



It's a Small World

Nanotechnology: Physical and Chemical Properties Can Change in Unexpected Ways When Materials Are Very Small



Dayton, OH (Wright-Patterson Air Force Research Lab)—Scientists are working with nanotechnology to manipulate elements so they can develop new materials and products such as flexible solar panels. Nanotechnology is the science of studying things that are very small—on the scale of atoms. Scientists are interested in controlling the way atoms are arranged in various materials so that the materials will exhibit different physical and chemical properties. Scanning tunneling microscopes and atomic force microscopes are being used to see at these very small scales and also to manipulate materials.

"Nanotechnology is the science of studying things that are very small." Joseph McDermott, **nanomaterials scientist**

Framework

Middle School

Standards

- NSES - B.iii.3 ➤ Light interacts with matter.
- STL - 3.E ➤ A product developed for one setting may be applied to another setting.
- STL - 3.F ➤ Knowledge from other fields has an effect on development of technology.
- STL - 10.G ➤ Invention and innovation play a role.

Content Illustrated

- Vials of solutions containing different-size nanoparticles of gold are lined up next to a large chunk of gold. The solutions exhibit a dramatic range of colors.



Content



Life Science

- A human hair is 50,000-80,000 nanometers in diameter.

Physical Science

- The size and shape of nanoparticles will cause varied interaction with light. The size of a lightwave is similar to the size of a gold nanoparticle. Slight differences in the sizes of nanoparticles will cause dramatic differences in the color observed when light reflects off these particles in solution.
- All matter is composed of atoms.
- Nanoparticles of elements have different physical and chemical properties than larger particles of the same element. When working at the nanoscale, materials may exhibit unexpected physical and chemical properties.

Technology

- Two different kinds of microscopes are used to see particles at the nanoscale. Scanning tunneling microscopes use electricity to see the surfaces of metals. Atomic force microscopes use lasers to look at the surfaces of everything else.
- Nanotechnology has allowed the creation of flexible solar cells made of nanostructured titanium dioxide.
- Regular solar cells are made from giant pieces of silicon on glass. Flexible solar cells are on plastic. They are cheaper, lighter, and 10,000 times more efficient than regular solar cells. One day you'll be able to go out and buy them.

Engineering

- Technologies exist that let scientists and engineers manipulate matter at the nanoscale. Manipulating atoms allows engineers to control the properties of materials.
- Scientists are learning about and creating methods for putting atoms "exactly where we want them."

Math

- One nanometer is one billionth of a meter. For every meter, there are one billion nanometers.

Guiding Questions

To think about as you watch:

- What is a nanometer? Why do you think material properties change at the nano-scale?
- What kinds of tools or technologies are needed to manipulate materials at such a small scale?

Suggested Activities

- Find out about the latest trends in nanotechnology. What materials are researchers using at the nanoscale?
- Come up with some examples of pairs where one item is 50-80,000 times smaller than the other.

➤ *It's a Small World* can be found online at www.ndep.us/Its-a-Small-World. Visit www.ndep.us/LabTV for a list of process skills modeled in webisodes.

Keywords

atom, atomic force microscope, flexible solar cell, nanometer, nanoparticle, nanotechnology, lightwave, properties, scanning tunneling microscope, silicon, solar cell, titanium dioxide