Knife, Fork ... And Nanoparticles?

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Wondering whether your anti-stink workout clothes are sending nanosilver into the environment?

Turns out that you should take a look at other silver objects you might be wearing or using as a potential source for sloughing off ultra-tiny bits, too.

A new study showing that large-scale silver objects can essentially shed nanoparticles is further complicating an already dizzying discussion over the potential hazards of nanotechnology — leaving scientists and regulators staring at big, hard questions.

The paper, which was published online this month by the scientific journal ACS Nano, outlines a method for observing nanoparticles and their behavior. When the authors looked at both nanosilver and larger silver objects, including workaday items such as forks and jewelry, they found that new nanoparticles emerged under certain conditions.

The findings, experts say, underline both the dynamic nature of nanomaterials and the extent to which humans have been living with them for thousands of years.

All of this raises the larger question: if our environment is full of nanoparticles, how can we tell which ones might hurt us, and how much might it take to do damage?

“I think there are two phases to it, and one of those is that we can’t think about static structures of things like nanosilver because the results of our study clearly show that there’s a dynamic behavior to these particles, which means that from a perspective of defining nanomaterials, if they’re changing, it’s very hard to pinpoint them and state precisely what the size is, for example,” said James Hutchison, a professor and researcher at the University of Oregon and one of the paper’s three authors.

“It also means that with respect to whatever environmental or health effects there might be, if those do depend on size, then we have a little bit of a moving target there,” he said. “I think that’s sort of the complicating side of things.”

Nanotechnology leverages the often amazing properties of super-small particles (a nanometer is a billionth of a meter) to create new products. These materials can make bike frames lighter and stronger and sunscreen more transparent on the skin, as well as new medical instruments and treatments that can save lives.

There is broad agreement that nanomaterials have lots of potential for a wide variety of applications. But shrinking these substances can change their properties; scientists are struggling to figure out whether, how and why that shift can make them dangerous in the process.

Nanosilver has become a hot topic amid the larger discussion, in part because it’s increasingly used as an antimicrobial agent. Over the past several years, the number of products containing nanosilver has exploded. It’s now in workout clothes and socks (the silver is supposed to block the bacteria growth that makes sweat stinky), hair dryers and sprays that aim to mask the human smell of hunters, to name just a few.

The silver industry has argued that the metal—nano-sized or not — has been safely used for many years, in everything from swimming pool disinfectants to wound dressings. The industry has urged the U.S. Environmental Protection Agency, which is looking at nanosilver as a pesticide, not to regulate the super-small version as a separate material. Environmental and consumer advocates, on the other hand, have pushed for new laws on some nano-related products, including silver, for several years.

The question of whether nanosilver poses a different risk than larger silver particles remains unanswered — and is both muddied and clarified by the findings of Hutchison and his co-authors.

“The fact that objects like silverware and jewelry appear to generate these particles means that we’ve been in contact with them for millennia,” he said.

As with most things involving nanotechnology, it’s not that simple. If nanosilver is out there, what is the baseline level that humans, animals and the environment have been tolerating? And how might the proliferation of nanosilver products affect that baseline?

“I don’t think you could then just make the jump and say because the materials were producing nanomaterials, they’ve always been there, and there’s no reason to worry about nanoparticles,” said Todd Kuiken, a research associate with the Project on Emerging Nanotechnologies at the Woodrow Wilson International Center for Scholars.

“It’s what you’re adding to the system is what you’re concerned about. You’re concerned about the background level in a sense, but not particularly for regulatory purposes, or even for human health, in a way,” he said. “From a regulatory standpoint, you really have to separate out what the background is and what you’ve now added to the system and what the changes are.”

In other words, when scientists found nanosilver in end-stage sewage sludge, where did those particles come from? Bigger silver objects, or man-made products?

“Those are all excellent questions, and they all have encyclopedic answers,” said Michael Hochella, a professor and researcher at Virginia Tech who worked on that study, of the larger effort to nail down the effect of nanomaterials. “We know pages 1 through 15, but not the remaining thousands of pages of answers.”

Hochella said he’s not at all surprised at Hutchison’s team’s findings. “Natural” nanoparticles are everywhere, he said, often moving smoothly between what we now consider the nanoscale and larger sizes. That doesn’t mean what’s out there is harmful on its face, he said.

He gave asbestos as an example: The particles are naturally occurring, and almost any human being on earth has a few bits in his or her lungs. But that small amount isn’t enough to cause the diseases associated with asbestos, such as mesothelioma.

It’s going to take research that simulates real-world conditions to the greatest extent possible to start telling scientists and policymakers what they really need to know about nanosilver and other nanomaterials, Hochella said.

“In my opinion, in many cases we won’t have to worry, but in some cases almost for sure we will, because depending on the additional engineered materials added to the environment, where they’re added, how they’re added … it could be highly deleterious,” he said.

Except in cases where a nanomaterial is known to be highly toxic on its face, he said, it’s probably too soon to formally regulate some of these substances.

“In my opinion, by doing all the science we’re doing now, we will be in the best position possible, when something is observed that may be problematic in nature, and a problem comes up where a duck is born with two heads or god forbid people get sick or whatever, we will be able to go, ‘Ah, look at this, we know what’s going on here, we can regulate it,’‘ Hochella said. “We can preregulate for nanomaterials for things that are really obvious, really highly toxic, but for most things, it will really be impossible to tell, and they probably shouldn’t be regulated until we see a really smoking gun.”

Hutchison, Hochella and Kuiken all said the new study illustrates the difficulty of defining, for the sake of regulation, exactly what constitutes a nanoparticle. A few weeks ago, the European Commission debuted its definition, which at is heart sets parameters of 1 to 100 nanometers in size. It makes no distinction between naturally-occurring and man-made nanoparticles, but doesn’t take into account the possibility that a material could start out bigger and get smaller — or vice versa.

“I think this is a prime example of the challenge that’s faced, because the definition is 1 to 100 nanometers — well, what if you have a 150-nanometer particle that’s shedding smaller particles?” Hutchison said. “If your product is producing them, then is it really not a nanomaterial? … This is the problem, and it’s a hard problem.”

Then there is the issue of telling one type of nanoparticle from another. While many engineered nanosilver particles are are coated or otherwise manipulated, it's not known how they mingle in the real world, Hutchison said.

Through weathering or degradation, he said, "I would imagine that the naturally occurring materials and the engineered materials would start to look more and more alike."

That could make getting a baseline sense of how much nanosilver is already out there difficult.

Hutchison said he hopes the paper will reinvigorate the debate over whether size really does matter, or whether the overarching amount of the material is the most important fact. .

"I think sort of the key thing is the continuing question of whether there are actually specific hazards that are related to that nanoscale size or not, and if not, then we really should be thinking differently. We really should be thinking about what the total amount of silver going into the environment is," Hutchison said.