Nano World: Nanoparticle toxicity tests

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Scientists have for the first time compared how toxic several different kinds of nanoparticles are with known toxic and nontoxic items and found certain nanoparticles appeared surprisingly toxic, experts told UPI's Nano World.

At the scale of nanometers or billionths of a meter, substances can take on radically different properties not seen in their bulk counterparts. As nanotechnology takes advantage these novel traits for use in a wide and growing range of applications, concerns are growing as to whether nanoparticles, nanotubes and other nanoscale components might have unintended consequences when exposed to humans or the environment.

When scientists test a nanoparticle for its toxicity, often they are not compared with other nanoparticles, or with known toxic or nontoxic compounds. Researcher Wendelin Stark, a chemical engineer at the Swiss Federal Institute of Technology in Zurich examined seven nanoparticles that are finding growing use by industry.

Public agencies and companies "will strongly profit from early investments in risk and toxicology research on nanoparticles," Stark said. "Down the line, this saves huge investments. Stopping a product development at a late stage is a huge loss. Recognizing early on, what may really succeed on the market, is a most valuable knowledge. It gives future researcher some security that the projects will make it into everyday applications."

The research team looked at nanoparticles made of highly insoluble

ceramics such as zirconia, titania and ceria, mildly soluble materials such as zinc oxide or iron oxide, and tricalcium phosphate nanoparticles. Moreover, they compared the nanoparticles with amorphous, aerosol-derived silica, a known nontoxic item often used as a food additive for more than 50 years, and crocidolite asbestos, a highly toxic carcinogen that is commonly thought of as the most dangerous kind of asbestos.

Titania and zinc oxide nanoparticles are used on a large scale in sunscreens, pigments, and in tires or polymers as stabilizers. Zirconia and ceria nanoparticles have broad, rapidly growing applications in catalysis and polishing, and as additives in dental materials and polymers. Surface-coated iron oxide has repeatedly been proposed for use in magnetic drug targeting systems and MRI diagnostics. Tricalcium phosphate nanoparticles are often used in orthopedic implants.

Stark and his colleagues tested compounds against human and rodent cells. They discovered the mildly soluble nanoparticles proved the most acute toxic response of those studied. For instance, the iron oxide nanoparticles appeared astonishingly toxic, roughly as toxic as the crocidolite asbestos toward human cells. "That was very surprising," Stark said.

Moreover, the zinc oxide nanoparticles reduced cell proliferation more potently than asbestos did in rodent cells. Overall zinc oxide nanoparticles and asbestos drastically reduced human and rodent cell culture activity the most.

The amount of iron oxide used in the nanoparticles for a toxic dose would itself not prove toxic if given in a completely dissolved form. This suggests there may be a toxic effect specific to nanoparticles, such as stress caused by the surface, size or shape of the particles, Stark explained.

These findings are "most useful in providing a series of findings that illustrate the need for more work to elucidate more clearly exactly what is happening," said environmental scientist and organic chemist Daniel Watts at the New Jersey Institute of Technology in Newark.

Stark acknowledges this work on lab grown cells needs to verification in animal studies. Moreover, their current experiments may not capture the long-term effects the more insoluble nanoparticles could have, as they get taken into cells and potentially affect them over time. Still, "this is a simple way of pointing which nanoparticles might need another look," he said.

The researchers presented their findings in the journal Environmental Science & Technology.