

www.nano4me.org

Today's Presenter

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NACK National Network
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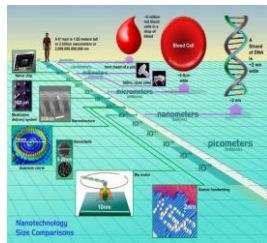


www.nano4me.org



Nanotechnology!

- What is it? What do you know about it?
- Broad term, referring to the manipulation of matter at the atomic level.
- Encompasses many scientific disciplines.
- Impacts daily life and our future greatly.



Diverse Applications

Movie



Cancer: Detection/ Treatment

Textiles



Copying Nature (Biomimetics)



Energy

Household



Clean Water

Nanotechnology is:

the creation of **functional** materials, devices, and systems through **control of matter** at the scale of **1 to 100 nanometers**, and the exploitation of novel properties and phenomena at the same scale.



National Nanotechnology Initiative

NNI Vision

A future in which the ability to understand and control matter at the nanoscale leads to a **revolution in technology and industry that benefits society**.



National Nanotechnology Initiative

A New Industrial Sector



An NSF study said 6 million nanotechnology workers will be needed worldwide by 2020, with **2 million of those in the US**.

- There are more than **70 nano-specific degree programs** in higher education institutions across the U.S.

- Many of these jobs can be filled by workers with **2-year degrees**
- There are currently at least 2 dozen Associate's Degree programs in the US, with **new programs launching every semester**



National Nanotechnology Initiative

NNI Strategic Plan: Organizing the Innovation Pipeline

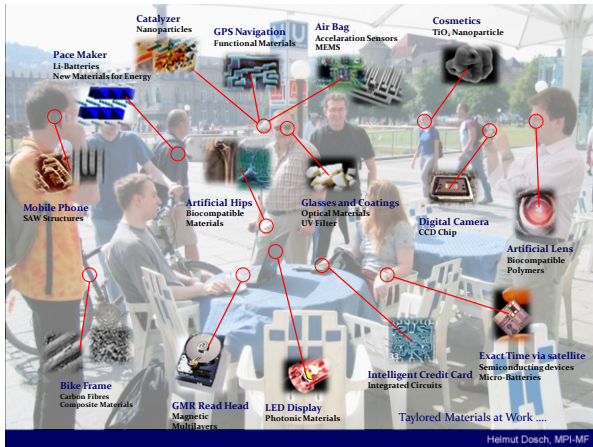
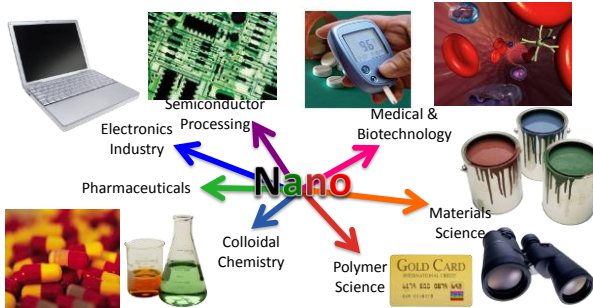
Goals

- Advance world-class nanotechnology research and development
- Foster the transfer of new technologies into products for commercial and public benefit
- **Develop and sustain educational resources, a skilled workforce,** and the supporting infrastructure and tools to advance nanotechnology
- Support responsible development of nanotechnology



So..where is nanotechnology used today?

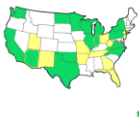
Because nanotechnology's unique phenomena are **based on size** it is studied and implemented in a **broad range of scientific fields and industries.**





What is NACK?


The Mission of NACK is to enable Nanotechnology Education at:



- 2-year Community & Technical Colleges
- 4-year Universities and Colleges in Partnership with Community & Technical Colleges



NACK's Approach

- Build Partnerships 
- Educate for a Wide Spectrum of Industries 
- Broad Foundational Nano Education 
- Enable CC/TC Delivery in Entire US 



Remote Access & Control

From our labs...



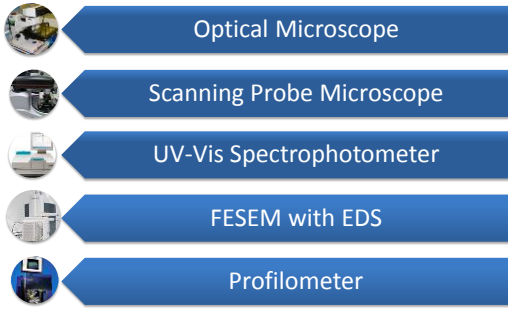
...to any classroom



REMOTE ACCESS

- Bringing nano-scale characterization and the experience of practitioners into your classroom via audio and video immersion
- Learning the background and scientific fundamentals of tools, processes, and their application
- Performing relevant hands-on lab activities with instant qualitative outcomes and quantitative observations done remotely

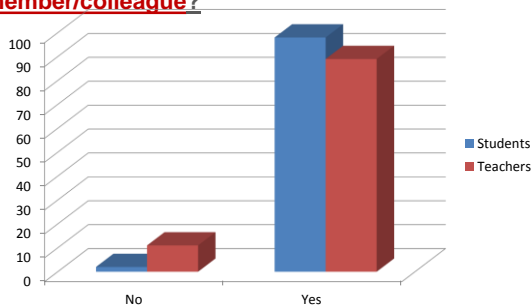
What Tools Are Available?



Remote Access can be utilized

- For an Outreach Experience
- For Workshop Demonstrations
- For Class Demonstrations
- To Supplement the Equipment at your Institution
- For “Hands-On” Access by your students in your laboratory experiences

Would you recommend this type of activity to another teacher/classmate , faculty member/colleague?



Let's Try It !!!!



From our lab...

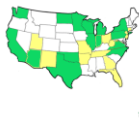
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PCAST Report (April, 2012, page 12)



REPORT TO THE PRESIDENT AND CONGRESS ON THE FOURTH ASSESSMENT OF THE NATIONAL NANOTECHNOLOGY INITIATIVE

Workforce Development

With the support of the NSF's Advanced Technology Education (ATE) program, Penn State has developed a nationwide partnership of research universities and community colleges that is bringing meaningful core-skills nanotechnology workforce education to technical and community colleges across the United States. This partnership, the NSF National Nanotechnology Applications and Career Knowledge (NACK) Network, fosters (1) resource sharing among community colleges and research universities for nanotechnology workforce development, (2) the availability of course materials, for web- or in-class use, covering a core set of industry-recommended nanotechnology skills and (3) broad student preparation for careers in the wide spectrum of industries utilizing micro- or nanotechnology. NACK has created and offers continually updated, free-of-charge core-skills course lecture and lab materials, web-accessible equipment capability, and faculty-development workshop curricula. Since the inception of the nationwide effort in 2008, NACK research university-community college partnership hubs have been set-up and are functioning in Puerto Rico, New York, Indiana, Minnesota, Texas, and Washington State. Others are under way and there are in addition to the hub comprised of 30 Pennsylvania schools and funded by the State of Pennsylvania since 1998. To date, there have been over 800 graduates from the nanotechnology core-skill classes offered by the NACK hubs, 20,881 web-downloads of NACK educational materials, and 97 educators who have completed professional development workshops. The Penn State nanotechnology workforce development program began as a Pennsylvania-focused activity with the founding of Pennsylvania Nanofabrication Manufacturing Technology (NMT) Partnership funded by the State in 1998. In 2003 the additional component of an NSF ATE regional center for nanotechnology workforce education was added. In 2008 this NSF ATE activity evolved into the NACK Network nationwide workforce development partnership. By creating education pathways from high school to skilled manufacturing careers across the country, the NACK Network is working to train the U.S. nanotechnology manufacturing workforce.

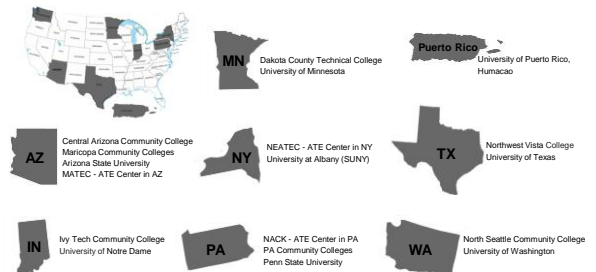


"With the support of the NSF ATE program, Penn State has developed a nationwide partnership of research universities and community colleges that is bringing meaningful core-skills nanotechnology workforce education to technical and community colleges across the United States....."

NACK Network

Nanotechnology Education Hub Areas

A working, productive nanotechnology workforce development network involving research universities and community and technical colleges across the U.S.



www.nano4me.org

NACK Courses — “Physical” offering at University Park

- This suite of six courses is taught twice/year – as a **service** by Penn State – for PA 2-year and 4-year degree-granting institutions
- Credits come from “home” school
- Taken to-date at University Park by 774 students from community colleges, colleges, and universities.
- Central Facility Model—i.e., facility for a region



What is the PA NMT Partnership



Capstone Semester = 18 credit hands-on immersion experience offered at Penn State for all PA partner schools

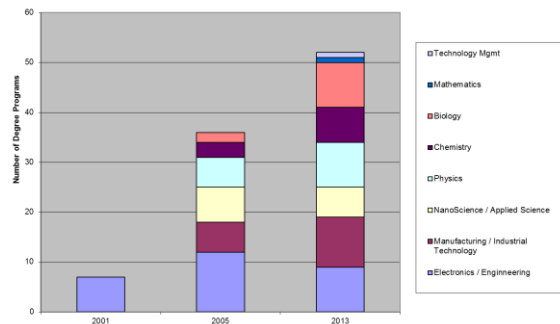


National Advisory Council

- Alcatel-Lucent
- Bio-Link Center
- Boeing
- Corning
- Cyoptics
- Dupont
- General Electric
- Imerys
- Information & Communications Technology Center
- Johnson & Johnson
- Lockheed Martin
- 3M
- National Council for Advanced Manufacturing
- National Coalition for Advanced Technology Centers
- Northrop Grumman
- PPG
- Plextronics
- Semiconductor Research Corporation
- Strategic Polymers
- Stryker
- Tyco
- University of Minnesota

As of May 2013

Diversity & Growth of Disciplines of PA Degree Programs in Nanotechnology



What approach is taken?

A General Approach to Nanotechnology/Nanofabrication with the Objectives of:

- 1) Providing a solid, broad information base that an individual can build upon; and
- 2) Creating a versatile nanotechnology workforce that can move from industry to industry with the ebb and flow of international market forces

Summary of Skill Sets Taught in the 6 Nanotechnology Courses

- Basic Nanotechnology EHS Awareness**
 - Basics of Chemical and Material Properties—Role of Scale
 - Chemical and Materials Handling, Storage, and Disposal
 - Nanotechnology Health, Safety, and Environmental issues
- Nanotechnology Equipment and Processing Foundation Skills**
 - Chemical Hoods and Glove Boxes: Use and Maintenance
 - Cleanrooms: Use and Maintenance
 - Pumps, Flow Control Systems, Scrubbers, Sensors: Use and Maintenance
 - Vacuum Systems: Use and Maintenance
 - Plasma Generating Systems: Use and Maintenance
 - Furnaces, Ovens, and Rapid Thermal Annealing Equipment: Use and Maintenance
 - Chemical Facilities and Maintenance
 - Contamination Control
 - Process Integration
 - Introduction to Statistical Process Control
- Nanotechnology Patterning**
 - Optical, e-beam, and Ion Beam Lithography
 - Stamping and Imprinting Lithography
 - Chemical techniques; e.g., Block co-polymer and SAMs
- Nanotechnology Fabrication**
 - Top-down Fabrication
 - Reactive Ion, Sputter, and Wet Etching
 - Chemical Vapor and Physical Vapor Deposition Systems
 - Ion Beam, Plasma, and Chemical Materials Modification
 - Nanoparticles: Etching and Grinding Approaches
 - Bottom-up Fabrication
 - Chemical, Physical, and Biological Self-Assembly
 - Nanoparticles: Colloidal Chemistry
 - Nanoparticles: Plasma Approaches
 - Nanoparticles: Chemical Vapor Deposition Approaches
- Nanotechnology Characterization**
 - Optical Microscopy
 - Scanning Probe Microscopy
 - Atomic Force Microscopy
 - Electron Microscopy
 - Scanning Electron Microscopy (SEM and FE-SEM)
 - Transmission Electron Microscopy (TEM and FE-TEM)
 - Chemical Characterization
 - X-ray (EDS)
 - Secondary Ion Mass Spectroscopy
 - Auger Electron Spectroscopy
 - Fourier Transform Infrared Spectroscopy
 - Electrical Characterization
 - Current-Voltage Measurements
 - Capacitance Measurements
 - Opto-electronic Device Measurements
 - Physical Characterization
 - Spectrophotometer
 - Profilometer
 - X-ray Diffraction
- Nanotechnology Professional Skills**
 - Team Building
 - Problem Solving
 - Project Organization and Planning
 - Research Skills
 - Assessing Cost of Ownership
 - Presentation Skills
 - Technical Reporting and Documentation
 - Handling and Generating Intellectual Property

The suite of 6 Courses

- E SC 211 Material, Safety and Equipment Overview for Nanotechnology
- E SC 212 Basic Nanotechnology Processes
- E SC 213 Materials in Nanotechnology
- E SC 214 Patterning for Nanotechnology
- E SC 215 Materials Modification for Nanotechnology Applications
- E SC 216 Characterization, Testing of Nanotechnology Structures and Materials

Institutions That Have Hired Capstone Semester Graduates for Micro- and Nanotechnology Jobs

- | | | |
|--|---|---|
| <ul style="list-style-type: none"> 3M Corporation Accellent Adhesives Research, Inc Advanced Acoustic Concepts Advanced Coating Technologies Advanced Gas Technologies Advanced Powder Products Advancedtech AGAM Agema Alcan Allied Electronics Alkerm Products AMAX Minerals Ametek Amgen, Inc. Alpigen Products Arvin International Arval Technologies Biochips, Inc. B. Braun Boston Applied Technologies BD (Electron, Division) BP Solar Bridge Semiconductor Bush Vacuum Cabot Cadtek Microelectronics Carbon NanoProbes Cingone (Subsidiary) Chemicut Compass Sensors Cosmos Technologies Crysalis Cytoskin Dandamon ORL Laurel Technologies Dana Corporation Doucette Dorr's Salabs Dow Chemical Drexel University Espinas Chemical Company Epi Penn Manufacturing Et. One Fatchild Semiconductor Ficon Automation | <ul style="list-style-type: none"> First Energy F.S. Elliot General Dynamics Robotic System General Electric Glass w/semicon GlassMittikline Globaflex/andras GTS Helixus Nightlight Hale Products HealtheyMedical Center Hummer Infinera Innovative Micro Technology Intel Corporation INDEX ICE Johnson & Johnson Johnson Matthey Judson Technologies Keystone Communications Keystone Engineering Keystone Research & Pharmaceuticals Konigshof Defense Kurt J. Lesker Krytox America LCM Technologies Lighthouse Electronics Lockheed Martin Lucent Technologies Lutron Electronics Maxima Technologies Max Levy Autograph Maximale Bunk Products Membrane Assets Merck Minerva Corporation Nanotronics Natural Nano, Inc North American Hologas North Carolina State University Northrup Grumman, Inc OptiFlow Optical Systems P2 Penn State CNU | <ul style="list-style-type: none"> Penn State Dubois Penn State Applied Research Lab Penn State Electro-Optics Center Pfizer Energy Philips Medical Systems Philips Resonance Electronics Procter Unlimited Process PPG PSI Qor-Tek Sartek Rhotech Solum and Intra Russ Technologies ATI Schneider Industries Scientific Systems Singtel Technologies Siemens Co. SI International Slack Pk Solar Innovations Solarty Spectrum Technologies Strateme Strategic Polymers Structure Probes Inc. Syntex Teknor Tecton Imaging Thermo Electric PA Titanium Tyco Electronics US Air Force University of Optoelectronics University of Florida University of North Carolina - Charlotte University of Pittsburgh Vector International Velux Semiconductor Western Digital Westala Technologies Westwood/Mech. Testing & Research Xactix |
|--|---|---|



Job Titles for Nanotechnology Graduates

Nano in the Title ... Maybe Not??

Biological Laboratory Tech.	Laboratory Tech.	Production Scientist
Biofuels Tech.	Lithography Tech.	Quality Control Tech.
Chemical Laboratory Tech.	Materials Science Lab Tech.	Research Assistant
Cleanroom Tech.	Medical Devices Tech.	SEM Operator
Deposition Tech.	Microfabrication Tech.	SPM Operator
Device Tech.	Nanobiotech Researcher	Scientist Specialist
Equipment Maintenance Tech.	Nanoelectronics Expert	Solid State Tech.
Engineering Tech.	Nanofabrication Tech.	Test Tech.
Etch Tech.	Nanotechnologist	Thin Films Tech.
Failure Analysis Tech.	Process Tech.	Vacuum Tech.

Source - NACK Alumni Committee

Survey of PA NMT Capstone Graduates

(Completed March, 2011)

Some Survey Findings:

- When they completed the nanotechnology 6 course suite, 59% were enrolled in a 2-year associate's degree program and 41% in a baccalaureate program.
- 95% said it was a valuable education experience and 90% said it influenced their educational pathway
- At the time of the survey, **69% are employed in a nano field** & 65% said the capstone influenced their career pathway
- **95%** are currently either working or in a degree program full-time

What does industry say about PA NMT Grads?

- Cyoptics, Inc. (Breiningsville, PA):
 - ... relies heavily on PA NMT graduates to staff manufacturing operations.
 - “combination of nano-scale theoretical as well as hands-on training have in their educational toolbox enable them to “hit the ground running”, significantly reduce in house training time and enable them to be valuable long term contributors to bottom line company profitability.”

What does PA industry say?

Plextronics Testimonial



Robert J. Kumpf, Ph.D.

The Advantages of the Central Offering Model

- Resource sharing (Equipment and staff needed to support equipment only at one place)
- Expensive equipment dedicated only needed at one location
- Staff available at research university with awareness of, and giving attention to, health, safety, and environment issues



Some of the advantages to Community Colleges in partnering with research universities

- Not necessary to create new nano courses
- Course materials kept up-to-date by research university partners
- No need to invest in expensive equipment
- Staff for equipment support is not needed
- Able to offer nano program attractive to multiple disciplines
- Can create pathways for student articulation

Some advantages to a research university in partnering with local community colleges, colleges, and small universities

- Service to the State and community
- Supports local economic development
- Can build support for user facilities at research university (resource sharing)
- Graduate student support (need TAs)
- Post-doc support (need skilled teachers)
- Research support
- Pipeline of students from community colleges to 4-year degree programs and beyond



Overview of some NACK resources developed to-date



Want Some More Nano Overview Information?

Nano.gov
National Nanotechnology Initiative

Leading to a revolution in technology and industry that benefits society

Navigation: Home | Students | Alumni | Educators | Industry | About Us | Partners

Teacher Resources

Classroom Resources

- Journal: Career in Learning and Teaching (CILT) is dedicated to developing and offering nanotechnology-specific instructional modules, professional development, and a network of educator connections related to learning and teaching about the nanoscale. The website offers multiple resources across educational levels.
- Harvard Resource Portal at Northeastern University is a rich resource for nanotechnology curriculum development and lesson plans, as well as video simulations and links to games, research, awards, and news related to nanotechnology education.
- Materials: Recent studies offer the purchase of a series of interdisciplinary teaching modules assembled by Northeastern University on nanoparticles and materials topics—including composites, ceramics, concrete, biomaterials, biodegradable materials, smart sensors, polymers, fuel packaging, and space materials—will support a virtual community of middle schools. The modules are designed for use in middle and high school science, technology, and math classes; they have been used by more than 1,000 students in schools nationwide.

The Portal to NACK Resources

Nano4Me.org

For: Students, Alumni, Educators, Industry

NACK NETWORK
Building College-University Partnerships for Nanotechnology Workforce Development

Brought to you by the Nanotechnology Applications and Career Knowledge (NACK) Network

Navigation: Home | Students | Alumni | Educators | Industry | About Us | Partners

Access Nano4Me.org Tip: Access Nano4Me.org via the NACK Network

Students: Find a Nano Program, Find or Post a Job, Contact with Alumni

Alumni and Industry: Find or Post a Job, Contact with Alumni

Educator Resources: Find Educator Resources for Your High School or College Classroom, Remote Access: Connect, Share, and Bring Cutting-Edge Technology into Your Classroom

Sign Up: Browse, Login

Navigation: Home | Students | Alumni | Educators | Industry | About Us | Partners

NACK Educator Resources

- Post Secondary Resources
- Educator Workshops
- Webinars
- Remote Access to Tools
- K-12 Resources
- Interactive Multimedia

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Postsecondary Resources

K-12 Resources

Workshops

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Undergraduate Level Course Material for 6 NACK Courses

- Classroom presentation material
- Arranged in modular units
- Videotaped lectures are available
- Hands-on labs for the courses
- Matrix for each course

Brought to you by the Nanotechnology Applications and Career Knowledge (NACK) Network

Access NACK Resources | Nano4Me.org | Login | Join Now | Logout | Contact

Access NACK Resources

The NACK Center is committed to supporting the development of two-year degree programs in micro- and nanotechnology across the country by offering teaching resources suitable for the post-secondary level. NACK also provides materials for K-12 use. Click on a resource title below for more information.

AVAILABLE TEACHING RESOURCES
By accessing this material, you agree to the NACK Center's Terms of Use.

Post Secondary Resources

Undergraduate Level Modules: A series of thought-provoking nanotechnology PowerPoint presentations that with in-depth material surrounding various nanotechnology courses from which it is an extract. Free & practical, and what it can do.

Undergraduate Materials: Course to Course, Videos, and Assessment Tools: Packaged as six courses, each contains multiple modules and corresponding lab packages. All modules and labs can be rearranged to create new courses. Suitable for two-year degree programs, for certificate programs, and for freshman-experience use in four-year degree programs.

High School Level Research Academy Activities: A collection of informal activities created for a 1.5 day nanotechnology camp available to those interested in creating similar events on the regional or classroom experience.

High School Level Experiments: A collection of experiments and activities that introduce nanotechnology concepts and applications to high school students. Not all related to nanotechnology systems for fabrication, micro- and nanofabrication with common materials, micro- and nanomanipulation, and nanosensor applications.

Materials: A collection of interactive multimedia in nanotechnology. These resources are suitable for a variety of levels and subject areas.

Remote Access: Video learning modules and example lab experiments suitable for post-secondary and secondary classrooms. Please refer to our characterization equipment and bring cutting-edge technology into your classroom today.

K-12 Resources

Introduction Level Modules: A series of thought-provoking nanotechnology PowerPoint presentations that with in-depth material surrounding various nanotechnology courses from which it is an extract. Free & practical, and what it can do.

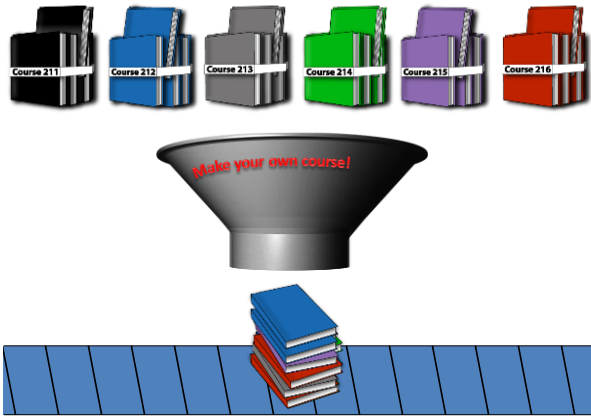
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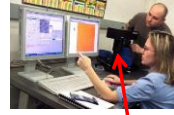
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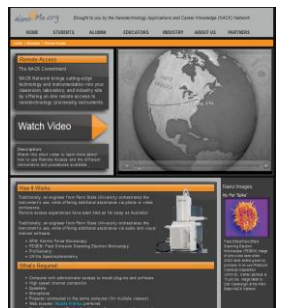


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A background image showing a group of diverse students, including a woman in a hijab, gathered around a laptop computer. They appear to be engaged in a learning activity, looking at the screen with interest.

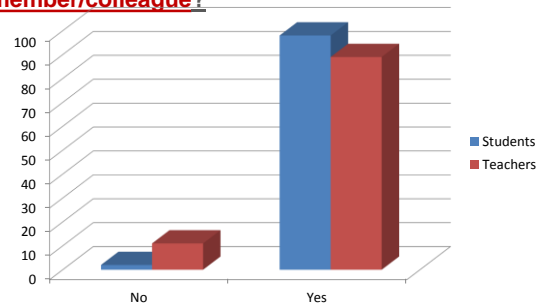
What Tools Are Available?

-  Optical Microscope
-  Scanning Probe Microscope
-  UV-Vis Spectrophotometer
-  FESEM with EDS
-  Profilometer

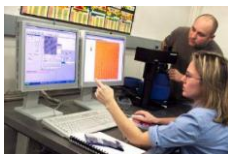
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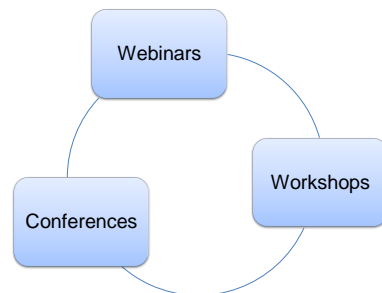


From our lab...

...to this room



Professional Development Opportunities





Workshops Available (for Educators and Administrators)

Two Types:

- *Introductory* Workshops – “Hands-On Nanofabrication Workshop”
- Workshops for Educators to *Learn how to Implement* NACK’s suite of 6 Courses



Educator Workshops

Attendees to Date

- 1143 Educators
- 36 States, DC, and Puerto Rico



2013 NACK Educator Workshop Schedule

- ~~May 7-9~~ & ~~Nov 12-14~~ Hands On – Intro Workshops
- ~~Apr 15-18~~ & ~~Sep 16-19~~ Nanotechnology Course Resources I
(Safety, Processing, & Materials)
- ~~Aug 12-15~~ & ~~Oct 7-10~~ Nanotechnology Course Resources II
(Patterning, Characterization & Applications)



NACK Webinars

- Live monthly webinars
 - hosted by MATEC NetWorks
- To engage and educate
- Last one September 27:
 - Fundamentals and Applications of Atomic Force Microscopy
 - 2013-2014 Webinar Schedule is Available



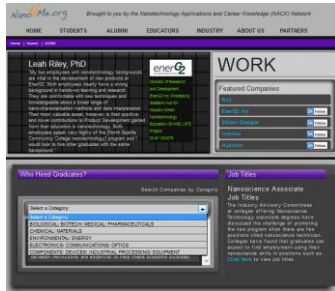
NACK Alumni Network

- To help graduates of nanotech degree programs enhance their professional opportunities, inform them of educational opportunities, and connect them with networking groups.
 - Provides online networking opportunities.
 - Access career resources
 - Connect s interested alumni and students in mentoring relationships.
 - Keeps alumni informed of current nanotechnology events and activities.
 - Shares alumni success stories



Companies Who Have Hired Graduates

Listing of companies arranged by industry sector that have hired program graduates of nanotech programs across the nation



Companies Who Have Hired Graduates

• An example company listing in one Industry Sector



Micro Nano Tech (MNT) 2014 Conference
Albuquerque, NM June 4-6

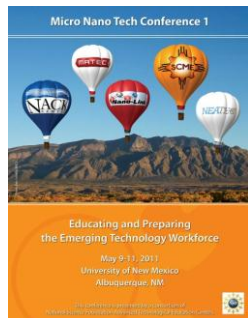
Taking MNT to New Heights

Produced by 6 ATE Centers

- MATEC – Arizona
- NACK – Pennsylvania
- Nano-Link – Minnesota
- NEATEC – New York
- SCME – New Mexico
- SHINE – Washington

Purpose:

Build and foster nanotechnology communities across the country



MNT Conference Goals

Participants will:

- Augment their existing MNT technical expertise and / or expand their expertise in related technologies
- Gain ideas for program development and improvement and access and apply nationally developed resource materials
- Apply an understanding of workplace knowledge, skills, and abilities requirements' in education programs
- Recognize leaders in their efforts to promote students success and workforce development

Introductory Level Modules

- series of thought-provoking nanotechnology presentations
 - in-depth material for students and workers of all knowledge levels.
- designed to be used in workshops, courses, and overview lectures
 - introduce nanotechnology and its applications.
- can be integrated into secondary and post-secondary curriculum as well as for nanotechnology outreach



Unit	Download Modules
<p>Module 1: Nanotechnology: What is it, and Why is it So "Hot" Now?</p> <p>Objective: This module gives an overview of nanotechnology, and the most "nanotechnology" items are shown. It also explains the differences between the nanoscale, microscale, and macroscale. Finally, the module explains how all nanotechnology is a nanotechnology and not a nanotechnology.</p> <p>NOTE: It is recommended that you download the supplemental materials along with this module to find the links to the multimedia files in the PowerPoint for lecture. If you have any issues with the links to the multimedia files, please contact us.</p>	<p>Module 1</p> <p>Supplemental Materials</p>
<p>Module 2: A Brief History of Nanotechnology</p> <p>Objective: This module explores the history of nanotechnology, from human using gold and silver nanoparticles in their glass over 2000 years ago to modern day ultra nanotechnology and biology and its treatment.</p>	<p>Module 2</p>
<p>Module 3: A Snapshot of Nanotechnology Today</p> <p>Objective: This module gives an overview of nanotechnology today including the current state of nanotechnology, medical devices, and some examples of nanotechnology being used to solve the global energy crisis.</p> <p>Module 3: The Importance of the Nanoscale</p> <p>Objective: This module shows the critical attributes of the nanoscale and some examples of those critical attributes, mostly at the atomic, high surface to volume ratio, quantum effects, and some examples of ultra nanotechnology.</p>	<p>Module 3</p> <p>Module 4</p>
<p>Module 4: How Do We "See" Things at the Nano-scale: An Introduction to Characterization Techniques</p> <p>Objective: This module provides an introduction to characterization techniques including Scanning Electron Microscopy, X-ray Diffraction, Atomic Force Microscopy, and Spectroscopy.</p> <p>Supplemental Materials</p> <p>NOTE: It is recommended that you download the supplemental materials along with the module to find the links to the multimedia files in the PowerPoint for lecture. If you have any issues with the links to the multimedia files, please contact us.</p>	<p>Module 4</p> <p>Supplemental Materials</p>
<p>Module 5: How Do We Make Things So Small: An Introduction to Nanofabrication</p> <p>Objective: This module provides an introduction to nanofabrication techniques including top-down and bottom-up nanofabrication, and some examples of nanofabrication being used to solve the global energy crisis.</p> <p>Supplemental Materials</p> <p>NOTE: It is recommended that you download the supplemental materials along with the module to find the links to the multimedia files in the PowerPoint for lecture. If you have any issues with the links to the multimedia files, please contact us.</p>	<p>Module 5</p> <p>Supplemental Materials</p>



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Bringing Nanotechnology to Education & Industry!
www.nano4me.org

Supplemental Material

Some Resources for You

Need Helpful Web Resources?

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<http://www.nanotechproject.org/inventories/consumer/>
 (included in handout)

Some Videos on Nano-Applications:

- NOVA Making Stuff Series (2011):
 - Making Stuff: Stronger
 - Making Stuff: Smaller
 - Making Stuff: Cleaner
 - Making Stuff: Smarter
- Each is one hour long



<http://www.pbs.org/wgbh/nova/tech/making-stuff.html>

(included in handout)

Some Local PA Applications:

- Nano in the Bathroom.... Really???
- Never Wet Coatings
- Nano Filtration
- Nano Silver
- Safer More Effective Drug Delivery

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- Nano-Link: <http://www.nano-link.org/>
- NNIN.org education portal – RET lessons and more: http://www.nnin.org/nnin_k12teachers.html
- Mid-continent Research for Education and Learning McREL: <http://www.mcrel.org/NanoLeap/>
- SCME: http://scme-nm.net/scme_2009/index.php?option=com_docman&Itemid=53
- NCLT - Materials World Modules: <http://www.materialsworldmodules.org/>
- University of Wisconsin – Madison – MRSEC: <http://mrsec.wisc.edu/Edetc/modules/index.html>
- NanoHUB: <http://nanohub.org/education/nanocurriculum/>
- Molecular Workbench – <http://mw.concord.org/modeler/>
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Physical Science
Investigating Basic Forces to Explain The Mystery of the Gecko

Lesson 1 Lesson 2
Lesson 3 Lesson 4
Lesson 5 Lesson 6

Physical Science-Benchmark Experiments (PSE 1-6)
Physical Science Teacher Toolkit (PST 1-6)

Physical Science-Benchmark Experiments (PSE 1-6)

Lesson 1: How Can a Gecko Walk on the Ceiling?

Students will:
• Formulate and test a hypothesis about the forces that keep a gecko on a wall.
• Identify the forces that keep a gecko on a wall.
• Explain the importance of surface area and adhesion in the gecko's ability to walk on a wall.

Lesson 2: What Do the Holes Within We Speak About?

Students will:
• Explain the structure of carbon and how it is used in different forms.
• Identify the different types of carbon and their uses.

Chemistry
Nanoscience Materials and Their Properties

Unit 1 Pre-Test
Unit 2 Pre-Test

Unit 1: What is Nanoscience?

Students will:
• Explain the importance of nanoscience research and technology in their lives.
• Identify the importance of nanoscience research and technology in their lives.

Unit 2: What is Nanoscience?

Students will:
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NNIN Education Portal

Nanotechnology Education Network

Nanotechnology

Learn all about the world's most exciting technology. Discover the latest in nanotechnology education and research.

Featured NNIN Education Topics

Additional topics available upon completion of NNIN.

Nanotechnology Education

Nanotechnology Education

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SCME-NM.ORG

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Some of the advantages to Community Colleges in partnering with research universities

- Not necessary to create new nano courses
- Course materials kept up-to-date by research university partners
- No need to invest in expensive equipment
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- Nano Filtration
<http://www.prweb.com/releases/OKOfilteredwaterbottle/01/prweb9100258.htm>
[You can buy these on Amazon!](#) - I Have!
- Nano Silver
<http://www.smartsilver.com/>
<http://www.youtube.com/watch?v=apFYwC-fx00>
- Safer More Effective Drug Delivery
<http://www.keystonenano.com/>
<http://www.youtube.com/watch?v=OG7dMUE0rI>

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Module Completion - Lessons 1-6
Physical Science-Benchmark Experiments (PSE 1-6)
Physical Science Teacher Toolkit (PST 1-6)

Produce
The benchmark project represents an approach for teachers to introduce the study of forces to students in a way that is both engaging and meaningful. The module is designed to be used in conjunction with the Physical Science-Benchmark Experiments, 1-6, the Student Journal (PST 1-6), and the Student Journal (PST 1-6).

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Students will:
• Explain the structure and composition of the gecko's feet.
• Test materials with various adhesives.
• Develop a list of materials that might be used to create a gecko's adhesive.
• Develop a list of materials that might be used to create a gecko's adhesive.
• Develop a list of materials that might be used to create a gecko's adhesive.

Lesson 2: What Do the Holes Within the Gecko's Feet Have to Do with It?
Students will:
• Explain the structure and composition of the gecko's feet.
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Chemistry
Nanomaterials and Their Properties

Unit 1 Unit 2
Unit 3 Unit 4

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Lesson 1: What is a Nanomaterial?
• Teacher Journal (PST 1-6)
• Student Journal (PST 1-6)
• Student Journal (PST 1-6)
• Student Journal (PST 1-6)
• Student Journal (PST 1-6)

Lesson 2: How are Nanomaterials Different?
• Teacher Journal (PST 1-6)
• Student Journal (PST 1-6)
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Nanotechnology Process
Nanotechnology Process (PST 1-6)

Nanotechnology Careers
Nanotechnology Careers (PST 1-6)

Nanotechnology Experiments
Nanotechnology Experiments (PST 1-6)

Nanotechnology Materials
Nanotechnology Materials (PST 1-6)

Nanotechnology Applications
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