

NRC Associate Works on Environmental Implications of Nanoparticles

Dr. Manomita Patra joined the EPA's, Human Exposure and Atmospheric Sciences Division at the Las Vegas, NV location in June 2007. Her research project parallels her previous interests in the genotoxicity of mercury in plants. She is working with Dr. Kim Rogers and Tammy Jones-Lepp (NERL-Environmental Sciences Division, Las Vegas, NV) in the emerging area of environmental implications of nanomaterials.

Nanomaterials possess unique properties which are often dissimilar from macro-scale particles with the same elemental composition. Because they show the potential to improve many of the physical characteristics of a wide range of products, their prevalence in the environment is likely to increase, along with the potential risks for human and ecosystem exposure. The potential for exposure will be affected by physical and chemical properties that influence nanomaterial movement through air, soil, and aquatic ecosystems. These characteristics also influence the biological/environmental interface. Because nanomaterials have not been well characterized with respect to potential environmental contamination, part of her work has focused on this area. Nanomaterials being studied include nanosilver (an antimicrobial used in a number of household products ranging from socks to food storage containers), titanium dioxide (used in sunscreens and cosmetics) and fullerenes (such as Bucky balls, used as additives for polymers and potential carriers for pharmaceuticals). These materials are being investigated with respect to size, shape, surface charge and aggregation behavior in aqueous environmental media. The chemical and structural analyses of these materials rely on techniques such as UV-Visible spectroscopy, Transmission Electron Microscopy, Laser particle sizer (using nanoparticle motion analysis) and Graphite Furnace Atomic Absorption Spectroscopy.

Another aspect of this project involves the study of ecosystem exposure. Organisms often used as ecosystem indicators include the planktonic crustaceans which are generally the food and energy link between the primary producers (algae) and secondary consumers (fish and fish larvae). Due to their rapid filtration rate these filter feeding organisms impact water turbidity and algal composition and consequently play an important role in fresh water ecosystems. Dr. Patra has also been investigating, exposure of the micocrustacean indicator organism *Thamnocephalus platyurus* to the carbon nanomaterial C₆₀.

In the absence of an added food source, *T. platyurus* were found to accumulate the fullerene C₆₀. The accumulated nanoparticles have been chemically identified as well as visualized in the digestive tract of these organisms using optical microscopy and thin section TEM. Because of the tendency for these organisms to filter and excrete carbon-based nanomaterials in an agglomerated state, they have the potential to significantly change the size distribution and fate of these nanoparticles in the environment.

Dr. Patra has also been working with another ecosystem indicator assay that involves cellular growth in root tip of plants. This technically simple, relatively fast, and inexpensive assay for genotoxicity (Allium test) is conducted using microscopic analysis of onion root tips. This test detects various chromosomal aberrations seen as chromosome breaks, polyploidy, early or late separation, lagging of chromosomes, sticky bridges, uneven separation, clumping and multiple pole formation. A trend toward decreases in mitotic index (index of measuring cell division), and increase in frequency of chromosomal aberrations were observed with increased exposure of the developing root tip cells to several types of nanoparticles. These findings are significant since cell damage in indicator plant species may be transmitted to subsequent generations, possibly affecting the whole organism and the exposed local biota as well.

Dr. Patra has presented her research at the American Chemical Society and Society of Environmental Toxicology and Chemistry national meetings and she was most recently invited to be a guest speaker at an international conference in India.

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