Research Triangle Nanotechnology Network: Convergence Nanotechnology Hub

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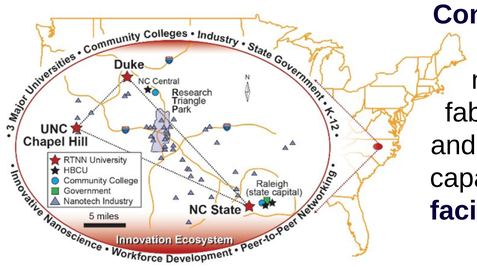
Overview



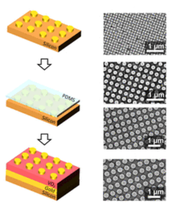
Convergence nanotechnology hub for transformative nanotechnology research, fabrication, commercialization, and education that leverages the capabilities and expertise of **user facilities** at research universities in the Research Triangle.

Core Strengths

- **Turn-key and dynamic facilities**
  - >65 new/upgraded tools introduced into facilities since 2016 (>$20M value)
- **Unique capabilities**
  - Bio-processing bays, plasma focused ion beam microscopy, hot embosser, X-ray and neutron imaging, bio- and cryo-electron microscopy, *in situ* microscopy and diffraction
- **Well-supported faculty research in nanotechnology**
- **Large non-traditional, multidisciplinary user community**
- **Well-established user base in traditional technologies**
- **Expertise in emerging needs and capabilities**
  - Non-traditional characterization and fabrication (e.g. soft, bio-based, and flexible materials)
- **Capacity for technology transfer**
  - Research Triangle Park, NC State's Centennial Campus
- **Quantitative social science research**

Research Focus Areas Linked to NSF Big Ideas

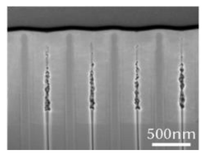
- **Low Dimension and Layered Nanomaterials**
- **Materials for Energy Efficiency and Sustainability**
- **Nanomaterials for Biology, Medicine and Environmental Assessment**
- **Advanced Materials and Interfaces**

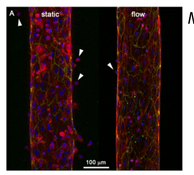


Actively Tunable Metasurfaces via Plasmonic Nanogap Cavities with sub-10 nm VO_2 Films[1]

Quantum Leap

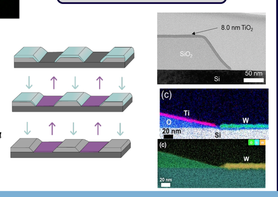
Hafnia-Filled Photonic Crystal Emitters for Mesoscale Thermo-photovoltaic Generators[2]





Microfluidic Model of Monocyte Extravasation Reveals the Role of Hemodynamics in Regulating Endothelial Integrity[3]

Rules of Life



Multimaterial Self-Aligned Nanopatterning by Simultaneous Adjacent Thin Film Deposition and Etching[4]

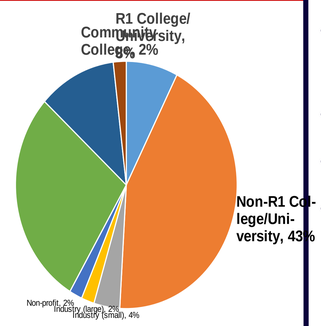
Building the User Base

Kickstarter Program

- Provide *free* access to facilities to new, non-traditional users
- **87 projects (>1,300 hours of use)**
- **>40% of participants have returned to facilities with own financial support *(>$302,000 in facility fees)***

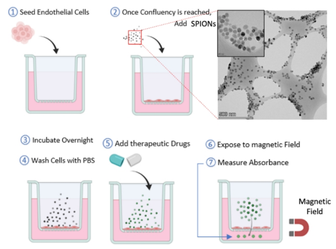
"…it really helped us move along in our research project."

"…the staff was very, very helpful."

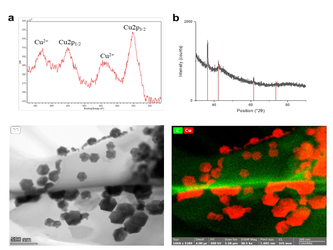


Affiliations of Kickstarter participants

Selected Participant Results



Magnetic control of the endothelium permeability and TEM Imaging of nanoparticles



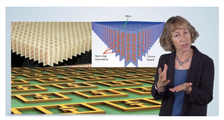
Sensors based on a Carbon-Copper Composite for the Detection of Glyphosate

Nanotechnology: A Maker's Course

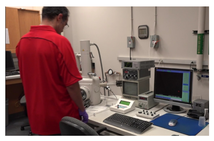
- **M**assive **O**pen **O**nline **C**ourse (hosted on Coursera)
- Educational foundation in nano-fabrication and characterization
- Demonstrations of state of the art equipment
- **Since September 2017 launch:**
  - >261,100 visitors; >32,800 enrolled
  - High satisfaction, e.g. course materials rated 6.4 on a scale with 7 being the highest
  - > 90% of respondents "likely" or "very likely" to recommend course

"Gracias…me divertí mucho en este curso y definitivamente con mas ganas de seguir aprendiendo."

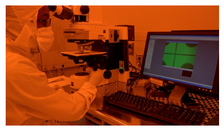
www.coursera.org/learn/nanotechnology



Lecture on nanofabrication



Demo of energy-dispersive X-ray spectroscopy

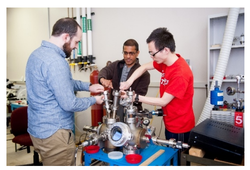


Photolithography demo in the clean room

Technical workshops and short courses

- Exposure to cutting-edge equipment and techniques
- Hands-on learning experiences prepare participants for use
- **2021-2022: >10 events, >115 participants**

Workshop attendees analyzing samples using Raman spectroscopy

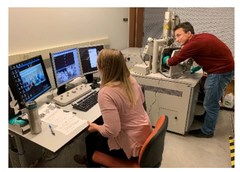


Participants working on a vacuum system

Community college educators gowned for clean room entry

Community Engagement

- **Immersive lab experiences**
- **Remote connections to instruments, students, and staff in the facilities**
- **Classroom visits with portable SEM**
- **Partnerships with Girl Scouts, museums, and libraries**
- **NanoDays: lab tours, demos, and hands-on activities**



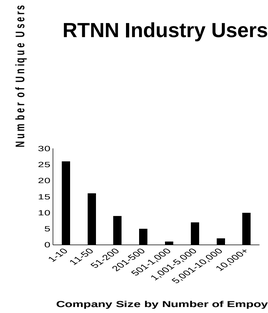
Remote SEM session with 5th grade classroom

Girl Scouts STEM Day @ Duke

Visitors examine samples with light and electron microscopes during Nanomonth at the Museum of Life and Science

Impact

- **User base**
  - >1,000 users and >50,000 hours of collective use annually
- **Research projects with diverse funding sources**
- **Industry**
  - Invaluable resource to small companies
- **Publications:** >210 peer-reviewed publications *(2021)*
- **Patents:** >30 awarded, >50 filed (2021)
- **NNCI network activities**
  - Leadership of NNCI subcommittees/working groups, multi-site proposals
- **Engagement**
  - > 1,200 people reached so far in Year 7
  - > 60% participation by girls and underrepresented minorities in STEM *(NSF INCLUDES)*

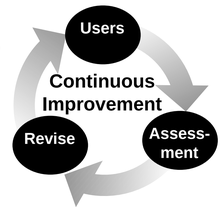


Societal Implications of Nanotechnology

Goals: Leverage the RTNN team and user base to:

1) enhance the instruction and understanding of how humans engage with nanotechnology *(Future of Work)*,
2) study governance involving multiple stakeholder groups

- **Deep assessment**
  - Quantitative evaluation of programs **drives change**
- **Nanotechnology resources for the public**
  - New **social media programs** to study how social networks influence **nanotechnologists' decision making**
  - **Clearinghouse** of crowd-sourced nanotechnology information



@RTNNsocial

References: *1. Boyce et al. In Press at Nano Letters (2022); 2. Sakakibara et al Solar Energy Materials and Solar Cells 238 (2022); 3. Perez-Rodriguez et al. Biomicrofluidics 15 (2021); 4. Song et al. ACS Nano 15 (2021)*