As microscopic materials proliferate, ensuring they are safe is a priority

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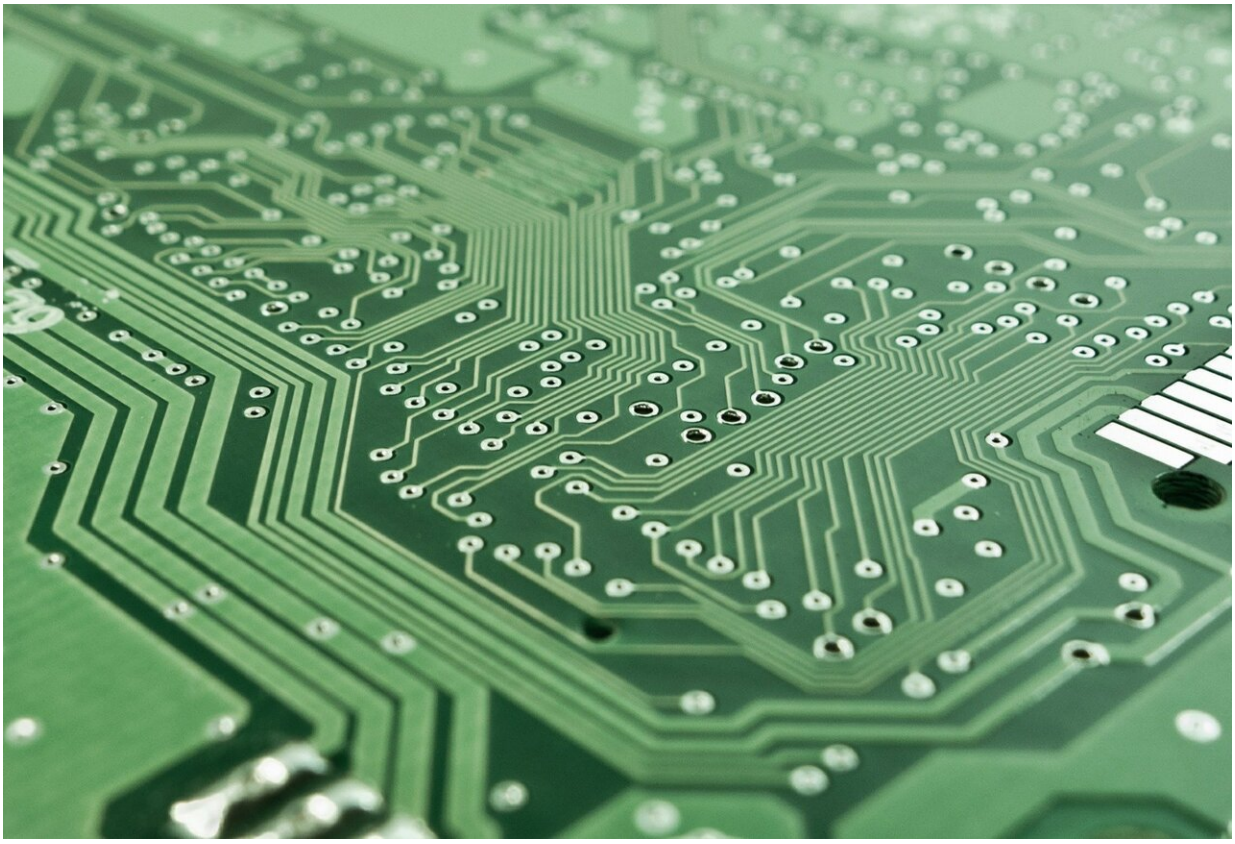

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Researchers in Europe are working to counter potential risks from nanomaterials used by a range of industries for technological advances.

While others might dream big, Dr. Otmar Schmid dreams small. That's because he works on nanomaterials, which are so tiny they're invisible to the naked eye.

Demand around the world for nanomaterials is growing. Industries such as electronics, energy, food, medicine and transport rely on nanomaterials to make a host of technological advances.

New world

Nanomaterials include synthetic types—made for example from metals or carbon—or naturally occurring versions such as ash and cellulose. They're used in products ranging from computers and clothes to bicycles and paints.

Given the waves they're creating in numerous manufacturing sectors, nanomaterials are regarded by some as the basis of a new industrial revolution. By influencing the interactions among atoms, these materials hold the promise of myriad new products ranging from better medicines to cleaner energy.

For example, they already increase the amount of electricity generated by solar panels and improve the durability of construction materials. They could just as well lead to faster computing, self-cleaning clothes and more customized health care.

The Nobel Prize in Chemistry has been awarded for scientific advances in nanotechnology, with three researchers from Europe winning the award in 2016 and three U.S.-based ones claiming it in 2023.

Yet these materials have such microscopic components that traditional rules on product safety might no longer apply.

"There is a whole new world opening up with these new materials," said Schmid, head of the pulmonary aerosol group at the Helmholtz Research Center in Munich, Germany. "Many have different properties than conventional materials, which may alter their risk for human health. This doesn't mean that nanomaterials are necessarily more dangerous, but it means that we need different methods to see whether there is cause for concern."

Schmid and colleagues are pioneering ways to determine when nanomaterials become a safety risk—and when companies and governments need to take action.

"We need to engineer these materials in such a way that risk is minimized," said Miguel A. Bañares, research professor at the Spanish National Research Council, or CSIC. "This needs to be top of mind during the design phase."

Bañares led a research project to develop computer models capable of predicting whether a nanomaterial could be hazardous. The project, called NanoInformaTIX, wrapped up in February 2023 after four years.

Bañares stressed the importance of the whole area of research by comparing nanomaterials to sand.

"Imagine if you have a closed bottle of sand," he said. "If you open that bottle, nothing will happen. If, however, you open a bottle with nanoparticles in it, just removing the lid will spread the particles. So you might, for example, breathe them in."

Staying ahead of the curve

In sum, nanomaterials have a different "risk profile" than traditional materials.

"We predict and model the properties of the nanomaterial," said Bañares. "In this way, we can better understand how they will interact with the environment and the human body."

Such information can be useful for companies when designing these materials and for regulators when weighing product safety.

So far, regulatory regimes in Europe and elsewhere have been updated to cover simple nanomaterials. The challenge is to ensure rules keep pace with the development of the next generation of nanomaterials, which will have more components and greater complexity.

In nanomaterials, the smallest units are less than 100 nanometers. That's a thousand times smaller than the diameter of a human hair.

"You need electron microscopes to make it visible," said Schmid.

Next generation

Together with a colleague named Dr. Tobias Stoeger, Schmid coordinates a research project to ensure that future nanomaterials are safe.

Called HARMLESS, the project runs for four years until the end of January 2025 and is focusing on materials with new shapes.

"We're developing measurement methods and modeling techniques," said Schmid. "With them, we and others can see how much risk a material represents."

He used the example of batteries to highlight the research and regulatory challenge, saying they have an 'enormous amount' of chemical complexity.

"There are billions of parameters that can be changed to optimize the performance but which can also turn out to be hazardous," said Schmid.

Nanomaterials can be risky only when present in certain quantities or when applied together with other materials. Learning more about the right amounts and combinations for nanomaterials is a priority for HARMLESS.

"There is a knowledge gap," said Schmid. "We need to understand the underlying biological mechanisms associated with these materials. If we know this, we can decide what safe levels of exposure are."

Safe by design

A goal is to ensure safety in the design phase of new nanomaterials.

Called "Safe and Sustainable by Design," or SSbD, this would avoid the current situation where companies create materials first and assess their potential risks later.

"Companies need to make safe and sustainable products from the very beginning," said Schmid. "You don't want to waste money producing something that turns out to be hazardous."

In 2022, the European Commission published an SSbD report on chemicals and materials to establish a framework for further action by regulators and companies in this area.

The report and projects like HARMLESS and NanoInformaTIX highlight the need for governments and industries to work together on the future safety of nanomaterials.

Hand in hand

EU research projects provide regulators with information to sharpen their own knowledge of the materials and stay a step ahead of what is a rapidly evolving market.

"Regulators depend on their knowledge," said Bañares. "It's very important that the information we gather is presented in an understandable way to them."

At the same time, new nanomaterials are often so complex that some responsibility for safety will remain with the companies themselves, according to Schmid.

"These materials are incredibly advanced," he said. "They're just very hard to regulate in advance."

More information:

- NanoInformaTIX
- HARMLESS

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