Engineers unmask nanoplastics in oceans, revealing their true shapes and chemistry

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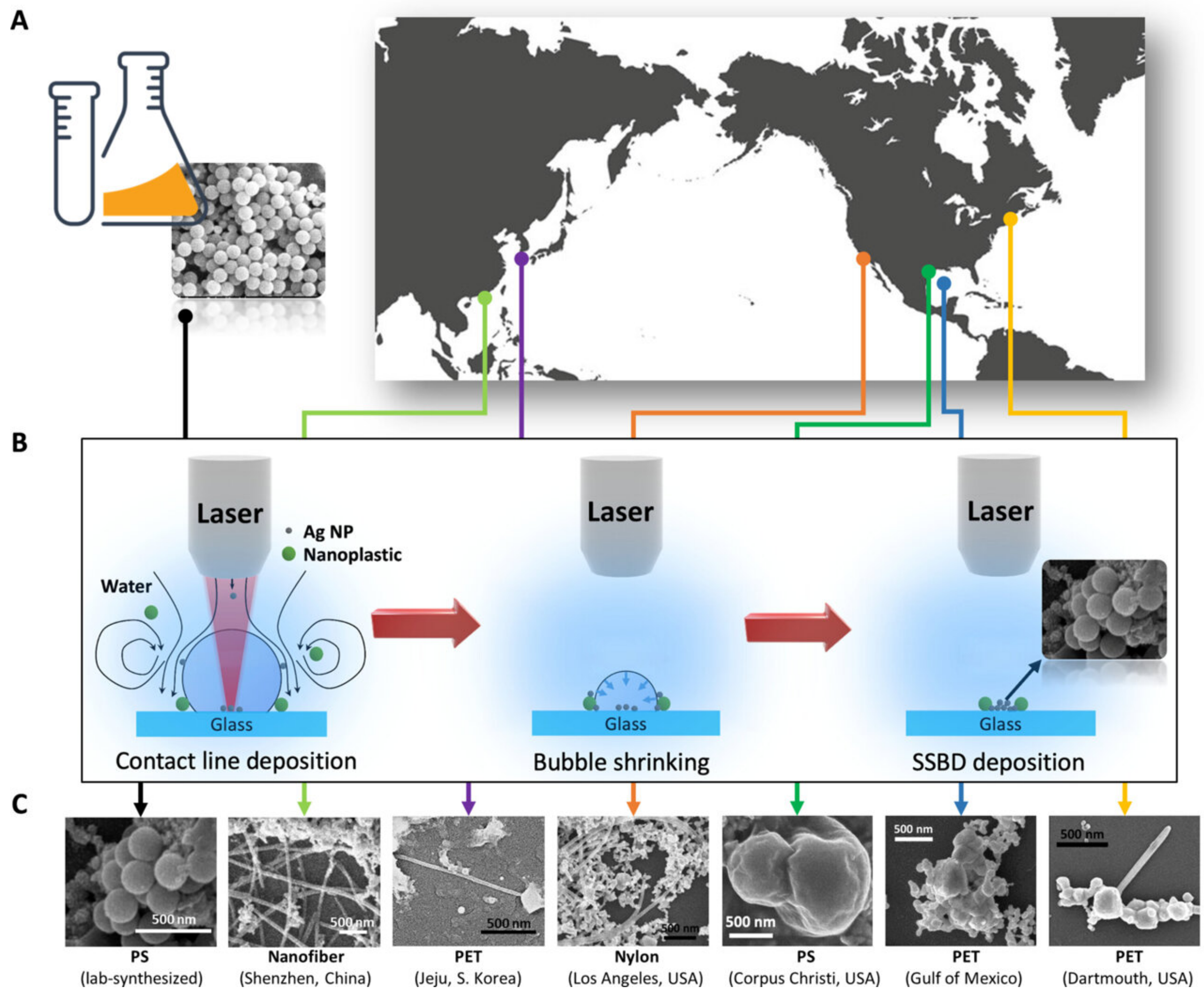

Direct observation of nanoplastics from ocean water around the world. (A) Locations of seawater collection on the coastlines of China, South Korea, the United States, and in the Gulf of Mexico, together with a laboratory reference PS colloidal water sample. (B) Schematics of the SSBD process, where a thermal bubble generated by laser heating creates a thermofluidic flow to collect suspended particles and deposit them to a high-density spot (right inset) after the bubble shrinks and vanishes. (C) SEM images of nanoplastics observed from different water samples. Credit: *Science Advances* (2024). DOI: 10.1126/sciadv.adh1675

Millions of tons of plastic waste enter the oceans each year. The sun's ultraviolet light and ocean turbulence break down these plastics into invisible nanoparticles that threaten marine ecosystems.

In a new study, engineers at the University of Notre Dame have presented clear images of nanoplastics in ocean water off the coasts of China, South Korea and the United States, and in the Gulf of Mexico. These tiny plastic particles, which originated from such consumer products as water bottles, food packaging and clothing, were found to have surprising diversity in shape and chemical composition.

The research was published in *Science Advances*.

"Nanoplastics are potentially more toxic than larger plastic particles," said Tengfei Luo, the Dorini Family Professor of Aerospace and Mechanical Engineering at the University of Notre Dame. "Their small size makes them better able to penetrate the tissues of living organisms."

Previously, nanoplastic particles synthesized in laboratories had been used in toxicity studies to investigate their effect on marine life. Luo's team of researchers, in collaboration with the lab of Wei Xu at Texas A&M, decided to search for actual nanoplastics in the world's oceans, suspecting they might be significantly different from the lab-created versions, which are highly uniform in shape and composition. Any differences found may affect toxicity studies.

Nanoplastics are believed to exist at extremely low concentrations in the ocean. To find them in seawater, Luo's team used a unique bubble deposition technique that they had previously developed to find traces of DNA molecules for early detection of cancers.

The team mixed seawater samples with silver nanoparticles and heated the solution with a laser until a bubble formed. Variations in surface tension cause the nanoplastic particles to accumulate on the bubble's exterior. The bubble shrinks, then vanishes, depositing the particles in one concentrated spot. Electron microscopy and Raman spectroscopy are then used to reveal the nanoplastics' shapes and chemistries.

Luo's team found nanoplastics made of nylon, polystyrene and polyethylene terephthalate (PET)—plastic polymers used in food packaging, water bottles, clothing and fish nets—in these seawater samples. Some of the particles' diverse shapes can be traced back to the different manufacturing techniques used to create them. Surprisingly, PET nanoparticles were found in water samples collected approximately 300 meters deep in the Gulf of Mexico, suggesting nanoplastic contamination is not restricted to the ocean surface.

Follow-up studies will focus on quantifying ocean nanoplastics, Luo said.

"The nanoplastics we found in the ocean were distinctively different from laboratory-synthesized ones," Luo said. "Understanding the shape and chemistry of the actual nanoplastics is an essential first step in determining their toxicity and devising ways to mitigate it."

More information: Seunghyun Moon et al, Direct observation and identification of nanoplastics in ocean water, *Science Advances* (2024). DOI: 10.1126/sciadv.adh1675

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