Fate of nanoparticles

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Materials made from particles one-millionth the size of a fine-point pen tip are touted daily for their current uses and dreamed of possibilities, but a pressing question remains as to the environmental impact of manufactured nano-sized materials. Purdue University scientists are investigating the interactions between these tiny, many-sided structures and the environment. To further this research, the National Science Foundation (NSF) and Environmental Protection Agency (EPA) have awarded grants totaling nearly $2 million to the Purdue Nanoscale Interdisciplinary Research Team and a colleague from the University of Minnesota.

"This is one of the first major studies solely interested in the environmental fate of carbon-based manufactured nanoparticles," said Purdue's Ron Turco, principal investigator on the project. "We will test Buckyballs and other manufactured nanomaterials in all types of soil and in water to determine their effect on the environment, including any toxicity toward bacteria and fungi that are key indicators of damage to the ecosystem."

Buckyballs are multi-sided, nano-sized particles that look like hollow soccer balls. The full name for the cluster of carbon atoms is Buckminsterfullerene, after the American architect R. Buckminster Fuller. His design for the geodesic dome is much like the shape of Buckyballs, also known as fullerenes.

First found in a meteorite in 1969, Buckyballs are the third naturally occurring pure carbon molecules known. The others are graphite and

diamonds. Experts say that tiny carbon-based manufactured nanotubes are 100 to 1,000 times stronger than steel.

In 1985, researchers began making Buckyballs, which led to a Nobel Prize. These are among the carbon-based manufactured nanoparticles the Purdue scientists will study. Other studies are delving into various aspects of all types of nanoparticles.

"We want to know what would happen if these materials enter the environment in either high or low concentrations," Turco said. "What happens when they get in the soil or the water? I don't think there will be a problem, but we need to have data."

The scientists will investigate not only the manufactured nanoparticles' affect on the environment, but also the environment's affect on them. Using techniques that they employed in assessing the environmental impact of other materials such as pesticides, they will examine how bacteria and fungi in soil and water contribute to the degradation of manufactured nanoparticles.

Other studies are delving into aspects of naturally occurring nanoparticles.

The research team, which was formed by Purdue's Environmental Science and Engineering Institute, will conduct their work in laboratory settings using all types of soil and water, said Turco, an environmental microbiologist in the School of Agriculture.

Nanomaterials already are used for stain-resistant slacks, sunscreens, cosmetics, automobile paint and bowling balls. In fact, the Eastman Kodak Co. and other corporations began employing nano-sized material as early as the 1930s. Kodak's use of the material was nano-silver for film coating.

Scientists are testing sensors that use nano-scale materials for detecting biological weapons and other pathogens that may cause disease. Researchers also believe that stronger-than-steel materials made from carbon-based nanotubes could produce the next generation of electronics and even tougher bulletproof vests. Drug delivery and food production may be revolutionized by nanoparticles, which derive the nano part of their name from the Greek meaning dwarf.

The National Science Foundation funding is a four-year, $1.6 million grant for the research team's Response of Aquatic and Terrestrial Microorganisms to Carbon-based Manufactured Nanoparticles project. The EPA is providing $365,000 over three years to study implications of the materials on soil processes and aquatic toxicity.

The project is composed of five parts handled by seven researchers. The Purdue researchers are Turco, Department of Agronomy; Bruce Applegate, Department of Food Science; Natalie Carroll, Department of Agricultural and Biological Engineering and Department of Youth Development and Agriculture Education; Tim Filley, Department of Earth and Atmospheric Sciences; and Chad Jafvert and Loring Nies, both of the School of Civil Engineering. Robert Blanchette, of the University of Minnesota's Department of Plant Pathology, also is on the team. Turco and Filley also are members of the Purdue Climate Change Research Center. Applegate is a member of the Center for Food Safety Engineering.

The project components and researchers involved are:

• Determine the degradability and solubility of carbon-based manufactured nanoparticles in soils and water - Jafvert.
• Determine baseline information on the toxic effects of carbon-based manufactured nanoparticles on aquatic bacteria - Applegate and Turco.
• Examine how microbes in the soil react to and alter themselves due to the presence of carbon-based manufactured nanoparticles - Nies, Filley

and Turco.
• Determine how carbon-based manufactured nanoparticles are broken down in the soil, how long the degradation takes, and how the change in their chemical structure during this process affects soil toxicity and processes - Filley, Blanchette and Turco.
• Educational outreach to promote public awareness and understanding of nanoscale science and its applications - Carroll.

Source: Purdue University