



# Resources for Learning and Teaching Nano

## *Presenters:*

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This presentation will be available for viewing on:

<http://nano4me.org/educator-resources>

# What is the PA NMT Partnership



**PA Associate & Baccalaureate  
Students**



**“Hands-On” Capstone Semester  
@ PSU**



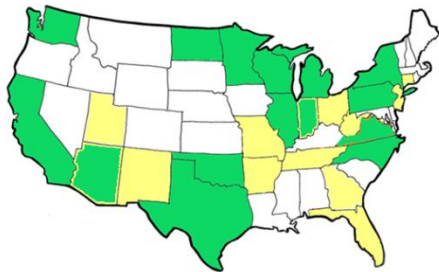
**Grads to PA Industry /  
Academia**

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

# 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

## 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 nation-wide 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

underway and these 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 957 educators who have completed professional development workshops. The Penn State nanotechnology workforce development programs 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.



Courtesy: NACK Center

*“With the support of the NSF ATE program, Penn State has developed a nation-wide partnership of research universities and community colleges that is bring 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.



Dakota County Technical College  
University of Minnesota



University of Puerto Rico,  
Humacao



Central Arizona Community College  
Maricopa Community Colleges  
Arizona State University  
MATEC - ATE Center in AZ



NEATEC - ATE Center in NY  
University at Albany (SUNY)



Northwest Vista College  
University of Texas



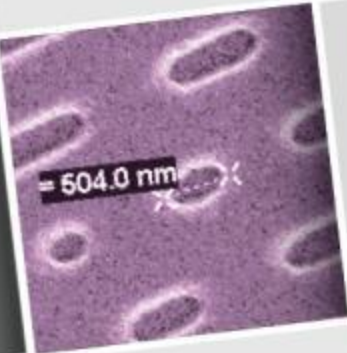
Ivy Tech Community College  
University of Notre Dame



NACK - ATE Center in PA  
PA Community Colleges  
Penn State University

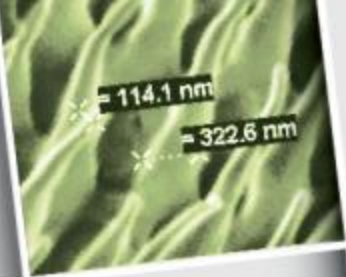


North Seattle Community College  
University of Washington



= 504.0 nm

A scanning electron micrograph showing several purple, oval-shaped structures on a textured surface. A scale bar indicates a length of 504.0 nm.



= 114.1 nm

= 322.6 nm

A scanning electron micrograph showing green, fibrous structures. Two scale bars indicate lengths of 114.1 nm and 322.6 nm.

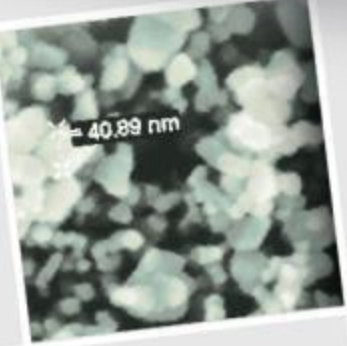
= 322.6 nm



= 160.6 nm

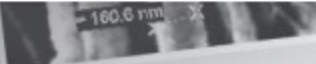
A scanning electron micrograph showing white, fibrous structures. A scale bar indicates a length of 160.6 nm.

# Resources Developed by NACK



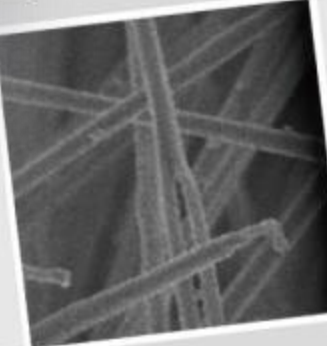
= 40.89 nm

A scanning electron micrograph showing green, granular structures. A scale bar indicates a length of 40.89 nm.



= 160.6 nm

A scanning electron micrograph showing white, fibrous structures. A scale bar indicates a length of 160.6 nm.



# Integrating Nano Into the Classroom

## NEED:

I want to utilize nanotechnology to teach science or integrate modular intro to micro- nanotechnology units into my classroom or curriculum.

## CHALLENGE:

- How can I personally learn more about it?
- Where can I find some good resources to utilize in my classroom?



# The Portal to NACK Resources

Visit:

[www.nano4me.org](http://www.nano4me.org)

The screenshot shows the Nano4Me.org website homepage. At the top, the logo "Nano4Me.org" is displayed next to the tagline "Brought to you by the Nanotechnology Applications and Career Knowledge (NACK) Network". A navigation menu includes links for HOME, STUDENTS, ALUMNI, EDUCATORS, INDUSTRY, ABOUT US, and PARTNERS. Below the navigation is a "Home" section with a video player titled "Nanotechnology keeps the shine on silver" and a "Science Nation" logo. To the right, there is a "NACK Educational Program Development" section with a "read more" link, and an "Upcoming Events – Webinars & Workshops" section listing a webinar on January 31, 2014, and a workshop on April 7-10, 2014. The main content area is divided into three columns: "Students" with a "Find a Nano Program" button and a map of the United States; "Alumni Resources" with a "Connect with fellow Nano Alumni today!" message, a LinkedIn logo, and an "Alumni Network" button; and "In the News – Featured Stories" with three news items: "White House report highlights Penn State Nano Program", "University of Puerto Rico – Humacao opens its teaching classroom", and "Cut to Invest: Support the Designation of 20 'U.S. Manufacturing Universities'", each with a "Read More" link. Below this is a "Want more News?" link. The bottom section is divided into "Educator Resources" (with "Sign Up", "Login", and "Browse" buttons), "Remote Access" (with a "Connect Remotely" button and a Wi-Fi icon), and "NANOFEED" (with a list of news items: "Nanoparticles to probe mystery sperm defects behind infertility", "Graphene nanoribbons with nanopores can be used for fast DNA sequencing", "Revisiting quantum effects in MEMS", and "New hologram technology created with nanoantennas"). A pagination bar at the bottom of the NANOFEED section shows "Prev 1 2 3 4 Next". At the very bottom, there is a navigation bar with links for "Students", "Alumni", "Educators", "Industry", "About Us", and "Partners". The footer contains the NACK Network logo and text: "Building College-University Partnerships for Nanotechnology Workforce Development", the NSF logo, and text: "Funded, in part, by a grant from the National Science Foundation. DUE 1205105". The copyright notice at the bottom reads: "© 2007-2013 Penn State University Center for Nanotechnology Education and Utilization (Sitemap)".



# NACK Educator Resources

Visit: [www.nano4me.org/educator-resources](http://www.nano4me.org/educator-resources)

The screenshot displays the Nano4Me.org website interface. At the top left is the logo "Nano4Me.org" with a stylized orange "4". To its right is the tagline "Brought to you by the Nanotechnology Applications and Career Knowledge (NACK) Network". A navigation menu below the logo includes links for HOME, STUDENTS, ALUMNI, EDUCATORS, INDUSTRY, ABOUT US, and PARTNERS. A breadcrumb trail below the menu reads "Home | Educators | Educator Resources".

The main content area is split into two columns. The left column features a "Resources" header, followed by the text "The NACK Commitment" and "NACK's mission is to provide quality Resources to K-12 & Post-Secondary educators. Nano4me Resources are free for registered users." Below this is a "To Create an Account:" section with a "Sign Up" button that includes a play button icon.

The right column features a "Student and Alumni Resources" header, followed by the text "Help students find a pathway: [find](#) 2-year nano degree programs near you!" and "Are you nano students looking for jobs? Encourage them to [Join](#) The National Nanotechnology Alumni Network where they can find career resources, job posting information, and more!".

At the bottom of the page is a dark grey footer containing four white buttons: "K-12 Resources", "Post-Secondary Resources", "Professional Development", and "Additional Resources".

# Undergraduate Level Course Material for 6 NACK Courses

## Undergraduate Materials: Course Lectures, Videos, and Associated Labs

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–sophomore use in four-year degree programs.

[E SC 211](#) | [E SC 212](#) | [E SC 213](#) | [E SC 214](#) | [E SC 215](#) | [E SC 216](#) |

[Read More](#)

# Undergraduate Level Course Material for 6 NACK Courses

- Classroom presentation material
  - Arranged in modular units
  - Videotaped lectures
- Hands-on labs for the courses

## E SC 211 - Undergraduate Level Course - Classroom Presentations

### Lab Mode Availability:

“Download Template Laboratory” gives you an example of the lab as taught at Penn State;  
“Download Turnkey Laboratory” gives you a lab experience complete with video.

E SC 211 / [212](#) / [213](#) / [214](#) / [215](#) / [216](#)

### E SC 211: Materials, Safety, and Equipment Overview for Nanotechnology

Unit	Lecture Video and PowerPoint Availability	Associated Laboratory Availability	Topics Covered
<b>Unit 1 - Safety and Environmental Concerns</b>			
Lecture 1: General Safety Awareness, Safety and Environmental Concerns	PPT PDF Video	Template Laboratory	General Safety Awareness, and Wet Chemistry Safety
Lecture 2: Gas Safety, Biological Safety, and Nanomaterial Safety	PPT PDF Video	Template Laboratory	Gas Safety, Biological Safety, and Nanomaterial Safety
Lecture 3: Energy, Safety, and Environmental Concerns	PPT PDF Video		Energy, Safety, and Environmental Concerns

# Laboratory Activities Available for Download:

- All labs have an **overview** to introduce you to the **core objectives**
- Include **sample questions** to quiz students

E SC 211 Associated Laboratory Availability			
ESC 211 Labs			
Unit	Template Laboratory	Turnkey Laboratory	Supplemental Laboratory
<b>Unit 1 - Safety and Environmental Concerns</b>			
Lecture 1: General Safety Awareness, Safety and Environmental Concerns	Lab 1: EHS: Chemical & Materials Overview		
Lecture 2: Gas Safety, Biological Safety, and Nanomaterial Safety	Lab 2: EHS: Equipment Safety Awareness		
Lecture 3: Energy, Safety, and Environmental Concerns			
<b>Unit 2 - Processing/Manufacturing Infrastructure</b>			
Lecture 1: What is Infrastructure and Why Do We Need It?			
Lecture 2: Facilities			
Lecture 3: Overview of Vacuum Based Systems	Lab 3: Vacuum Equipment Simulation Lab with EquipSim Lab 4: Vacuum Equipment Components & Systems Part 1 Lab 5: Vacuum Equipment Components & Systems Part 2	Lab 3: Vacuum EquipSim Labs PDF Lab 4: Intro to PVD Final PDF	
Lecture 4: More on Vacuum Systems, Part I			
Lecture 5: More on Vacuum Systems, Part II			
Lecture 6: More on Vacuum Systems, Part III			
Lecture 7: Overview of Non-Vacuum Based Systems			

# Introductory Level Modules






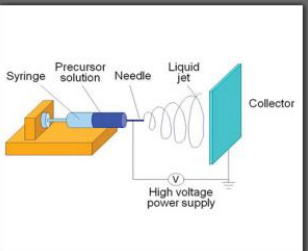
- Introduce nanotechnology and its applications.
- In-depth material for students and workers of all knowledge levels.
- Can be integrated into secondary and post-secondary curriculum as well as for nanotechnology outreach

Unit	Download Modules
<b>Module 1: Nanotechnology: What Is It, and Why Is It So "BIG" Now?</b>	
<b>Description:</b> This module gives an overview of nanotechnology, what the word "nanotechnology" means, and where it comes from. It also explores the differences between the macro-scale, micro-scale, and nano-scale. Finally, this module explores how old nanotechnology is with a brief history and concludes with why nanotechnology is so popular today.	Module 1 Supplemental Materials
<b>NOTE:</b> It is recommended that you download the supplemental materials along with the module so that the links to the multimedia files in the PowerPoint file function. If you have any issues with the links to the multimedia files, please <a href="#">contact us</a> .	
<b>Module 2: A Brief History of Nanotechnology</b>	
<b>Description:</b> This module explores the history of nanotechnology: from Romans using gold and silver nanoparticles in their glasswork 2,000 years ago to modern day where nanoparticles are being used in cancer treatments.	Module 2
<b>Module 3: A Snapshot of Nanotechnology Today</b>	
<b>Description:</b> This module gives a snapshot of nanotechnology today including the worldwide investment in nanotechnology, workforce demands, and some examples of nanotechnology being used to enhance consumer products.	Module 3
<b>Module 4: The Uniqueness of the Nano-scale</b>	
<b>Description:</b> This module covers the unique attributes of the nano-scale and some examples of these unique attributes, including small size, high surface to volume ratio, surface forces in relation to bulk forces, quantum mechanical effects, and wave properties of light.	Module 4
<b>Module 5: How Do We "See" Things at the Nano-scale: An Introduction to Characterization Techniques</b>	
<b>Description:</b> This module provides an introduction to characterization techniques including transmission electron microscopy, scanning electron microscopy, x-ray spectroscopy, scanning probe microscopy tools, and quantum mechanical tunneling.	Module 5 Supplemental Materials
<b>NOTE:</b> It is recommended that you download the supplemental materials along with the module so that the links to the multimedia files in the PowerPoint file function. If you have any issues with the links to the multimedia files, please <a href="#">contact us</a> .	
<b>Module 6: How Do You Make Things So Small: An Introduction to Nanofabrication</b>	
<b>Description:</b> This module provides an introduction to nanofabrication including what is made through nanofabrication, how nanofabrication is directed, and the various processes involved in nanofabrication: top-down, bottom-up, and hybrid.	Module 6
<b>Module 7: How Do You Build Things So Small: Top-Down Nanofabrication</b>	
<b>Description:</b> This module gives an in-depth exploration of the process of top-down nanofabrication including the basic steps: deposition, pattern transfer, etching, and materials modification.	Module 7
<b>Module 8: How Do You Build Things So Small: Bottom-Up Nanofabrication</b>	
<b>Description:</b> This module gives an in-depth exploration of the process of bottom-up nanofabrication including the basic steps: building-block fabrication and self-assembly.	Module 8
<b>Module 9: Nanotechnology, Biology, and Medicine</b>	
<b>Description:</b> This module provides various examples of the impact of nanotechnology on biology and medicine. Biology topics include intra-cellular machinery and cancer cell structure. Medicine topics include disease intervention, drug delivery, and disease detection.	Module 9 Supplemental Materials
<b>NOTE:</b> It is recommended that you download the supplemental materials along with the module so that the links to the multimedia files in the PowerPoint file function. If you have any issues with the links to the multimedia files, please <a href="#">contact us</a> .	
<b>Module 10: Nanotechnology: Impact on Microelectronics</b>	
<b>Description:</b> This module explores the impact of nanotechnology on the field of microelectronics, the latest innovations, alternatives to nano-scale microelectronics, nanoelectronics, and moltronics.	Module 10

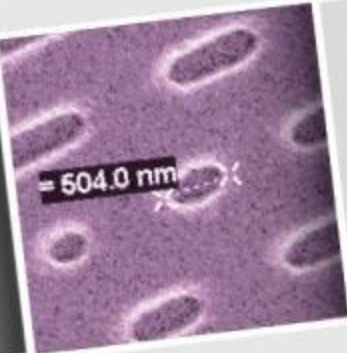
# NACK Webinar Series

- Live webinars
- Hosted by MATEC NetWorks
- Engage **and** Educate
- **FREE to attend**
- Recordings and slides available

2013 / 2014 Webinar Series

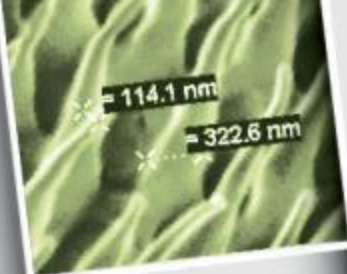
 <p><b>Fundamentals of Metrology and Characterization for Nano</b></p> <p>Friday, September 27, 2013</p> <p>Presenter: <b>Diane Hickey-Davis, Ph.D</b> Nanoscience Instruments</p> <p><a href="#">Archived Links</a></p>	 <p><b>Nanotechnology: Needs, Risks, and Opportunities</b></p> <p>Friday, November 1, 2013</p> <p>Presenter: <b>Dr. Daniel J. C. Herr</b> Professor and Nanoscience Department Chair</p> <p><a href="#">Archived Links</a></p>	 <p><b>K-12 Resources in Nanotechnology</b></p> <p>Friday, January 31, 2014</p> <p>Presenter: <b>Joyce Palmer</b> Georgia Tech NNIN</p> <p><a href="#">Description</a> <a href="#">Register</a></p>
 <p><b>RET Experience: Activities for the HS Classroom</b></p> <p>Friday, March 28, 2014</p> <p>Presenter: <b>Theresa Burch</b> Ironwood High School</p> <p><a href="#">Description</a> <a href="#">Register</a></p>	 <p><b>Industry Partners for Your Nano Program</b></p> <p>Friday, April 25, 2014</p> <p>Presenter: <b>Sam Agdasi</b> Ivy Tech Community College</p> <p><a href="#">Description</a> <a href="#">Register</a></p>	 <p><b>Electrospinning</b></p> <p>Thursday, May 15, 2014</p> <p>Presenter: <b>Dr. Nicholas Pinto</b> University of Puerto Rico</p> <p><a href="#">Description</a> <a href="#">Register</a></p>





= 504.0 nm

A scanning electron micrograph showing several purple, oval-shaped structures on a textured surface. A scale bar indicates a length of 504.0 nm.



= 114.1 nm

= 322.6 nm

A scanning electron micrograph showing green, fibrous structures. Two scale bars indicate lengths of 114.1 nm and 322.6 nm.

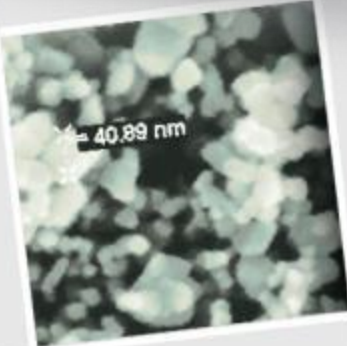
= 322.6 nm



= 160.6 nm

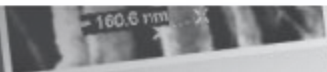
A scanning electron micrograph showing white, fibrous structures. A scale bar indicates a length of 160.6 nm.

# Resources Developed by Others



= 40.89 nm

A scanning electron micrograph showing green, granular structures. A scale bar indicates a length of 40.89 nm.



= 160.6 nm

A scanning electron micrograph showing grey, fibrous structures. A scale bar indicates a length of 160.6 nm.

= 160.6 nm



# National Nanotechnology Initiative

Home | Sitemap | NSET Agencies | Contact Us | Search Nano.gov

# Nano.gov

National Nanotechnology Initiative

Nanotechnology 101 | Nanotechnology & You | About the NNI | Collaboration & Funding | Publications & Resources | Education | Newsroom | Events

## For K-12 Teachers

One of the great strengths of nanoscience can also pose tough choices for teachers. Nanotechnology does not fall under one just discipline such as physics, biology, chemistry, materials science, or engineering, but all these and others. In science, technology, engineering, and math (STEM) education circles, there is an ongoing debate about nanotechnology education: Should it have its own individual curriculum? Or should nanotechnology be woven into the many scientific—and social—disciplines comprising its many elements?

This section won't settle that argument, but it does provide a wide variety of resources to help teachers who are making nanotechnology a part of their lesson plans.

### Related Resources

You can find additional, useful resources for teachers on the [K-12 page](#).

### Education

For K-12 Students

**For K-12 Teachers**

College and Graduate Programs

Associate Degrees, Certificates, & Job Info



Contact us for up to 400 copies of our educational brochures for students and anyone eager to learn.

### Classroom Resources

- **Mid-Continent Research for Education and Learning (McREL) NanoTeach** project is an NSF-funded program that combines an instructional design framework with nanoscale science content using multiple delivery methods for high school science teachers. McREL NanoLeap is specifically geared towards teaching nanoscience and technology.
- **The National Nanotechnology Infrastructure Network Education Portal** has useful guidelines for approaching how to integrate nanotechnology into your curriculum. The portal has a searchable database of approximately 60 K-12 lessons primarily written by teachers for teachers.
- **Nanooze** is an online and print science magazine created by Cornell University as part of the education programs of the NNIN. Nanooze has special topic print editions which teachers may download or order from NNIN.

# STEM Education at McREL



- Resources in Technology and Engineering include:
  - NanoExperiences
  - NanoTeach
  - NanoLeap

# NanoExperiences



Pathways to Workforce Success

EXPLORE ALL THE  
AWESOME POSSIBILITIES:  
NANOSCIENCE & TECHNOLOGY



HOME

WHAT IS NANOEX?

CAREER PATHWAYS

PARTNERS

FOR STUDENTS

*Student website & more*

FOR PARENTS

*Information for parents*

FOR MENTORS

*Tools & resources*



Want to... Learn cool stuff with friends in new and different ways? Be on your way in a well-paying career by 21? Make a difference in your community? NanoEx is for YOU!

# NanoTeach

**MREL**

Mid-continent Research for Education and Learning  
Delivering research and practical guidance to educators

**NanoTeach**

[Home](#)

[Project Goals](#)

[Nanoscience & Technology](#)

[Remote Access](#)

[Designing Effective Science Instruction](#)

[Peer Review Team](#)

[Virtual Classroom](#)

[Project Team](#)

## Integrating Nanoscience and Technology into the High School Curriculum

The NanoTeach project is breaking new ground by developing and testing professional development that combines an instructional design framework with nanoscale science content using multiple delivery methods for high school science teachers.



NanoTeach Photo Gallery



# NanoLeap

## Physical Science

### Investigating Static Forces in Nature: The Mystery of the Gecko

Lesson 1                      Lesson 5  
Lesson 2                      Lesson 6  
Lesson 3                      Lesson 7  
Lesson 4                      Lesson 8

NanoLeap

#### Entire Compilation—Lessons 1-8

- + [Physical Science Student Journals](#) (PDF 1.5 Mb)
- + [Physical Science Teacher Guides](#) (PDF, 2 Mb)

#### Preface

The *NanoLeap* project represents an approach for teachers to introduce the exciting world of nanoscale science and technology to their classes by integrating interdisciplinary research with traditional science concepts.

- + [Preface, Learning Objectives, Standards, & Big Ideas](#) (PDF 150 Kb)
- + [Materials Sheet](#) (PDF, 109 Kb)

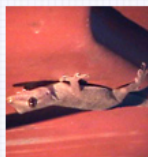


#### Lesson 1: How Can a Gecko Walk on the Ceiling?

Students will:

- Make observations and interpretations of how the gecko's foot interacts with surfaces
- Formulate possible adhesive methods that might be considered for further investigations

- + [Teacher Guide](#) (PDF, 68 Kb)
- + [PowerPoint](#) (PPT, 373 Kb)
- + [Student Journal](#) (Word, 3 Mb)
- + [Tricky Feet](#) (WMV, 5.8 Mb)
- + [NanoSize Me](#) (QT, 4.7 Mb)



#### Lesson 2: What Do We Mean When We Speak About Surfaces in Contact?

Students will:

- Compare the amount of surface contact (real contact) to total unit area (apparent contact) at the macro level
- Understand that different textures of surfaces have different contact ratios

- + [Teacher Guide](#) (PDF, 55 Kb)
- + [PowerPoint](#) (PPT, 1.2 Mb)
- + [Student Journal](#) (Word, 4.6 Mb)



## Chemistry

### Nanoscale Materials and Their Properties

Unit 1                      Poster Assessment  
Unit 2                      Unit 3

NanoLeap

#### Preface

The *NanoLeap* project represents an approach for teachers to introduce the exciting world of nanoscale science and technology to their classes by integrating interdisciplinary research with traditional science concepts.

- + [Preface](#) (PDF 31 Kb)
- + [Teacher Resource Guide](#) (PDF 414 Kb)
- + [Student Handbook Student Version](#) (Word Doc 4 Mb)
- + [Student Handbook Teacher Version](#) (PDF 818 Kb)
- + [National Science Education Standards Addressed](#) (PDF 31 Kb)
- + [Materials Sheet](#) (Popup)



#### Unit 1: What is it?

Students will:

- Define nanoscience as the study of the fundamental principles of structures having at least one dimension lying roughly between 1 and 100 nanometers.
- Explain the importance of nanoscience research and technology.
- Evaluate the ethical considerations associated with nanoscience research and nanotechnology.
- Recognize the interdisciplinary nature of nanoscience.
- Identify the requirements of nanoscience and nanotechnology.

Lesson 1.1: What is Nanoscience?

- + [Teacher Guide](#) (PDF, 37 Kb)
- + [PowerPoint](#) (PPT, 463 Kb)

Lesson 1.2: What Makes Nanoscience So Different?

- + [Teacher Guide](#) (PDF, 90 Kb)
- + [PowerPoint](#) (PPT, 678 Kb)

Lesson 1.3: What Makes Nanoscience So Important?

- + [Teacher Guide](#) (PDF, 114 Kb)
- + [PowerPoint](#) (PPT, 535 Kb)



# National Nanotechnology Infrastructure Network (NNIN)



National Nanotechnology Infrastructure Network

Serving Nanoscale Science, Engineering & Technology

Search

Home

About Us

Research Support

REU

Education & Training

Society & Ethics

News & Events

The central banner features the 'NANOOZE' logo in a stylized, blue and yellow font with a molecular structure. Below it, the text reads 'Nanotechnology for kids' in white, followed by 'magazine • website • exhibits' in yellow and 'www.nanooze.org' in white. At the bottom of the banner is a row of eight numbered tabs (1-8), with tab 6 highlighted in yellow. The background of the banner is dark grey with several ball-and-stick molecular models in white, red, and blue.

**NANOOZE**  
Nanotechnology for kids  
magazine • website • exhibits  
www.nanooze.org

1 2 3 4 5 6 7 8

Quick Links

- [Nanooze-Science Magazine for Kids](#)
- [Nanotechnology Curriculum Materials for K-12](#)
- [Research Experience for Teachers Program](#)

Nanooze, the NNIN Science News Magazine for Kids, is available free of charge to schools and other public education organizations.



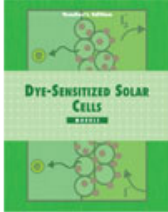


# NCLT – Materials World Modules

- Nanotechnology Center for Learning and Teaching (NCLT)
- MWM – products designed by NCLT partners to integrate into classroom curricula

## Dye-Sensitized Solar Cells Module

[MWM Resources](#) - List of MWM Modules  
Written by MWM editor  
Monday, 07 November 2011 11:46



The students will learn to fabricate an artificial photosynthetic device using nanotechnology and plant pigments to capture sun's energy and convert it to electricity. Each Activity prepares students for the Design Project, in which they are challenged to create the most efficient dye-sensitized solar cell, using vegetable and/or fruit dyes, that is capable of powering an electronic device.

The **new** math extension deals with a variety of math topics, linked by subject matter or a key word or concept to the material presented in the activities and design project. These include density and specific gravity of materials, growth curves (a simple model and two more complex ones), waves and electromagnetic spectrum data (represented by NASA-type problems) and lastly, electric current and resistance problems.

When advanced or particularly difficult problems are included, they have been marked with an asterisk (\*) in the Table of Contents.

[Info Sheet \(PDF\)](#)

[Module At-a-Glance](#) [Connecting to Your Curriculum](#) [Resources](#)

# whatisnano.org

The screenshot shows the homepage of whatisnano.org. At the top left is the logo 'whatisnano.org' in a purple box. To the right are language options 'English' and 'Español'. Below the logo is a navigation bar with 'Home | NanoDays | Nano Exhibition'. On the right side of the navigation bar are logos for 'vimeo' and 'facebook' with the text 'Find us on facebook'. The main content area features a large video player. The video shows a man in a blue shirt holding a long wooden meter stick in a park. A large play button is overlaid on the video. Below the video is the text 'Imagine... comparing this meter stick to a super tiny nanometer...'. To the right of the video is a light blue box with the text 'Nanotechnology the potential the way we live'. Below the video player are three content cards. The first card is titled 'NanoDays' and features an image of children at a table. The second card is titled 'NanoBuzz' and features three small images with text about carbon nanotubes, water as a lubricant, and preventing heart attacks. The third card is titled 'K-12 Teachers' and features an image of a girl with a molecular model. A small box above the third card says 'nanoHub - Purdue University'.

whatisnano.org

English Español

Home | NanoDays | Nano Exhibition

vimeo Find us on facebook

Play

Imagine... comparing this meter stick to a super tiny nanometer...

Nanotechnology the potential the way we live

### NanoDays

NanoDays is a nationwide festival of educational programs about nanoscale science and engineering and its potential impact on the future.

[> Learn more](#)

### NanoBuzz

Current nano news:  
join the conversation!

Carbon nanotubes on a spider silk structure may be able to conduct electricity  
Posted September 30, 2013

Water is the Optimal Lubricant for Nanomachines  
Posted September 3, 2013

Preventing Heart Attacks. One Nanobot At A Time  
Posted August 29, 2013

nanoHub - Purdue University

### K-12 Teachers

Curriculum and activity resources for K-12 teachers to use in their classrooms.

[> Learn more](#)

# 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)



# Need Helpful Web Resources?

- The Project on Emerging Nanotechnologies has kept **track of the impact** nanotechnology has in the **economy** and **public and environmental health**
- Searchable inventory of **over 1,000 consumer products**
- Funded by ***Woodrow Wilson International Center for Scholars*** and ***The Pew Charitable Trusts***

<http://www.nanotechproject.org/inventories/consumer/>

(included in handout)

# Want to integrate MEMS Technology?

The screenshot shows the SCME-NM.ORG website. The header includes the logo and navigation menu. The main content area is titled 'Kits for the Classroom' and lists 11 different MEMS activity kits. A sidebar on the left contains various navigation links and news sections.

**SCME-NM.ORG**  
NSF ATE Regional Center

Home News Educational Materials Partners SCME Events Job Links About Us Safety

Main Menu

- [Educational Materials](#)
- [Videos](#)
- [Publications and Presentations](#)
- [What's New on Site?](#)
- [Synergy Project](#)
- [WEB Links](#)
- [Matt's Corner](#)
- [SCME Calendar](#)
- [MTTC Events](#)
- [Jim's Corner](#)
  - [Industry Relations](#)
- [Fab. Notes](#)
- [SCME Tech Corner](#)
- [Workshop News](#)

Partner News

- [Read all the News Flashes!](#)
- [SIP/ News](#)
- [CNM News](#)
- [NW Vista College News](#)
- [UNM MTTC Cleanroom](#)

Who's Online

We have 32 guests online

For Administrators

- [Administrator](#)

SCME Home » [Educational Materials](#) » Kits for the Classroom

Newsflash: Turn your cell phone camera into a microscope – the folks at University of California at Davis figured this out – we will try this to image small stuff in our classrooms – never know, a kit may come out of this! Check out each of the links:

- [Researchers Turn iPhone Into 350x Microscope on the Cheap](#)
- [Turning The iPhone Into A 350x Medical Microscope For Under \\$50](#)
- [Cell-Phone-Based Platform for Biomedical Device Development and Education Applications](#)

Downloads Home Search Document

## Kits for the Classroom

This category contains information about the SCME kits that are available to instructors who are planning to incorporate MEMS Technology into their classroom and are looking for exciting, thought-provoking activities.

1. Anisotropic Etch Activity and Kit
2. Crystallography Activities and Kits
3. GeneChip Model Activity and Kit (available Fall, 2011)
4. Dynamic Cantilever Activity and Kit
5. Lift-Off Activity and Kit
6. LIGA Micromachining Activities and Kit (available Fall, 2011)
7. MEMS: Making Micro Machines DVD Kit
8. MEMS Innovators Activity and Kit
9. Pressure Sensor Model Activity Kit
10. Pressure Sensor Process Activity and Kit
11. Rainbow Wafer Activity and Kit

To order a kit, please complete the [SCME Kit Order Form](#).

Files may not download with Internet Explorer – use Mozilla Firefox browser (free).

Files

[www.scme-nm.org](http://www.scme-nm.org)

# SHINE – Based in Seattle, WA



# SHINE Materials Include:

- Learning objectives
- Applications
- Material list
- Student Lab

And more!

To receive login information for the site, please email [shine@northseattle.edu](mailto:shine@northseattle.edu)



# Nano-Link – Based in Rosemount, MN

Home

About Nano-Link

Nano-Infusion Project

Workshops and Events

Presentations



## Educator Training

The Nano-Link consortium has trained instructors ready to come to your school district or area to help instructors learn how to integrate nanotechnology concepts and experiments into their curriculum. Learn more about our Educator Workshops, and see if we can help you bring a workshop to your area!

# Nano-Link Materials Include:

- Visit Nano-Link
- Primary mission: Provide **topical, nanoscience content** in an **easy to integrate modularized format** for high school, college educators, and industry.
- Modules:
  - Require 3 to 5 hours of class time
  - **Inclusive package of activities, experiments, background information slides, questions** and other related material.
- Tailor the modules to meet needs of your classroom.



# NEATEC – based in Albany, NY



**NEATEC** Northeast Advanced Technological Education Center

Email Sign Up Login Follow Us   

Home About NEATEC What We Do Resources News & Events Testimonials Contact

The Northeast Advanced Technological Education Center (NEATEC) was established in September 2010 through the National Science Foundation (NSF) Advanced Technological Education (ATE) program.

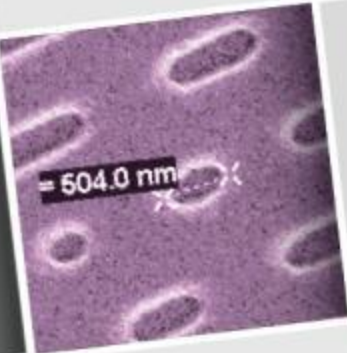
**Register for Access**  
To a vast library of courses, materials, and resources. Quickly find, and sign up for upcoming events, and stay informed with updates and news.

**Get Started Now Free**

Share     

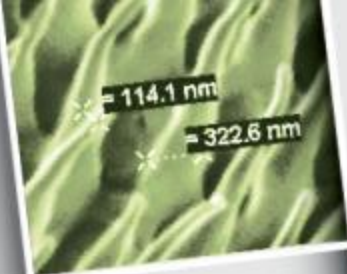
# Some Additional Web Resources

- National Nanotechnology Institute (NNI): [www.nano.gov](http://www.nano.gov)
- Nano-Link: <http://www.nano-link.org/>
- NNIN.org education portal – RET lessons and more:  
[http://www.nnin.org/nnin\\_k12teachers.html](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](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/>



= 504.0 nm

A scanning electron micrograph showing several purple, oval-shaped structures on a textured surface. A scale bar indicates a length of 504.0 nm.



= 114.1 nm

= 322.6 nm

A scanning electron micrograph showing green, fibrous structures. Two scale bars are present, indicating lengths of 114.1 nm and 322.6 nm.

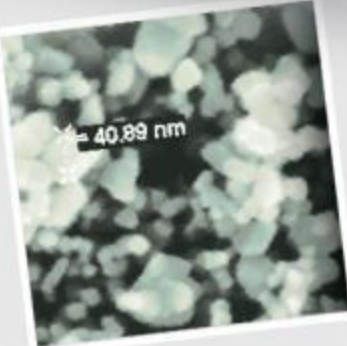
= 322.6 nm



= 160.6 nm

A scanning electron micrograph showing white, fibrous structures. A scale bar indicates a length of 160.6 nm.

# Resources for Educators



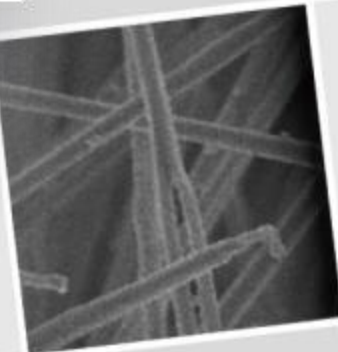
= 40.89 nm

A scanning electron micrograph showing green, granular structures. A scale bar indicates a length of 40.89 nm.



= 160.6 nm

A scanning electron micrograph showing white, fibrous structures. A scale bar indicates a length of 160.6 nm.



# **To engage today's learners we need to:**

- Present content and information in different ways
- Provide multiple means of engagement
- Universal Design for Learning:  
<http://www.cast.org/udl/>



## Universal Design for Learning

### Recognition Networks

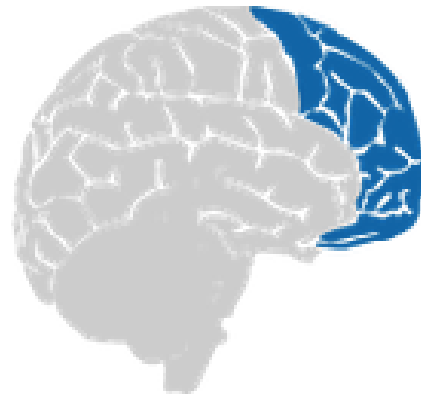
The "what" of learning



How we gather facts and categorize what we see, hear, and read. Identifying letters, words, or an author's style are recognition tasks.

### Strategic Networks

The "how" of learning



Planning and performing tasks. How we organize and express our ideas. Writing an essay or solving a math problem are strategic tasks.

### Affective Networks

The "why" of learning



How learners get engaged and stay motivated. How they are challenged, excited, or interested. These are affective dimensions.

# Objectives

- Help students grasp concepts in nanotechnology through multimedia:
  - Animations
  - Interactives
  - Video
  - Simulations/emulations
- And, how do we blend these in?

# Rationale for Use

- **Complexity**
  - Hard to visualize, analyze or explain
- **Variable**
  - If a system is variable with respect to time or process
- **Interdependency**
  - Multiple inter-dependent variables

# And sometimes...

You just want to show something  
in a different way

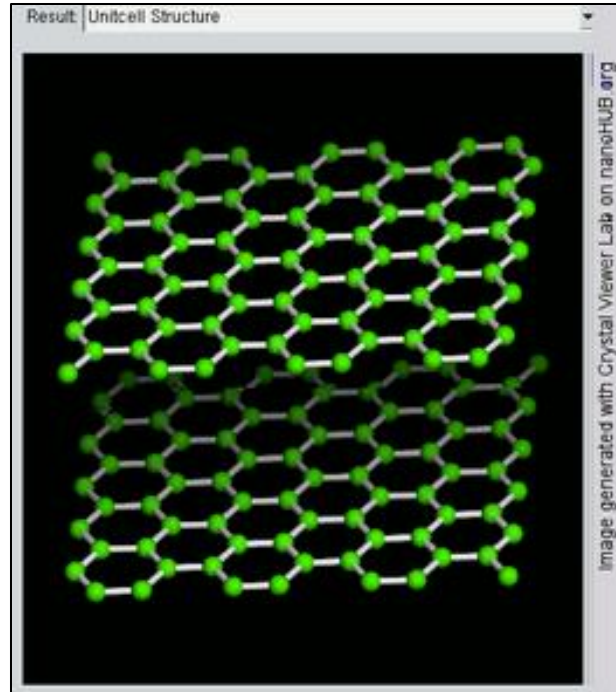


# Multimedia Possibilities

- Show:
  - Animations
  - Interactives
  - Video
- Do:
  - Simple simulations
  - Complex simulations and emulations

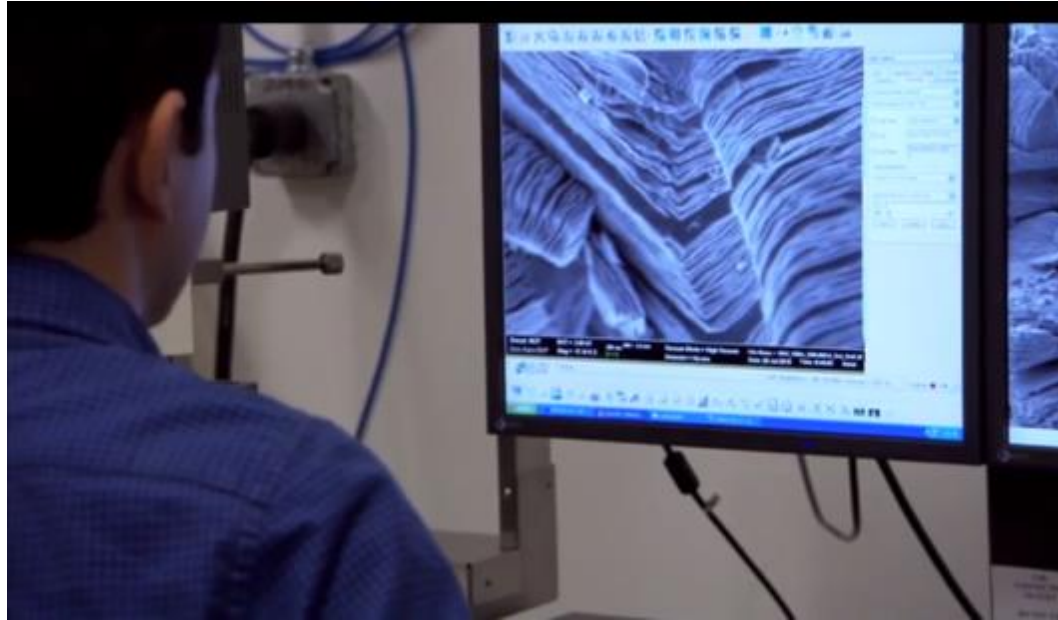
# Nanotechnology Animation Gallery

nanoHUB - <https://nanohub.org/resources/8882>





# Nanomaterials for Energy Efficiency



[http://www.youtube.com/watch?feature=player\\_embedded&v=-WQ28DJWhZk#!](http://www.youtube.com/watch?feature=player_embedded&v=-WQ28DJWhZk#!)

# Spanish Language Videos on Nanotechnology



The screenshot shows the NanoDYF website's multimedia section. At the top left is the NanoDYF logo, which consists of a stylized atom symbol with a yellow nucleus and blue and green orbits, followed by the text "NanoDYF" in green and orange. To the right of the logo are navigation links: "NanoDYF...", "Grupos participantes", "Publicaciones", "Multimedia" (highlighted in a blue box), "Eventos y Noticias", and "Lin". Below the navigation is a horizontal banner with six small images: a glowing pink sphere, a blue and green molecular structure, a petri dish with a pipette, green spherical particles, a blue and silver mechanical part, and red molecular structures. Below the banner is the heading "Multimedia" in black text. Underneath is the sub-heading "Videos" in red text. Two video thumbnails are displayed. The first is titled "CSIC-Nanoarte" and shows a laboratory setting with various pieces of equipment. The second is titled "Nanoarte-Fotografía Científica" and features a green and white abstract image with a play button overlay. The name "Carmen Munuera" and her affiliation "ICMM-CSIC, Madrid (Spain)" are visible in the top right corner of the second video thumbnail.

NanoDYF... Grupos participantes Publicaciones **Multimedia** Eventos y Noticias Lin

## Multimedia

Videos

CSIC-Nanoarte

Nanoarte-Fotografía Científica

Carmen Munuera  
ICMM-CSIC, Madrid (Spain)

<http://www.nanodyf.org/multimedia.php>

# nanoHub – Purdue University

The screenshot shows the nanoHUB.org website homepage. The header features the nanoHUB.org logo with the tagline "ONLINE SIMULATION AND MORE FOR NANOTECHNOLOGY" and the "an NCN project" logo. A search bar and "Login" and "Sign Up (Free)" buttons are in the top right. A navigation menu includes Home, Resources, Members, Explore, nanoHUB-U, Partners, About, and Support. A "Need Help?" button is also present. The main content area is divided into several sections: a promotional banner for the "NEW nanoHUB.org iPad App" with a sub-header "Download the NEW nanoHUB.org iPad App!" and a description "Launch, run, & monitor simulation tools from anywhere with the new nanoHUB iPad App! Learn More"; a central list of features including "SIMULATE with over 320 tools for nanoelectronics, nanophotonics and more", "RESEARCH & COLLABORATE via groups, question board and more", "TEACH & LEARN with nanoHUB-U, tool-powered curricula, courses, seminars and more", and "SHARE & PUBLISH tools and research through our easy upload process"; and a right-side section titled "Over 280,000 users annually" with a sub-section "35 Live Simulation Sessions" and links for "Detailed statistics" and "Who's online?". A slide navigation bar is at the bottom left.

**nanoHUB.org**  
an NCN project

ONLINE SIMULATION AND MORE  
FOR NANOTECHNOLOGY

Search

Login Sign Up (Free)

Home Resources Members Explore nanoHUB-U Partners About Support

Need Help?

**Download the NEW nanoHUB.org iPad App!**

Launch, run, & monitor simulation tools from anywhere with the new nanoHUB iPad App! [Learn More](#)

**SIMULATE** with over 320 tools for nanoelectronics, nanophotonics and more

**RESEARCH & COLLABORATE** via groups, question board and more

**TEACH & LEARN** with nanoHUB-U, tool-powered curricula, courses, seminars and more

**SHARE & PUBLISH** tools and research through our easy upload process

A resource for nanoscience and nanotechnology, nanoHUB.org was created by the NSF-funded Network for Computational Nanotechnology.

**Over 280,000 users annually**

35 Live Simulation Sessions

[Detailed statistics](#) | [Who's online?](#)

1 2 3 4 5

# Powers of 10



[http://www.youtube.com/watch?feature=player\\_embedded&v=0fKBhvDjuy0#!](http://www.youtube.com/watch?feature=player_embedded&v=0fKBhvDjuy0#!)

# NACK Network Multimedia

## Multimedia

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

### NACK Animations

Other Resource Center Nanotechnology Animations

#### MATEC NetWorks

##### The Deposition Process

This animation shows the chemical vapor deposition process.

##### The Diffusion Process

This animation shows the diffusion process.

##### Dressing for Work in the Cleanroom-Video

A video is presented in which a technician at a semiconductor fab explains the gowning procedure she uses at work. (70mb file)

##### The Etch Process

This animation shows the plasma etching of silicon dioxide. In this type of plasma etching, Chlorine gas and Argon gas mixture is used.

##### How a Plasma Etcher Works

This animation shows how a plasma etcher works.

##### Ion Implant

This animation shows an overview of the ion implant process.

##### Bourdon Tube Gauge

This animation shows the workings of a Bourdon tube gauge.

##### Five Stages of Flow

This animations shows the stages that molecules go through as they move from the turbulent stage of viscous flow, transition into laminar flow, and then transition again into molecular flow.

<http://nano4me.live.subhub.com/categories/multimedia>

# Animations

PROCESS & EQUIPMENT I			
Title	Description	Objective	Link
How a CMOS Device Works	An animation of how a CMOS device Works.	Identify the required electrical variables that allow a CMOS device to operate.	<a href="#">Launch</a>  <a href="#">iPod / iPhone video</a>
n-Channel Enhancement MOSFET Characteristic Curves	This is an animation of a n-Channel Enhancement MOSFET Characteristic Curves.	Determine the active non-active operation regions of an n-Channel MOSFET gate.	<a href="#">Launch</a>
The Making of the CMOS Microchip	How a CMOS Microchip is made.	Determine the process steps needed to complete a CMOS device.	<a href="#">Launch</a>
The Deposition Process	An animation of the chemical vapor deposition process.	Identify the process of chemical vapor deposition.	<a href="#">Launch</a>
Workflow in the CVD Tool	Animation of Workflow in the CVD Tool.	The steps in the CVD process cycle will be a unique step in the recipe. There may be more steps, or minor variations, but most CVD process recipes will look very similar	<a href="#">Launch</a>

[www.matec.org/animations](http://www.matec.org/animations)





# Thank You!

**Want to know more? Contact:**

[michael.lesiecki@domail.maricopa.edu](mailto:michael.lesiecki@domail.maricopa.edu)

[xaxiri.yamane@domail.maricopa.edu](mailto:xaxiri.yamane@domail.maricopa.edu)

*This presentation will be available for viewing on:*

<http://nano4me.org/educator-resources>