Exploring Nano-Products

Description:
The instructor introduces products that have been made using nanotechnology. The students explore the products and explain them to the rest of the class. Finally, the instructor discusses other products that are available now and some that may be available in the future.

Prerequisites:
Student should have an introductory knowledge of nanotechnology (which can be provided by Kits 1 and 2).

Instruction Time:
Approximately 30 minutes

Audience:
Middle or high school students

Lesson Objective:
Students will learn about some current nanotechnology products and others that may soon be available. Students will explore the products and present them to their peers.

National Science Education Standards:
Content Standard E: Understandings about Science and Technology.

Illinois State Learning Standards:
13.B.5b Analyze and describe the processes and effects of scientific and technological breakthroughs.

Instructional Method:
The instructor introduces students to nanotechnology products. Then students work in teams to read about the products, explore them, and explain how they work to the class. Finally, the instructor uses a PowerPoint presentation or overheads to discuss other products on the market or in development.

Materials:
• 1 evaluation and 30 assessments
• Power Point presentation and documents on CD
• overhead transparencies of slides
• 9 nano-products with fact sheets, experiment sheets, and exploring materials in pouches

Teacher needs: LCD or overhead projector

Preparation:
Read the product fact sheets. Fill the water bottles for student use. Set up the packages, fact sheets, and other materials in stations throughout the room or in tubs. Prepare to do the presentation. Divide the students into groups.

Background Information:
The products explored in this lesson are produced using nanotechnology. Nanotechnology is technology that is focused on the nanoscale. A nanometer is one-billionths of a meter. At the nanoscale, the properties of matter differ from their properties at larger scales.

There is a great deal of activity in science, engineering, and industry to develop nano-products that have novel properties. Researchers are working towards developing better tools and methods so that products can be made more efficiently and affordably. This lesson gets students acquainted with some of the currently existing and upcoming nano-products. The inquiry-based lesson also helps students to be aware of the need to be critical when dealing with advertising that claims support from science.

This learning kit was made possible through a generous gift from Motorola, Inc., and through support from the National Science Foundation.
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**Safety:**

Students who deal with the waxes should use gloves when doing the experiment. Otherwise, involvement in this activity poses minimal safety issues.

**Presentation Details:**

**Slide 1 (Exploring Nano Products):** Today we will be exploring nanotechnology even more.

**Slide 2 (Objectives):** The purpose of this activity is for you to become aware of some of the nanotechnology-based products on the market and others that are being developed. We will use inquiry to explore the products.

**Slide 3 (Nano-products):** With your group members, you will get a package including a nano-product, a fact sheet, and an experiment. I’d like you to check out the product and follow the directions given to experiment with the product. With your team members, decide if the claims made by the company seem to be accurate. After you have had a chance to explore it, you will tell the class what is cool about it and what is nano about it. You will also state why someone would want to buy it. (Engage the students in a follow-up discussion. Discuss if, in general, the products lived up to the students’ expectations. If they did not, discuss why this might be the case. Some reasons include that the experiments need to be better controlled, some of the observations are subjective and require instruments for us to make more objective measurements, some of the products may not be as good as the company claims that they are, etc.) As you have seen today, there are numerous nano-products available on market.

**Slide 4 (Diamonds grown in labs):** What you saw in your exploration is just a fraction of those companies who claim that nanotechnology is used in their production. I’d like to show you a few more products that are on the market and in development. Some companies, like Apollo Diamond, are claiming that they can make diamonds from raw materials using nanotechnology. We will be able to use them for jewelry and they will be used in manufacturing to etch and cut materials.

**Slide 5 (Personalized cosmetics):** One company called Bionova is producing individualized cosmetics. Some very wealthy tennis stars and others think that the nanotechnology used to make the cosmetics makes a difference. You can go to the Bionova website and specify your unique characteristics, like your age, skin problems, climate, etc., to order the product that is right just for you! At this point the products are very expensive—several hundred dollars for a few ounces of skin cream.

**Slide 6 (Health and environment):** There is a new cleaning agent made by Envirosystems called EnviroTru (formerly EcoTru). It is different from traditional cleaners in many ways. Read the company’s claims on the slide. Can you think why this product might be useful? (Answer: For use in airplanes, hospitals, bioterrorist attacks, military, etc.) It is already used in health care facilities, cruise ships, and airplanes. It is unique in that it is the only EPA-registered Tox Category IV product for disinfecting. What this means is that if you get it on your skin or eyes, consume it, or inhale it, it does not harm you. Actually, when Doctors without Borders (a non-profit traveling medical team) ran out of their usual antiseptic in their operating room, they ended up having to use EnviroTru on their patients. Out of the 500 patients that this product was used on, none got an infection!

**Slide 7 (Computers):** With transistors being made at the nanoscale, our computers will become lighter, smaller, slimmer and will increase computing abilities.
Slide 8 (Shipping): I’d like you to think of some problems associated with the shipping of materials. (Answer: There are bioterrorist issues, items can spoil, items may be contaminated, etc.) Nanotechnology may provide some solutions to these issues. Scientists and engineers are working on developing ultra-sensitive sensors that can detect bioterrorist agents. In addition, sensors like these could detect spoilage or contamination of food.

Slide 9 (Current medicine): What are some problems with the current options for cancer treatment? (Answer: sickness and hair loss caused by treatments, high cost, ineffective results, cancer discovered when it is too late, etc.) In upcoming years, nanotechnology may be able to help us prevent and treat cancer better than we have ever been able to do before.

Slide 10 (Better treatments): The National Cancer Institute is using nanotechnology to improve the way that we treat cancer. Researchers anticipate major changes in cancer treatment options in the next five years. Scientists and engineers are focusing on a number of areas of research. One of these areas is personalized therapy. Using genetic information, a cancer patient might soon be able to get treatment specific to his/her particular type of cancer. Scientists are also working on improving the ability to detect cancer early. This involves developing devices that can detect just one cancerous cell, so that the cancer can be dealt with before it is too late. Researchers are also working on nanoparticles that can image or "show" cancerous cells in order for surgeons to be able to see them more precisely, and thus, remove all of the cancer. Nanoshells are being developed that can deliver the cancer-killing drugs directly to the cancerous site without killing healthy cells. More effective drugs are being explored as well. Finally, researchers are working on biosensors that can detect changes in one’s genetic material or increases in numbers of certain cells.

Slide 11 (Medical nanobots) Now let’s look into the future: Researchers in the field of nanomedicine and cancer are interested in the possibility of nanorobots or “nanobots”: nanoscale machines that could be released into parts of the body to do “miniature surgery” on DNA, organelles, and cells. Instead of getting chemotherapy or invasive surgery for cancer, medical nanorobots could be released into the body at the specific site of the cancer and destroy only the cancerous cells. Some scientists believe that curing certain diseases like cancer with nanotechnology may be possible soon.

Slide 12 (Carbon nanotubes): Let’s now focus on a material that has amazing properties. Scientists and engineers have learned how to make a material called carbon nanotubes. These structures are 100 times stronger than steel, but much lighter. How do you think these properties might be useful? (Answer: Stronger and more durable materials can be manufactured.)

Slide 13 (Sports equipment): Due to their amazing strength, carbon nanotubes are being used in sports equipment. Why do you think that is the case? The carbon nanotubes are added to other material to make composites for use in tennis rackets, bicycle handlebars, and golf clubs. This equipment is becoming more durable and, at the same time, lighter due to nanotechnology. Scientists and engineers have found other uses for it as well.

Slide 14 (The space shuttle): Let’s get to our last topic: space exploration. Can you think of some problems associated with the use of space shuttles? (Answer: They are very expensive to build and operate, they are dangerous (because people are sitting on a tank of explosive fuel), fuel is costly, there is some damage to the ozone as the shuttle passes through that layer, etc.) What if we make the fuel more efficient? What if we could construct the shuttle from materials that contained self-healing polymers? We could save a lot of money on repairs of spacecraft. Nanotechnology offers us the potential to do so. But what if we could eliminate the need for the space shuttle, by building an "elevator" to space?
**Slide 15 (The space elevator):** For a long time, researchers explored the idea of building a structure high enough to reach outer space. It seemed that this would be impossible since no material seemed to be strong enough to prevent the structure from collapsing on itself. After carbon nanotubes were discovered, scientists and engineers started thinking again about replacing the space shuttle with a space elevator. The space elevator would be a structure with a carbon nanotube backbone that would allow us to send material into space, and potentially explore space more cheaply. Can you imagine the possibilities? (Answer: Material could be sent into space cheaply, we could save on fuel and building costs, we could travel to space, etc.) Sending material into space using a space elevator could cost as low as $100-400/lb. vs. the $10,000/lb. that it costs to use a space shuttle.

**Slide 16 (More to come!):** There will be more and more products developed in upcoming years. How do you think that these products might affect your life? (Allow students to be creative; the possibilities are exciting!) Today we have seen some of the nano-products that currently exist and some possibilities for the future. Hopefully, this lesson leaves you even more interested in nanotechnology!

**References:**


Established in 2003, the Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems (Nano-CEMMS) is funded by the National Science Foundation. Partnering Institutions include the University of Illinois, North Carolina Agriculture and Technical State University, Stanford University, University of Notre Dame, University of California – Irvine, and Northwestern University. Researchers are developing a nanomanufacturing system that will build ultrahigh-density, complex nanostructures. The Center’s research will ultimately result in a new way of working and has the potential to create millions of jobs for American workers. Our nation’s school children must be prepared to assume the new roles that will be the inevitable outcome of these emerging technologies.

This learning module is one of a series designed to interest middle and high school students in pursuing this new field. The Center also offers ongoing professional development for teachers through a continuous series of workshops and institutes. To sign up for a workshop or to order more learning modules, visit our website at http://www.nano-cemms.illinois.edu.

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