IISER Pune & IITB researchers find method to create metal nanoparticles to power disease detectors

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Pune: Just like a drop of water on a heated pan turns into tiny droplets, perfectly sized metal dots can be made from a thin layer of a metal. When heated between two surfaces, it breaks into extremely tiny, uniform nanoparticles.

Researchers from Indian Institute of Science Education and Research (IISER), Pune, and Indian Institute of Technology (IIT) Bombay have discovered this new method called confined dewetting which brings advanced nanotechnology closer to practical, everyday solutions.

Their breakthrough can be applied to build sensors using many metals and surfaces, opening doors for use in medicine, environment monitoring, and industrial quality control.

Published in the journal Small Methods, the study shows how this simple, cost-effective process can create high-quality metal nanoparticles for use in highly sensitive sensors which can detect diseases early or find traces of chemicals in the environment.

One of the paper's principal investigators Atikur Rahman said the study provides a theoretical framework explaining how the elasticity and low surface tension of PDMS (a flexible, silicone-based material) reduce particle size and enhance uniformity, offering a blueprint for further advancements using similar materials.

He added, "With applications ranging from medical diagnostics to chemical analysis and beyond, this breakthrough positions confined dewetting as a game-changer in nanotechnology."

The study, led by Ayesha Rahman, a research scientist at I-Hub Quantum Technology Foundation hosted by IISER Pune, Anirban Sain, a faculty member at the Department of Physics, , and Atikur Rahman, a faculty in the department of physics, IISER Pune, introduced a simple approach to create uniform, high-density metal nanoparticles on various surfaces, including flat, curved, and microtextured substrates.

Rahman added, "The technique can be applied to a variety of substrates, from glass slides to optical fibres. The PDMS (a flexible, silicone-based material) layer shapes the nanoparticles and protects them from oxidation. This results in pure and stable nanoparticles. These properties are important when using the sensing technology in practice."

The study received funding from National Mission on Interdisciplinary Cyber-Physical Systems in the department of science and technology (DST) through the I-HUB Quantum Technology Foundation, hosted by IISER Pune, and from a DST-SERB grant.

The high level of precision enables the detection of ultra-low concentrations of disease biomarkers such as cancer-related proteins in a patient's blood sample, or minute traces of harmful pollutants

like lead in drinking water, paving the way for earlier diagnostics and more effective environmental monitoring.

What is Confined Dewetting?

Imagine a super-thin layer of metal, about 10,000 times thinner than a human hair, like a gold film spread on a piece of glass

When you heat it, the metal starts to bunch into tiny droplets, similar to how water beads up on a non-sticky pan

This happens because the metal tries to minimise its surface energy

If we squeeze the metal film between two surfaces, like making a sandwich, and apply heat, it breaks up into tiny, uniform droplets that are packed closely together

This process is called confined dewetting, and it can be used to make highly sensitive sensors for biomedical and chemical applications

How is it done

The researchers sandwiched a thin metal film between a substrate and a layer of PDMS (a flexible, silicone-based material) during heating

They achieved precise control over the size and spacing of nanoparticles, resulting in particles with minimal size variation and gaps as small as a few nanometres

This level of precision is critical for applications requiring consistent and enhanced performance, such as detecting trace amounts of biological or chemical substances

Traditional methods of nanoparticle production are based on expensive and complex processes and often do not produce uniform nanoparticles

In contrast, the ‘confined dewetting' technique, applied on metal films is versatile and can be implemented on a large scale

Metals such as silver, gold, copper, and their alloys can be used in this technique, the study said.

Source:

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