

THE FUTURE IS...

N.E.A.R.

(Nanotechnology Education And Research)

North Penn High School Engineering Academy

**The Governor's Institute for Technology Education
The Future is N.E.A.R.
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**North Penn High School Engineering Academy
Nanotechnology Education and Research (N.E.A.R.)
(5495) Engineering Design and Development**

Mr. Michael A. Boyer

boyerma@npenn.org
www.TheFutureIsNEAR.org
www.engineering.nptechd.org

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Electrospinning Design of Experiment (Nanophlex)
Research Paper (Nanophlex)
Student Reflection Page About Nanotechnology

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Controlled Deposition of Poly (ethylene oxide) Fibers
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The Future is N.E.A.R. Newsletter Volume 1, Issue 2

Nanotechnology Links

1. <http://www.thefutureisnear.org>
The Future Is Near Website
2. <http://nanoresearch.thefutureisnear.org>
Student Research - The Future Is Near Website
3. <http://www.drexel.edu/coe/research/research-teachers.asp>
Drexel University – Research Experiences For Teachers Information
4. <http://www.cneu.psu.edu/>
Penn State Center for Nanotechnology Education and Utilization
5. <http://www.nano.gov/>
National Nanotechnology Initiative
6. <http://www.google.com/search?hl=en&q=nanotechnology>
Google Search: Nanotechnology
7. <http://www.zyvex.com/nano/>
General nanotechnology Information
8. <http://www.nanoscience.com/education/AFM.html>
Atomic Force Microscopy Overview
9. <http://www.mos.org/sln/SEM/>
Scanning Electron Microscopy Overview
10. <http://www.nanoscience.com/education/index.html>
Nanoscience Education Links and Information

Grant / Funding Links (Search Google)

1. ING Unsung Heroes
 2. Toshiba
 3. Toyota Tapestry
 4. NSF
 5. DuPont
- and many more... just Google search it...

Lesson 03 Nanotechnology Pre-assessment

Name _____ Date _____ Period _____

Instructions:

For this activity, please answer the following questions to the best of your ability. At this time, do not use any assistance from the Internet or books. This is a pre-assessment of your knowledge. Place your answers directly below each statement in **red**. This pre-assessment is utilized to gain your knowledge about nanotechnology and electrospinning prior to beginning this activity.

Nanotechnology Basics

1. The prefix "nano" comes from a Greek word meaning _____. Dwarf
2. What is a nanometer?
3. What is the typical range (in nm) to be considered nano?
4. If a nanometer were as big as the width of a pin head, about how long would a meter be?
Example:
As long as a trip from Washington, D.C. to Atlanta, Ga.
A pin head is about a millimeter wide. If a nanometer were as wide as a pinhead, then a meter would have to be a billion times bigger or a billion millimeters. One billion millimeters is equal to about 1,000 kilometers (or about 620 miles). The distance (traveling by road) between Washington, D.C., and Atlanta, Ga. is 632 miles.
5. What is a micrometer (micron)?
6. What is the average diameter of a human hair?
7. How would you measure the diameter of a hair?
8. What is the unit of measure called the Angstrom?
9. How many hydrogen atoms lined up "shoulder to shoulder" would fit in a one nanometer space?
10. What is a nanonewton?
11. Since traditional Newtonian Physics does not apply in the nano world, what other field within Physics must be utilized?
12. What is the confinement theory?
13. What is meant by the term convergence?
14. What is Moore's Law?

15. Who started the revolution of thinking at the sub-micron level?

16. What are the benefits of nanotechnology?

17. What are the downfalls of nanotechnology?

Electrospinning Basics

18. What is electrospinning?

19. What are the two major ways that can you electrospin? (Orientation)

20. How can this process produce nanofibers?

21. What is a kilovolt?

22. How many volts/cm are typically used in an electrospinning apparatus?

23. What electrical principle is the key to the electrospinning process?

24. What are the contributing factors that control the fiber diameter in an electrospinning apparatus?

25. What environmental conditions affect the electrospinning process?

26. What are the necessary materials and equipment to electrospin?

27. What are the main influential factors/conditions that affect the resulting fiber?

Polymer Basics

28. What is a polymer?

29. What is molecular weight?

30. What effect does molecular weight have on fiber production?

31. What is DeIonized water?

32. What is PEO?

33. Where is PEO used commercially?

34. What polymers are typically used in the formation of conductive fibers?

35. What is a solvent?

36. What is a solute?
37. What is meant by the term, weight percent?
38. How do you calculate the weight percent of a polymeric solution?
39. How do you prepare a polymer for electrospinning?
40. What is the difference between weight percent and volume percent?
41. How do you prepare a polymer solution for electrospinning?
42. What is viscosity?
43. How do you measure viscosity?
44. What is a MSDS and what does it tell a consumer?
45. What is statistical analysis?

Measurement and Quantification

46. How do you measure the strength of a nanofiber?
47. How can you manipulate a nanofiber?
48. What equipment (instruments) are used in the study of nanotechnology?
49. What is a SEM?
50. What is a TEM?
51. What is a STM?
52. What is Raman Spectroscopy?
53. What is FTIR?

Lesson 06 Nano-Products Activity

ALL All Group Activity

Preface:

This activity is designed to introduce the students to products that are utilizing nanotechnology today. The Penn State University nano-products kit will be utilized to introduce the students at a relatively simplistic level while sparking their interest in and promoting discussions about nanotechnology. Conversations about the past, present and future uses and other related topics will be discussed.

Expected Timeframe and Start Date:

4 Class Periods

Standard Statement(s):

Listening, Writing, & Speaking Standards

Content Objective(s):

For this activity, the students will:

1. Research and collect data about current products that utilize nanotechnology from the nano-products kit supplied by Penn State University.
2. Students will use the Internet to reinforce that data found in the product literature and record that information in their journals.
3. Prepare and introduce a presentation about their specific product to the class.
4. Ask and answer questions about their products.
 - a. In particular: Why is it nano? Where else can it be used?
5. Document their work and the work of their peers in their engineering journals.

Procedures:

1. Opening discussion about products that utilize nanotechnology today:
 - a. Are their nanotech companies in business today?
 - b. Where do you think nanotechnology is being utilized today?
2. Introduce products from kit to students with a brief introduction to the activity.
 - a. In the bag is one product and a brief write up.
 - b. Read and familiarize yourself with the product.
 - c. Search for information specific to the product:
 - i. Product Website?
 - ii. Other companies and products that utilize that same form of technology
 - iii. Record findings and website addresses in journal.
 - d. Prepare a presentation to the group.
 - i. Teacher will demonstrate one product. (Model)
 - ii. Students will write a rough outline of their presentation in their journals. Students will include the following information:

Suggested Level:

Grades 10- 12

PA State Standards:

Reading, Writing, Speaking

- | | |
|--------------------|----------------------|
| 1.1.11 A,B,D,E,F,G | Read Independently |
| 1.4.11 B,D | Types of writing |
| 1.6.11 A,D,E,F | Speaking & Listening |
| 1.8.11 A,B,C | Research |
| 3.1.12.D | Science & Technology |

Materials:

Course Website (Network and Internet)
 Internet
 Engineering Journal
 Nanotech Bag – (PSU)
 PowerPoint

Contacts:

Amy Brunner (Penn State University)
abrunner@engr.psu.edu

Mike Boyer
boyerma@npenn.org

1. Display the product.
 2. Explain what it does.
 3. What makes the product a "nano" product?
 4. Explain and discuss the specific nanotechnology behind the product.
 5. Develop a PowerPoint presentation
 6. Present, ask and answer questions.
- e. Wrap up discussions

Assessment Strategies:

1. Presentation Evaluation
2. Journal Evaluation

Related Web Sites:

http://www.nnin.org/nnin_nanoproducts.html

<http://www.sciencemuseum.org.uk/antenna/nano/>

http://www.nanovip.com/directory/Products_and_applications/Commercial_products/index.php

<http://www.thefutureisnear.org>

Nanotechnology Products

Name _____ Date _____ Period _____

Nanotechnology, as new as it is, is being utilized commercially in many products today. Most consumers are not even aware that their products are "high tech". The goals of this activity are to research several different products that have incorporated nanotechnology into their designs and to identify how the technology is being utilized.

Activity Goals

For this activity, you will be given a product that has incorporated nanotechnology. Your goal will be to complete the steps outlined below:

1. Familiarize yourself with the product. Read the supplied information sheet.
2. Search and document the manufacturer's website and other Internet websites for supporting information of the actual product or other products that utilize the same technology (competitors).
3. Record findings, web addresses, and other supporting information in your journal.
4. Prepare a presentation:
 - a. PowerPoint (minimum 3 slides)
 - b. One page class handout
 - i. Name and Picture of Product (You will have access to a digital camera)
 - ii. Description of product's purpose
 - iii. Description of the nanotechnology that is utilized
 - iv. Other supporting information
 - c. Future/other applications of the product and/or technology
 - d. Questions/wrap-up
5. Present product to class (5 to 7 minutes)

Your activities will be posted to the class website on the Internet. Be sure to do your best work!

Expected Timeframe

Expected Timeframe:

Introduction to the activity
Product Research and data compilation
Class Presentations

4 Class Periods
1/2 class period
1-1/2 class periods
1-1/2 class periods

Polymer Preparation – Mass Percent (Weight Percent) Calculations

Name _____ Date _____ Period _____

This activity is designed to introduce you to the procedures in preparing a polymer solution for Electrospinning.

Process and Materials Manager Responsibilities (PM²)

Your responsibility for this activity will be to prepare a given weight percent of polymer solution (PEO/DiWater) for your group to electrospin. This solution will be utilized for the introduction to electrospinning activity. You will develop a standard procedure (step by step) for preparing a polymer solution in a Word document and have your CM post it to your website after a final review.

Communication Manager (CM) and Safety Manager (SM) Responsibilities

The safety managers will develop a set of safety procedures for the polymer preparation process and equipment. The communication managers will develop a set of instructions on how to utilize the pipetter, the gram scale and the magnetic stirrer.

Manager Responsibilities

For this activity, all team managers will have specific responsibilities as outlined below.

Responsibilities:

Process and Materials Managers	Communications and Safety Managers
<ol style="list-style-type: none"> 1. Calculate the requirements for your polymer solution. 2. Prepare your polymer solution <ol style="list-style-type: none"> a. Record all steps and procedures b. Identify any possible safety hazards and forward them to you safety manager for inclusion into their documentation. 3. Create a Word document that outlines the procedures for preparing the polymer solution. <ol style="list-style-type: none"> a. Section 1: Title b. Section 2: Introduction (Background Info/Formulas) c. Section 3: Materials d. Section 5: Initial Conditions (solution calculated, materials obtained, etc.) e. Section 6: Procedure (Include Images) f. Section 7: Safety Considerations g. Section 8: Other Information 4. Submit the file for evaluation and a copy of the final to your CM for inclusion onto the website. 	<p>Communications Managers</p> <ol style="list-style-type: none"> 1. Create a set of operating instructions for the following equipment: <ol style="list-style-type: none"> a. Green Pipetter b. Gram Scale c. Magnetic Stirrer 2. Place your procedures in separate word documents. Submit to your CM for placement onto the website after final review. <p>Safety Managers</p> <ol style="list-style-type: none"> 1. Develop a set of safety precautions for the polymer solution process and the three pieces of equipment listed above. 2. Finalize your findings in separate word documents. 3. Submit the file for evaluation and a copy of the final to your CM for inclusion onto the website.

Your activities will be posted to the class website on the Internet. Be sure to do your best work!

Expected Timeframe

Expected Timeframe:

Introduction to the activity
 Product Research and data compilation

4-½ Class Periods
 ½ class period
 4 class periods

Laboratory Safety – MSDS Sheet Activity

Name _____ Date _____ Period _____

This activity is designed to introduce you to Material Safety Data Sheets (MSDS), how to locate them, assess the information within, and most importantly, create a reference library for your research team. This activity will be performed by all members within each team. The Safety Managers (SM) will perform their research on the polymers and solvents that will be utilized in our research, the other team members (CM and PM²) will be performing research on other items identified in class.

Safety Manager Responsibilities

Once each Safety Manager has performed their research, they will meet with all safety managers, compile their information into a PowerPoint, and relay the information back to their individual team members. The communications manager will be responsible for posting the MSDS information onto the team website.

Communication Manager (CM) and Process and Materials Manager (PM²) Responsibilities

All other members will submit their MSDS research in word document format for evaluation and inclusion into the team website.

Manager Responsibilities

For this activity, all team managers will have specific responsibilities as outlined below.

Responsibilities:

Safety Managers	Communications and Process and Materials Managers
5. Locate and Download the following MSDS sheets: <ol style="list-style-type: none"> Polyethylene Oxide Polyvinyl Alcohol DeIonized Water 	2. Locate and Download the following MSDS sheet: <ol style="list-style-type: none"> Polyaniline
6. Summarize the 8 major sections of each MSDS into a PowerPoint. <ol style="list-style-type: none"> Section 1: Product/Manufacturer's Identity Section 2: Hazardous Ingredients Information Section 3: Physical Data Section 4: Fire and Explosion Hazard Data Section 5: Reactivity Data Section 6: Toxicological Properties Section 7: Preventative and Control Measures Section 8: Emergency First Aid Procedures 	3. Summarize the 8 major sections of the MSDS into a Word Document. <ol style="list-style-type: none"> Section 1: Product/Manufacturer's Identity Section 2: Hazardous Ingredients Information Section 3: Physical Data Section 4: Fire and Explosion Hazard Data Section 5: Reactivity Data Section 6: Toxicological Properties Section 7: Preventative and Control Measures Section 8: Emergency First Aid Procedures
7. Compile a PowerPoint for each of the three materials.	4. What is so special about this polymer in relationship to the electrospinning process?
8. Present your PowerPoint to the class	5. Any other pertinent information.
	6. Finalize your findings in a word document.

Your activities will be posted to the class website on the Internet. Be sure to do your best work!

Expected Timeframe

Expected Timeframe:
 Introduction to the activity
 Product Research and data compilation
 Team Presentations

3-1/2 Class Periods
 1/2 class period
 2 class periods
 1 class period

Nanotechnology Unit Summary

For this activity, the students in the senior design capstone course of the Engineering Academy at North Penn High School will study and perform formal research in the emerging field of nanotechnology. The students will collaborate in teams of three; each with a specific responsibility. Their ultimate goal will be to design and perform their own electrospinning experiments that will plot the diameter of their electrospun nanofibers as a function of a series of identified variables such as: (1) polymer concentration, (2) electric field strength and (3) collection plate distance. The students will research the chemical properties of the polymer, locate and summarize the eight major sections of its Material Safety Data Sheet and identify how to measure, create and store their polymer solutions. Engineering documentation, design of experimentation, web-based proposal and documentation development, a study of the societal impacts of nanotechnology, properties of polymeric materials, chemistry and physics in the materials environment, and the use of high level instrumentation at Drexel University in Philadelphia, PA are all a part of the proposed activity.

This activity is like no other at the high school level. Students participating in the Future is N.E.A.R. (Nanotechnology Education And Research) program will be applying their knowledge of nanoscience and nanotechnology to engineering research through the use of higher level mathematics, statistical analysis, physics (quantum vs. Newtonian), chemistry and formal research. Through this rigorous research activity, students will learn to design their own experiments, analyze, quantify, assess and present their collected research data while at the same time, prepare themselves for the rigors of college life and the competitive, globalized world.