

nanoparticles

WHAT ARE NANOPARTICLES?

Nano- is a word that refers to very small things. A nanometer is a measurement of one billionth of a meter (10^{-9} meter). **Nanoparticles** are tiny particles in the size range from 1 to 100 nanometers. They can only be seen with a microscope. For comparison, a human hair is 40,000 - 100,000 nanometers thick!

Nanoparticles can be classified according to their source as **naturally occurring particles** (also called ultrafine particles), **incidental nanoparticles**, and man-made or **engineered nanoparticles**.

Engineered nanoparticles are used in a variety of areas, such as: automotive industry, communication technology, pharmaceutical and chemical industries, as well as food and cosmetic industries. For example, zinc, and titanium oxide nanoparticles can be found in sunscreens; ceria, alumina, and silica nanoparticles are used in the semiconductor industry; carbon nanotubes are used in sporting goods; and iron nanoparticles are applied in environmental pollution cleanup.



Elemental tellurium nanoparticles (black flakes) attached to microorganisms taken using transmission electron microscopy (Photo credit: Dr. Reyes Sierra and Tony Day).

Where do nanoparticles come from?

Naturally occurring particles are released into the environment from **natural processes** like volcanic eruptions, wind erosion, and sea wave sprays.

Incidental nanoparticles are **produced accidentally during a man-made process**. These particles can be found in cooking smoke, automobile exhaust, welding fumes, and industrial effluents.

Engineered nanoparticles are **made intentionally in many industries**, such as the petroleum, chemical, environmental, and biomedical. They can be found in products from fabric in clothing, to computer microchips, to personal care products like sunscreen.

What are nanoparticles used for?

According to the Woodrow Wilson Institute's Project on Emerging Nanotechnology, there are over 1,600 consumer products that contain engineered nanoparticles. Some of these products are:

Sunscreen - A lot of newer sunscreens contain zinc oxide or titanium oxide nanoparticles. Older sunscreens used larger zinc oxide or titanium oxide particles, which is what gave them a whitish color.



Clothing - Some fabrics are coated with zinc oxide nanoparticles to give better protection from ultraviolet radiation. Some clothing also have nanoparticles in the form of little hairs that help repel water and other materials that makes the clothing stain or odor resistant.



Antimicrobial bandages - Silver nanoparticles are used in special antimicrobial bandages. The silver interferes with the microbe's energy production pathways resulting in death. These bandages are commonly used for burns.



Rubber tires - Carbon nanoparticles are mixed with rubber to enhance the strength of some tires and to reduce abrasion and improve tire wear.

What are the potential problems with nanoparticles?

Nanoparticles act differently from larger sized particles even if they are the same materials. Due to their small size, nanomaterials are often highly reactive and have unusual electronic and optical properties that make them very attractive for many industrial and consumer applications. Nanomaterials can remain in air for several days and can be carried thousands of miles, much longer than larger particles. The novel properties of engineered nanomaterials raise concerns about the potential for adverse effects on biological systems. Once these particles enter a new environment, they can interact with the atmosphere, soil, or water, making their effects on the local environment very complicated.

One nanoparticle is to a soccer ball as a soccer ball is to the Earth!



0.01 meters



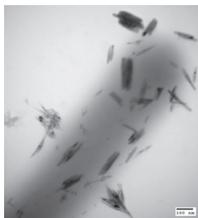
10,000,000 meters

Nanotechnology (the study and use of nanoparticles)

The nanotechnology industry has significantly expanded since the mid-twentieth century. The worldwide market for its products is estimated to reach over \$5.5 million by 2016.

Can nanoparticles affect my health?

Adverse health effects from nanoparticles depend on the particle size and makeup. Studies have shown that some of these particles pass into the human body by absorbing through the skin, while others do not. Additional studies have shown that certain nanoparticles move easily into sensitive lung tissues after inhalation, causing damage that can lead to breathing problems, or be transported to other parts of the body. Also, several studies have found that inhaled nanoparticles are able to enter the circulatory system to potentially cause cardiovascular problems. Other studies on nanoparticles have also shown little to no adverse health effects. **The bottom line: we are not sure at this time if nanoparticles are harmful (and when and which aren't).**



Breathing - Nanoparticles released into the air may remain suspended and inhaled. For example, spray-on sunscreen, antibacterial products in spray containers, and pesticides products can release these particles.

Swallowing - Nanoparticles that are released into the air may settle on food and can be ingested. These particles have been detected in drinking water, but it is uncertain if they are from natural or engineered sources. It is known that their removal from drinking water treatment systems will be difficult due to their small sizes (can represent a potential exposure through ingestion).

Skin contact - Creams and lotions containing nanoparticles that are applied directly to the skin and other products such as tennis rackets, helmets, fabrics, and antimicrobial soaps could also pose a potential risk.

Are nanoparticles harmful to the environment?

To date, there are limited regulations on nanoparticles disposal, so they could end up in our environment. The very things that make these particles so valuable for so many industries, increase the potential for harmful impacts on the environment. Nanoparticles have widely varying compositions, meaning that their potential toxicity varies greatly. Many kinds of nanoparticles are suspected of being harmful to animals, plants, and microorganisms. To add to the complexity, nanoparticles can increase the toxicity of other pollutants. For example, studies have found that nano-sized titanium dioxide (nano-TiO₂) can interact with heavy metals already present in the environment and double the amount of heavy metals found in fish.

How can I reduce my exposure to nanoparticles?

One way to prevent exposure is to avoid using products containing nanoparticles. At this time, manufacturers in the United States are not required to label products containing engineered nanoparticles, however, some voluntarily declaring the presence of these materials on their websites or packaging. Other guidelines to help reduce nanoparticles exposure are:

At work:

- Make sure to be properly trained on the safe handling of these materials.
- Request information on the hazardous properties and how to prevent exposure.
- Always use personal protective equipment (e.g., coats, gloves, respirator).
- Wash your hands before eating or leaving your workspace and do not eat or drink in work areas.

At home:

- Use a wet mop to clean floors.
- Use a vacuum cleaner with high efficiency particulate arrestance (HEPA) filters.
- Dust surfaces with a damp cloth.
- Wash your hands after being in contact with dust.



Want to learn more about nanoparticles?

U.S. ENVIRONMENTAL PROTECTION AGENCY

www.epa.gov/chemical-research/research-nanomaterials

www.epa.gov/expobox/exposure-assessment-tools-chemical-classes-nanomaterials

CENTERS FOR DISEASE CONTROL AND PREVENTION/NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

www.cdc.gov/niosh/topics/nanotech/

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

www.osha.gov/dsg/nanotechnology/nanotechnology.html

ENVIRONMENTAL HEALTH PERSPECTIVES

www.ncbi.nlm.nih.gov/pmc/articles/PMC3060016/pdf/ehp-119-a120.pdf

THE PROJECT ON EMERGING NANOTECHNOLOGY, CONSUMER PRODUCTS INVENTORY

www.nanotechproject.org/cpi/

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<https://www.superfund.arizona.edu/info-material/survey-form>

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