

Novel approach estimates nanoparticles in environment

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This is bulk titanium dioxide. Credit: Duke University

Without knowing how much of an industrial chemical is being produced, it is almost impossible for scientists to determine if it poses any threat to the environment or human health.

Civil engineers at Duke University believe they have come up with a novel way of estimating how much of one such material - [titanium dioxide](#) - is being generated, laying the groundwork for future studies to assess any possible risks.

This information is especially valuable if the chemicals are in the form of nano-particles, which possess unique properties because of their miniscule size. [Nanoparticles](#) are attractive for a wide range of products, little is known about their consequences in the environment. One of the most widely used is the nanoparticle form of titanium dioxide, which can

be found in such diverse products as sunscreens and toothpaste to paints and papers. It is also used in water treatment.

"The biggest problem we face in trying to determine any risks of titanium dioxide nanoparticles is that no one really knows how much of it there is," said Christine Robichaud, graduate student in civil and environmental engineering at Duke's Pratt School of Engineering. The results of her analysis were published online in the *Journal of Environmental Science and Technology*.

Robichaud found it especially difficult trying to collect this data, since the companies that process titanium dioxide were not willing to reveal information they deemed proprietary. So she used a novel approach developed by collaborators Lynne Zucker and Michael Darby at the University of California Los Angeles to estimate the rate of innovation in the biotechnology industry.

"We combined science and engineering knowledge with business and economic modeling to come up with what we think is the maximum amount of titanium dioxide nanoparticles out there," Robichaud said. "By taking the amount of bulk titanium dioxide produced, which is better understood, and applying the rates of new technologies to convert it to the nanoparticle form found in journal articles and patent applications, we estimated the maximum ceiling amount."

Based on her calculations, Robichaud found that the production of titanium dioxide nanoparticles was negligible in 2002 and rose to about 2.5 percent of the total amount of titanium dioxide produced today. By 2015, nanoparticle production is estimated to be about 10 percent of the total, as more companies switch to newer technology. Under the most aggressive scenario, practically all of titanium dioxide in the U.S., about 2.5 million metric tons, would be in nanoparticle form by 2025, Robichaud concluded.

"Knowing the amount of this material is important because the more of it we make, the more likely it is to enter the environment and come into contact with humans with unknown consequences," said Mark Wiesner, professor of civil and environmental engineering and senior member of the research team. He also directs the federally funded Center for the Environmental Implications of NanoTechnology (CEINT), which is based at Duke.

"We do not have a good handle on how much is out there, and even less about what that might mean," he continued. "Finding an upper limit on the potential for exposure is the critical first step in assessing risk. Even if these nanoparticles are toxic, a low exposure to them may limit the risk. We just don't know yet. I like to use the example of sharks. Everyone knows they're dangerous, but not if you spend your entire life in Nebraska."

Now that the researchers have a better idea how much of this nanomaterial could be produced in the coming years, they plan to focus on specific types of products.

"We want to get a better idea of where in the process these nanoparticles might be released into the air, water or soil," Robichaud said. "It could be during mining, during the production of the nanoparticles, production of the specific product using the nanoparticles, the use of the product, or its ultimate disposal."

Source: Duke University ([news](#) : [web](#))

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