Nanotech processing 'greener' than oil refining, study

October 5 2005

Using a method for assessing the premiums that companies pay for insurance, a team of scientists and insurance experts have concluded that the manufacturing processes for five, near-market nanomaterials -- including quantum dots, carbon nanotubes and buckyballs -- present fewer risks to the environment than some common industrial processes like oil refining. For two of the nanomaterials – nanotubes and alumoxane nanoparticles -- manufacturing risks were comparable with those of making wine or aspirin.

The study is slated for publication in the Nov. 15 issue of *Environmental Science and Technology*. It compares the environmental and health risks associated with the production of five nanomaterials -- single-walled carbon nanotubes, buckyballs, zinc selenide quantum dots, alumoxane nanoparticles and titantium dioxide nanoparticles -- with the risks of making six commonplace products -- silicon wafers, wine, high-density plastic, lead-acid car batteries, refined petroleum and aspirin.

"There are many unknowns about the impacts of nanomaterials on living organisms and ecosystems, but a great deal is known about the properties of the materials that are used to create nanomaterials," said study co-author Mark Wiesner, professor of civil and environmental engineering at Rice University. "Our goal was to produce an early estimate of the environmental 'footprint' for nanomaterials fabrication.

"The jury is still out on whether some nanomaterials pose a risk, but it is not too early to consider how we might avoid environmental and health

risks associated with making these new materials," Wiesner said. "We have a narrow window of opportunity to guide the emerging nanomaterial industry towards a green future. With this study, we hope to establish a baseline for the safe, responsible development of the nanomaterials manufacturing industry."

In developing their risk assessments, the research team developed a detailed account of the input materials, output materials and waste streams for each process. Risk was qualitatively assessed for each process, based on factors including toxicity, flammability and persistence in the environment.

Using an actuarial protocol developed by the Zurich-based insurance company, XL Insurance, the researchers developed three risk scores for each of the 11 processes: incident risk, which refers to in-process accidents; normal operations risk, which refers to waste streams and airborne emissions; and latent contamination, which refers to the potential for long-term contamination.

Wiesner said the incident risks for most of the nanomaterials were comparable or lower than those of non-nanoprocesses.

"That doesn't imply that the non-nano processes present an acceptable level of risk, or that there is no room for improvement across the board, but the study does suggest that the risks of making these new materials will not be drastically different from those we encounter in current industries," he said.

For example, the incident risks associated with alumoxane and nanotube production fell near or below the scores for wine production. Buckyballs had the highest incident risk rating among nanomaterials and scored near the risks associated with producing polyolefins, a broad class of polymers like polyethylene that are used in making plastics.

The normal operations risk scores for nanotubes and alumoxanes were comparable to those of wine and aspirin making, while the scores for buckyballs, quantum dots and titanium dioxide were comparable to the operations risks of making silicon wafers and car batteries. The normal operations risks associated with plastics and petroleum refining were greater than those for any nanomaterial.

For all of the nanomaterials except buckyballs, latent risk scores were comparable to those of silicon wafers, wine and aspirin production. Buckyballs had a latent score comparable to car battery and plastics production and considerably lower than the score for petroleum refining.

"We can't anticipate all of the details of how nanomaterials fabrication will evolve, but based on what we do know, the fabrication of the nanomaterials we considered appears to present lower risks than current industrial activities like petrochemical refining, polyethylene production and synthetic pharmaceutical production," said Wiesner.

Source: Rice University