Nanotechnology: An EPA Research Perspective

Factsheet

Nanotechnology is one of the top research priorities of the U.S. government. EPA is a part of the government-wide National Nanotechnology Initiative (NNI), which provides coordination and direction for this emerging field. While many definitions for nanotechnology exist, the NNI calls it "nanotechnology" only if it involves all of the following:

1. Understanding and control of matter at dimensions of roughly 1 to 100 nanometers, where unique phenomena enable novel applications;
2. Encompass nanoscale science, engineering and technology;
3. Imaging, measuring, modeling and manipulating matter at this length scale.

www.nano.gov

How does nanotechnology relate to the environment?

The laws of quantum mechanics often cause dramatic changes in the mechanical, optical, chemical, and electronic properties of materials on the nanoscale. These properties lead to useful and enhanced applications of nanotechnology in environmental protection including sensors for improved monitoring and detection capabilities, treatment and remediation techniques for cost-effective and rapid site cleanup, green manufacturing to eliminate the generation of waste products, and green energy technology for the creation of commercially viable clean energy sources.

Manufactured nanomaterials might also pose risks to human health and other organisms due to their composition, reactivity, and unique size. Thus it is equally important to consider potential interactions of nanomaterials with the environment and the potential associated risks. This involves studying the fate and transport of nanoparticles in the air, soil, and water and the lifecycle aspects of manufactured nanomaterials. Risk assessment also includes studies on the toxicity of natural and manufactured nanomaterials, as well as the routes of exposure to humans and other organisms and potential for bioaccumulation and biotransformation.

What is EPA doing in nanotechnology research?

EPA has taken a leadership role in planning research directions for the environmental applications and implications of nanotechnology—through its own research programs and participation in the interagency Nanoscale Science, Engineering, and Technology subcommittee of the White House Office of Science and Technology Policy, National Science and Technology Council.

EPA's nanotechnology research and development efforts include the following:

EPA's National Center for Environmental Research (NCER), through the Science to Achieve Results (STAR) program, has funded 35 research grants for more than $13 million in the applications of nanotechnology to protect the environment including the following: development of low-cost, rapid, and simplified methods of removing toxic contaminants from surface water; new sensors that are more sensitive for measuring pollutants; green manufacturing of nanomaterials; and more efficient, selective catalysts.

At least one application is moving rapidly toward commercial application—zero-valent iron nanoparticles are being field tested and proven effective in reducing chlorinated organics from contaminated groundwater sites.
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NCER's STAR progam has also funded research projects totaling over $10 million studying the possible harmful effects of manufactured nanomaterials, i.e., toxicity, fate, transport and transformation, and exposure and bioaccumulation. A new research solicitation for 2006 was announced in collaboration with three other federal agencies to study the health and environmental effects of manufactured nanomaterials.

Through its Small Business Innovation Research Program, EPA has awarded contracts to more than 30 small companies totaling over $2.5 million. Recently, an SBIR company demonstrated an activated carbon nanofiber filter with large surface area that more efficiently removes volatile organic compounds and particles smaller than 3μm from engine exhaust, power generators, and indoor air.

EPA research laboratories have begun nanotechnology research in such topics as the following: nanostructured photocatalysts as green alternatives to oxygenation of hydrocarbons; using nanomaterials as adsorbents, membranes and catalysts to control air pollution and emissions; optimizing engineered nanoparticles for rapid in situ removal of pollutants. Over 60 people from across EPA formed a Nanotechnology Impact workgroup that has developed a "white paper" that examines the potential applications and implications of nanotechnology on human health and the environment. This paper is undergoing peer review.

Research Workshops and Symposia

EPA has convened several workshops and symposia on environmental aspects of nanotechnology. EPA scientists and engineers organized a workshop to determine research directions for the NNI "grand challenge" on nanotechnology and the environment.

From 2003 to 2006, EPA scientists and engineers—along with their university, government, and industry colleagues—organized symposia on nanotechnology and the environment at the American Chemical Society's annual meetings. A book of proceedings from the 2003 meeting was released at the end of 2004.

Researchers from seven federal agencies presented results on nanotechnology applications and implications for the environment at workshops held in 2003. Proceedings can be found at:
http://es.epa.gov/ncer/publications/nano/index.html

Three EPA STAR research progress reviews have been held to summarize research results. Proceedings can be found at **http://es.epa.gov/ncer/publications/workshop/nano_proceed.pdf**

For EPA nanotechnology research information:
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