 ft$^2$ at class 100
  - Raised Floor Vertical Laminar Airflow
- Tight temperature control facilitates advanced processes and tools
  - 0.25ºF Temperature Control
  - 2.0% Relative Humidity Control
- State-of-the-art Deionized Water Generation Plant
- Compatible with Substrate Sizes up to 150 mm dia.
- Automatic Hazardous Gas Monitoring
  - Direct connection to NIST firehouse
- Multi-Camera CCTV Monitoring
- Coral Software Used for Account Tracking



# NanoFab Tools

- Thin Films
  - Sputter Deposition
    - 1 sputter tool dedicated to magnetic materials
  - E-beam Evaporation
  - Thermal Evaporation
  - LPCVD
  - PECVD
    - Including bio-compatible Parylene
  - Spin-On-Glass
  - Oxidation

# NanoFab Tools

- Reactive Ion Etching
  - ICP, chlorine based metal etcher
  - Deep-RIE for high aspect ratio etching
    - An invaluable tool for MEMS research
  - 2ea Fluorine Based Multipurpose systems
    - Supports research of new RIE processes
  - $XeF_2$ for rapid isotropic silicon etching
  - Microwave Oxygen Asher

*more RIE to come*

# NanoFab Tools

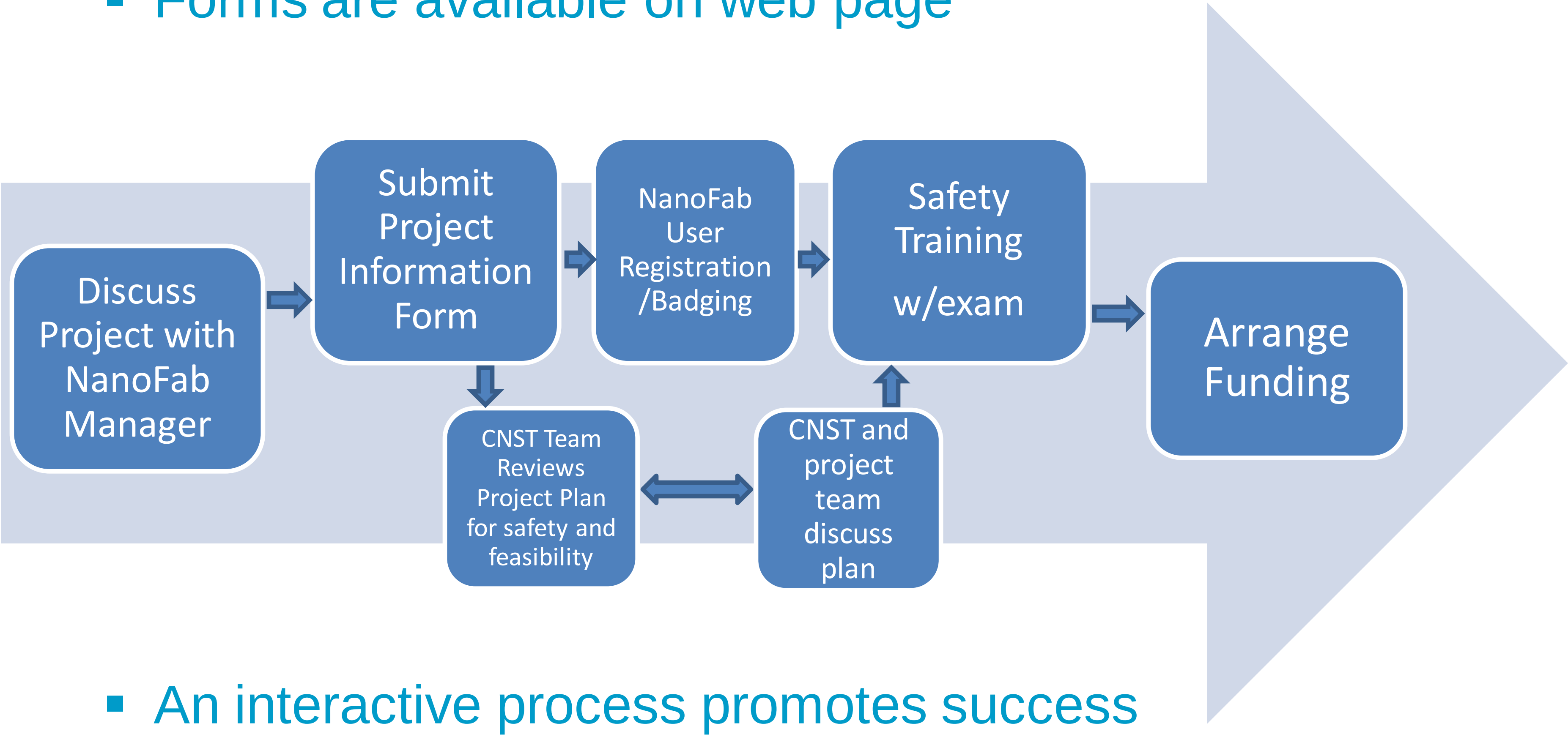
- Lithography
  - Vistec VB300 E-Beam Lithography
  - MA6 Front/Backside Contact Aligner
  - MA8 Frontside Contact Aligner
  - Nano-imprint Lithography
  - Laser Pattern Generator

# NanoFab Tools

- Metrology
  - Stress Measurement Tool: Toho Technology FLX-2320
  - Table-top SEM: Hitachi TM-1000
  - Scanning Electron Microscope: Zeiss Ultra-60 FESEM
  - Atomic Force Microscope: Veeco Dimension 3100
  - Atomic Force Microscope: Digital Instruments/Veeco
  - Dimension 3000 Contact Angle Goniometer
  - Spectroscopic Ellipsometer: Woollam XLS-100
  - Nanospec Reflectometer
  - Nanometrics Contact Profilometer: Dektak 6M

# Accessibility

- The Registration Process is Straight Forward
  - Forms are available on web page


Discuss Project with NanoFab Manager

Submit Project Information Form

NanoFab User Registration /Badging

Safety Training w/exam

Arrange Funding

CNST Team Reviews Project Plan for safety and feasibility

CNST and project team discuss plan

  - An interactive process promotes success

# NanoFab Process Development

Building Blocks for Nanotechnology Development

| | | | |
|---|---|---|---|
| E-beam Lithography Process EBL001 | E-beam Lithography Process EBL002 | E-beam Lithography Process EBL003 | E-beam Lithography Process EBL004 |
| Photolith Process CPL001 | Photolith Process CPL002 | Photolith Process CPL003 | Photolith Process CPL004 |
| Metal Dep Recipe SPT001 | Metal Dep Recipe SPT002 | Metal Dep Recipe SPT003 | Metal Dep Recipe SPT004 |

# Established Processes Facilitate Success

| | | | |
|---|---|---|---|
| E-beam Lithography Process EBL001 | E-beam Lithography Process EBL002 | E-beam Lithography Process EBL003 | E-beam Lithography Process EBL004 |
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Microsoft Office
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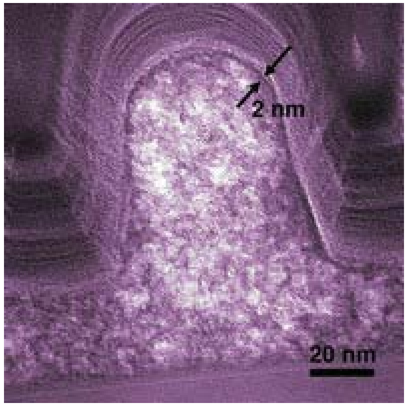
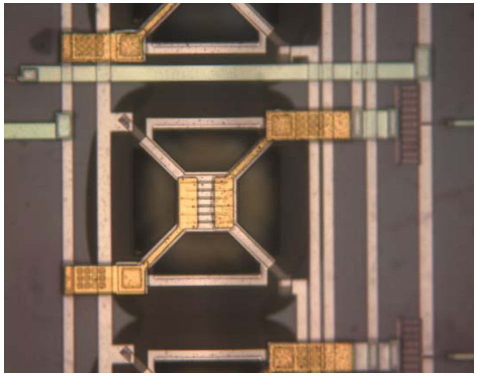
Hyun Wook Ro NIST/



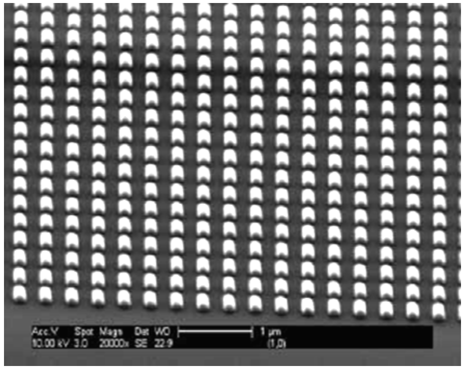
Nano-Imprint Technology

Dr. Yaqub Afridi NIST/SED



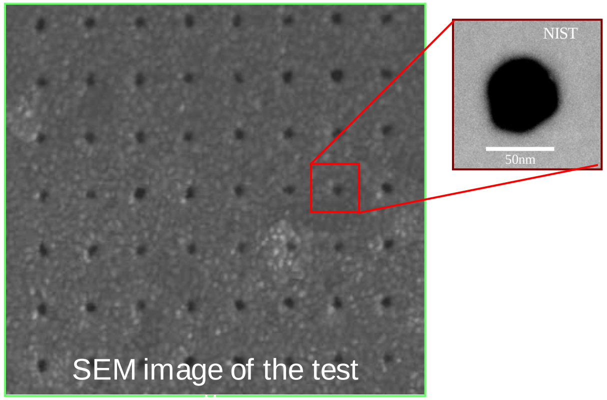
Micro-scale Gas Sensor

Prof. Sungho Jin UCSD



Magnetic Nanostructures

Dr. Wenyong Wang NIST/SED

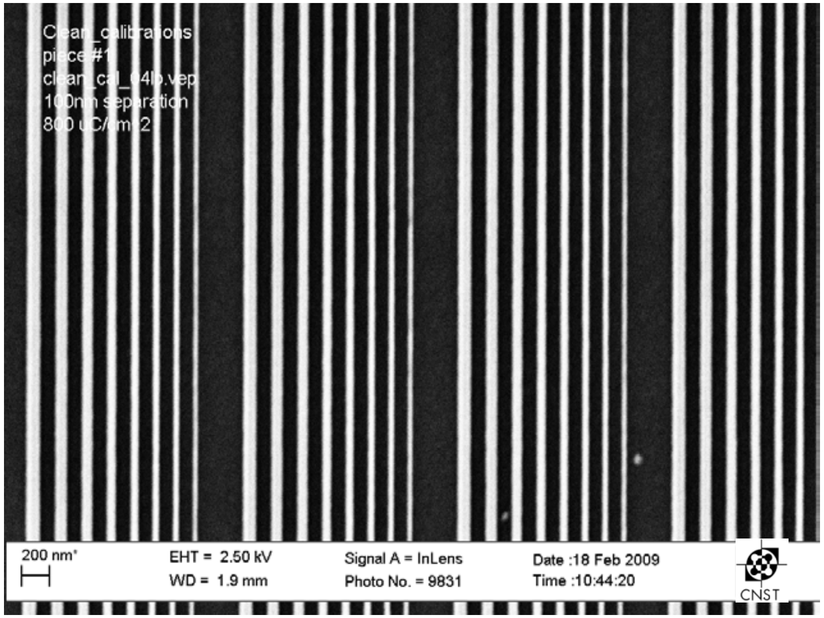


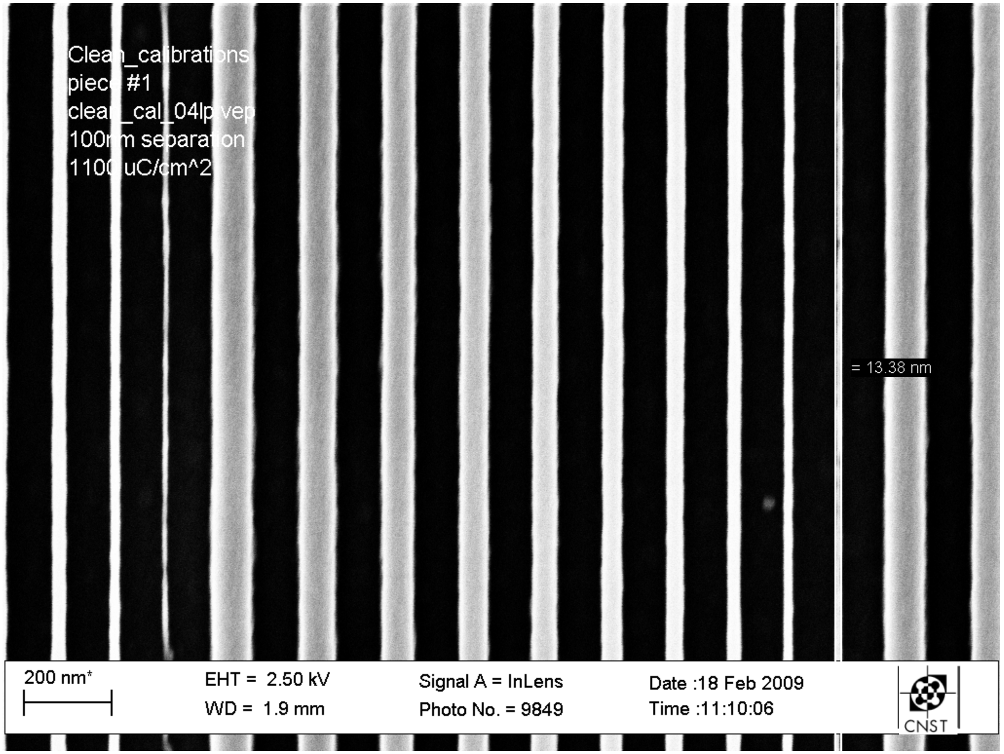
SEM image of the test

Nanopore Device for Molecular Transport Measurement

# Setting New Standards in Nanotechnology

- NIST/SEMATECH Project to create AFM Standards





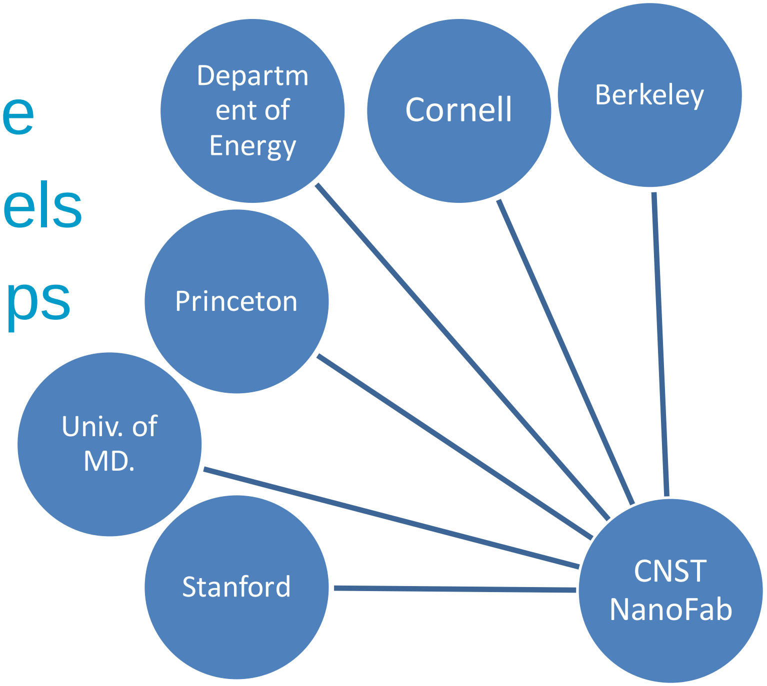
- Patterned HSQ Resist on Silicon

# Continuous Improvement

- New Capabilities
  - JEOL JBX 6300FS E-Beam writer 4/2009
    - Provides needed capacity of E-Beam Lithography
    - Back up for this vital capability
  - Oxford Atomic Layer Deposition System 4/2009
  - 2 more Oxford Multipurpose RIE Systems 4/2009
    - Both are ICP systems with 12 gas input channels
    - Cryo and heated substrate capability
  - Nanometrics 6100 Reflectometer 3Q2009
- Improved Systems
  - New Web based Project Registration 3Q2009
  - Coral Based Tool Interlocks 4/2009

# Ready for Prime Time

- The Time is right to launch Operation Outreach
  - The Tool set in the NanoFab is nearing Completion
  - The clean room environment has stabilized
  - Staffing is complete
  - Baseline Processes are in place
  - We have studied our Role Models
  - Established working relationships

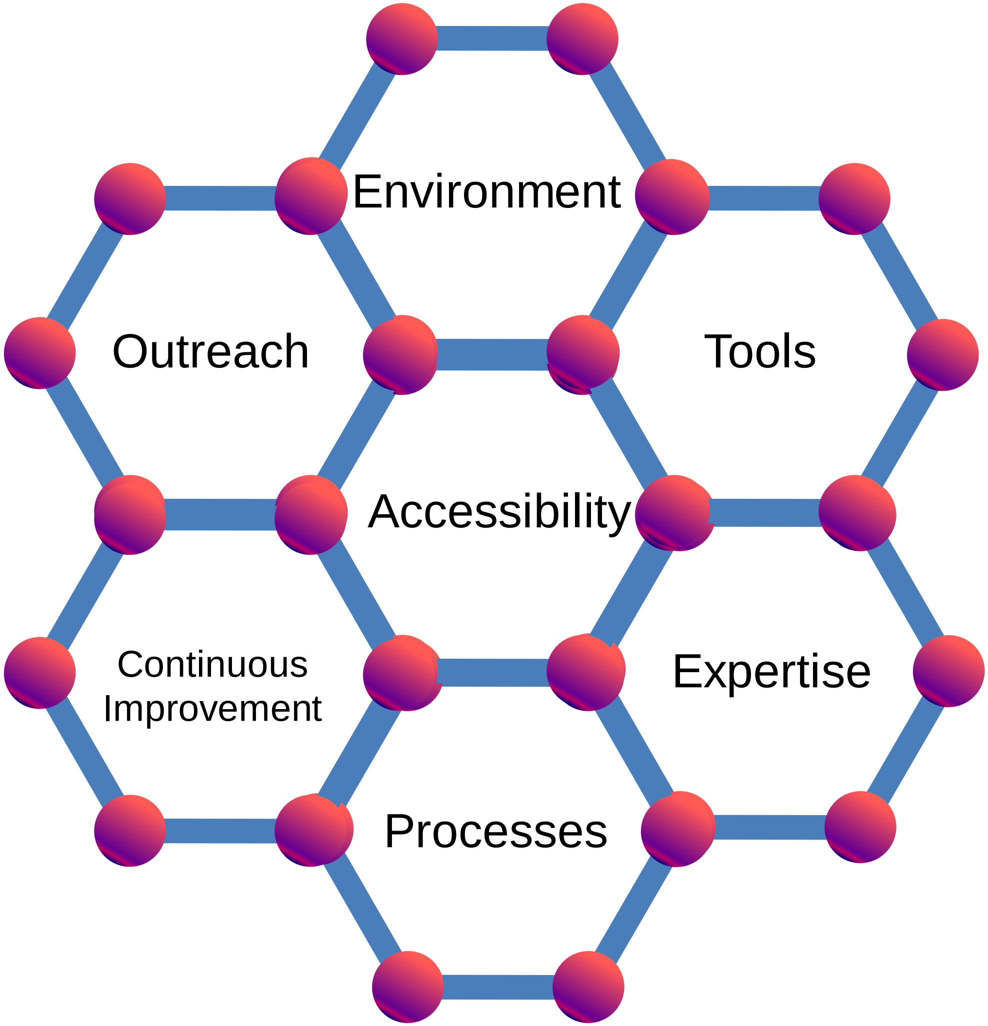


# NanoFab Operation Outreach

## Making Our Presence Known is Key to our Success

- Increased Presence at Conferences/Trade Shows
- 2 Open houses planned for Q3 and Q4
- Nanofabrication Workshop in Q3
- Working with Local Tech Councils and Users Groups
- Aggressive outreach within NIST
- New Database being developed to track and maintain growth

# NanoFab Summary


Environment
Outreach
Tools
Accessibility
Continuous Improvement
Expertise
Processes

## Helping the US Make Measured Progress in Nanotechnology