

Center for Nanotechnology Education and Utilization
The Pennsylvania State University
University Park, PA 16802
www.nano4me.org

Take Matter

Into Your Own Hands

Start changing your world.
Experience the
Penn State NMT Capstone Semester.
Take the first step
by visiting www.nano4me.org.

**The Capstone Semester:
Your Pathway to a Career in Nanotechnology**

NMT Partners

Pennsylvania Commission for Community Colleges
The Pennsylvania State System of Higher Education
Pennsylvania College of Technology
The Pennsylvania State University
The Pennsylvania Dept. of Community and Economic Development
The National Science Foundation
The Pennsylvania Campuses of the Allegany College of Maryland

The NMT Partnership is supported by the National Science Foundation and the Pennsylvania Department of Community and Economic Development.



The Pennsylvania State University is committed to the policy that all persons shall have equal access to programs, facilities, admission and employment without regard to personal characteristics not related to ability, performance or qualifications as determined by University policy or by state or federal authorities. It is the policy of the University to maintain an academic work environment free of discrimination and harassment against any person because of age, ancestry, color, disability or handicap, national origin, race, religious creed, sex, sexual orientation or veteran status. Discrimination or harassment against faculty, staff or students will not be tolerated at The Pennsylvania State University. Direct all inquiries regarding the nondiscrimination policy to the Affirmative Action Director, The Pennsylvania State University, 328 Boucke Building, University Park, PA 16802-5901; Tel 814-865-4700/V. 814.863-1150/TTY

Produced by the Penn State Department of University Publications
U. Ed. ENG 09-05

The Pennsylvania Nanofabrication Manufacturing Technology (NMT) Partnership



The National Science Foundation estimates that 2 million skilled nanotechnology workers will be needed worldwide by 2015, 1 million of them in the U.S.



The Capstone Semester at Penn State's Center for Nanotechnology Education and Utilization (CNEU) prepares you for an exciting lifetime career by giving you the opportunity to attend classes at one of the nation's leading research centers.

The Penn State NMT Capstone Experience... It will change your world!



The Penn State NMT Capstone Semester is a broad education experience in nanotechnology aimed not at preparing students for an industry, but for a lifetime career in nanotechnology.

- The Capstone Semester is available to all students within the Pennsylvania Nanofabrication Manufacturing Technology (NMT) partner college and university network across the state.
- Attending the Capstone Semester gives students the opportunity to spend one semester on Penn State's main campus, one of the nation's leading research universities.
- Students receive hands-on training with the latest nanotechnology fabrication and characterization equipment.
- For Pennsylvanians attending the Capstone Semester, the students pay tuition to their home institution while room and board costs are covered by a state grant administered by the CNEU.
- The Capstone Semester is an integral part of certificate, two-year and four-year degree programs at partner institutions across Pennsylvania.
- Upon completion of the Capstone Semester, students enjoy exclusive access to a powerful job network, receiving industry announcements and job postings, even if they are continuing with their education.

What is Nanotechnology?
Nanotechnology gives us the ability to see and manipulate matter atom by atom, to create materials, devices and systems with new and unique properties.

NANO FACT

Two-year degree graduates who have taken the Capstone Semester can look for starting salaries up to \$35,000 - \$55,000 per year in almost any industry.

"They let you learn by doing, which is just fantastic. It is a really different environment than I have ever been in."

— Michael Denny, Jr., Capstone Graduate



Out of the Lab, into Your Life

The Pennsylvania Nanofabrication Manufacturing Technology (NMT) Partnership is at the forefront of an exciting and innovative nanotechnology training initiative. The NMT Capstone Semester is the defining feature of this partnership.

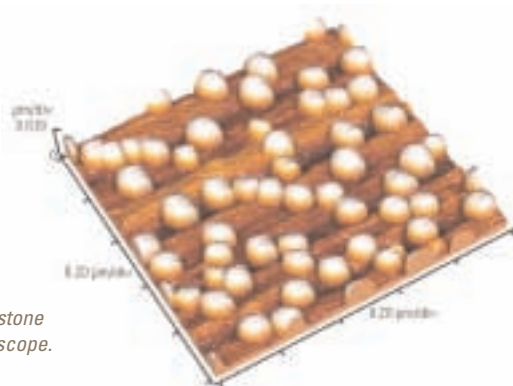
The objective of this unique collaboration is to equip a new generation workforce with nanotechnology-based manufacturing and new product development skills that companies need to move life-changing nano-scale applications out of the laboratory and into the marketplace.

Credits for Your Career Path

The 18 credits earned in the six-course Capstone Semester apply to every student's career path. The Capstone Semester is an integral part of either two-year associate or four-year baccalaureate degree programs at NMT partner institutions across Pennsylvania. When taken as a two-year degree, the 18 credits you earn in your Capstone Semester can later be transferred into select four-year degree programs across Pennsylvania.

Free Room and Board for Pennsylvanians

While attending the Capstone Semester, Pennsylvanians' room and board is covered by a state grant administered by the CNEU. Pennsylvanians simply pay the tuition for the Capstone Semester credits to their home NMT partner institution according to its current tuition schedule.



Silver nanoparticles characterized by NMT Capstone Semester students using an atomic force microscope.



Nanotechnology Degree and Certification Programs

All students enrolled in qualifying associate degree, baccalaureate degree and certification programs at their NMT partner institutions are eligible for the Capstone Semester in nanotechnology at Penn State's University Park campus.

What you'll need to attend the Capstone Semester:

- The recommendation from your home college or university
- An introductory understanding of chemistry and physics
- Proficiency in college-level algebra
- College-level writing skills
- Computer skills
- Good interpersonal skills

The path you take could change the world.

Nanotechnology is driving an advanced manufacturing and new product development revolution that's changing the way we live and learn on our planet — and the way we may solve some of our biggest challenges.

Nanotechnology can:

- Create functionalized nanoparticles for targeted drug delivery
- Develop nanoparticles for fluorescence imaging of tumors
- Produce cleaner, more affordable energy
- Detect and clean up hazardous chemicals in the environment
- Enable medical devices that can eliminate the need for surgery
- Give antibacterial properties to cell phones, refrigerators and toys
- Produce odor-free shoes, socks and clothing
- Make sunscreen and cosmetics more effective
- Ensure that food stays fresher longer
- Create smaller and faster electronic components



Group Dynamic

As a NMT Capstone Semester student, you'll receive the most current, hands-on exposure available in nanofabrication manufacturing and characterization technology.

You'll work in groups with other students from different schools and diverse backgrounds, enhancing each other's experience as you learn a new skill set that makes you uniquely qualified to work in the cross disciplinary field of nanotechnology.

The skill set, established by the NMT Industrial Advisory Board, includes:

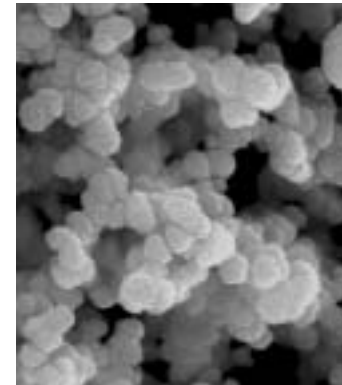
- Cleanroom protocols
- Material processing and characterization
- Hardware training
- Safety and environmental training
- Computer simulation



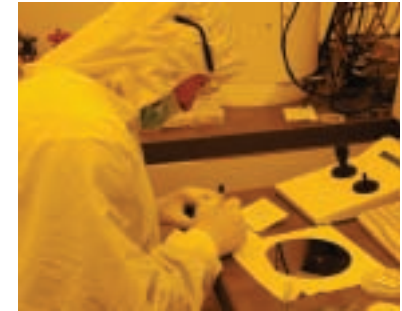
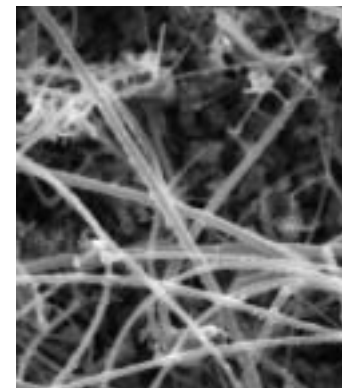
A silicon nanowire, 40nm in diameter, etched by a beam of finely focused high intensity electrons. This work was performed by Drs. Moses Chan, Shenyong Xu and Joan Redwing at Penn State University.



Gold nanoparticles characterized by NMT Capstone Semester students using a field emission scanning electron microscope.



Silicon nanowires characterized by NMT Capstone Semester students using a field emission scanning electron microscope.



What do NMT Capstone graduates do in the workplace?

Graduates of the Capstone Semester are highly trained individuals who may be involved in fabricating and characterizing nano- and micro-scale structures in research and development or manufacturing environments; in sales, or in product support — they are found anywhere nanotechnology is used to make consumer, industrial, and military products."

NANO FACT

Penn State's CNEU staff teach the Capstone Semester during all three scheduled semesters and continuously evolve the course to keep the content up to date.

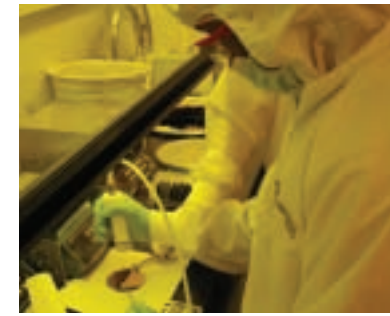
*"I would say that Capstone graduates are by far the best in terms of the training and the preparation for the nanotechnology workforce."
— Jay Jayashankar, Research Engineering Manager at Seagate Technology*

NANO FACT

Capstone Semester graduates have continued their education at academic institutions across Pennsylvania, and the nation, having gained employment in a multitude of different areas.

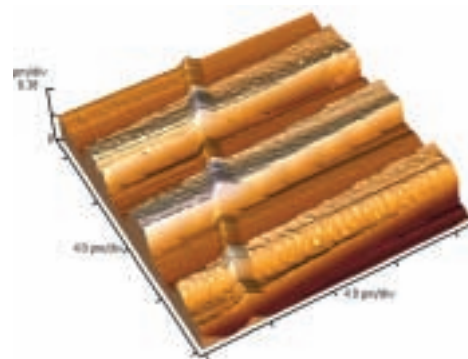
"Joining the program really guided my career. If it wouldn't have been for the program, I definitely would not be sitting here right now doing the type of work I am doing."

— Justin Ingram, PSU Neuroscience Graduate Student, Hershey Medical Center Intern, Capstone Graduate



How do I pursue a degree or certificate in nanotechnology?

- Meet with the NMT contact person or advisor at your college or university to learn more about a career that includes any aspect of nanotechnology.
- Enroll in the NMT degree or certificate program of your college or university.
- Have your NMT contact person reserve your place in the Capstone Semester at the University Park campus.
- Apply for financial assistance through the financial aid office of your college or university, if needed.
- Visit www.nano4me.org for:
 - A complete list of NMT partner institutions
 - Full course descriptions
 - Eligibility requirements
 - A quick form which can be filled out for additional information and we will contact you



A silicon nanowire covered by three patterned electrodes characterized by students using an atomic force microscope.

What if I'm still in high school?

Ask your advisor or guidance counselor to contact a CNEU staff member for details. Contact information can be found by visiting www.nano4me.org.

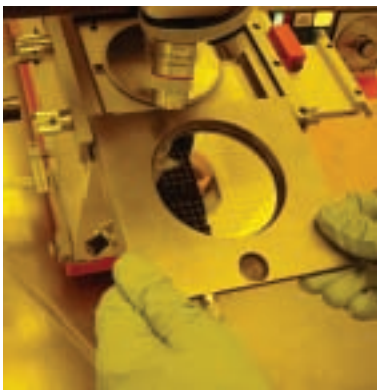
Do I need to be a student to take the Capstone Semester?

You do not have to be enrolled in any community college or university to earn a certificate in nanofabrication from the Capstone Semester. You must, however, demonstrate that you have the required foundational and technical skills to successfully complete the Capstone Semester. Contact any NMT partnership institution for a standardized form to confirm your eligibility.

How long is a nanometer?

Try this for size.

For the Penn State Nittany Lions football team to get a first down, they must gain at least 10 yards in four downs. That is equivalent to 9,146,341,463 nanometers, which sounds pretty tough for the offense!



Create your own nanotechnology-driven career in virtually any industry, including

- Pharmaceuticals
- Chemistry
- Biotechnology and Medicine
- Biomimetics
- Microelectromechanical Devices (MEMs)
- Optics/Photonics
- Sensors
- Water Purification
- Food
- Information Technology Management
- Forensics
- Microelectronics
- Forestry and the Environment
- Agriculture
- Automotive
- Construction Materials
- Advanced Manufacturing
- Security
- Textiles

...and more



Nothing so small has ever been so big.

Become part of a new revolution that's changing our world and creating exciting new career opportunities. For more information visit www.nano4me.org.

The Penn State Center for Nanotechnology Education and Utilization (CNEU) is dedicated to research, development and education across all aspects of micro- and nanotechnology, focusing its resources on the incorporation of nanotechnology into K-12 and post-secondary education, as well as industry training and application.

The Penn State CNEU is the home of the Pennsylvania Nanofabrication Manufacturing Technology (NMT) Partnership and its National Science Foundation (NSF) sponsored Advanced Technology Education Center.

"Small" Words with a Big Future

A Nano Glossary

Atom: The smallest unit of a chemical element, about a third of a nanometer in diameter. Atoms make up molecules and atoms and molecules make up all matter (solids, liquids, and gases).

Characterization: The process of identifying the atoms in a sample of matter, determining the sample's properties, or both.

Cleanroom: A clean space in which air velocity, pressure, temperature, humidity, and particle per volume count are controlled. Other environmental factors such as acoustic vibrations and stray electromagnetic (light, radio, etc.) energy content may also be controlled. Used in many types of industries from biotechnology to microelectronics.

Matter: Matter is the substance of which physical objects are composed.

Molecule: A group of atoms held together by chemical bonds.

Nano: A prefix meaning one billionth.

Nanofabrication: The practice of manipulating matter to make structures which have at least one dimension of 100nm or less. May include synthesis, processing, or both.

Nanoscale: Between 0.1-100 nanometers.

Nanotechnology: The characterization and manipulation of matter to create materials, devices and systems with new and unique properties.

Synthesis: Using chemistry to combine atoms and molecules into new materials.

Photos courtesy of the Penn State Department of Public Information and photographers John Fontecchio, Greg Greico, Chris Koleno, Walt Mills, Kate Morgan and Anne Marie Mountz.

"It gives the student a broader perspective than what they get in their own home institution. Penn State brings people together from all parts of the state."

— Barbara Canfield, Program Manager of Manufacturing Technologies at Northampton Community College

NANO FACT



Students who have completed the Capstone Semester are part of an extensive nanotechnology job network across Pennsylvania that includes chemical, pharmaceutical and materials companies.