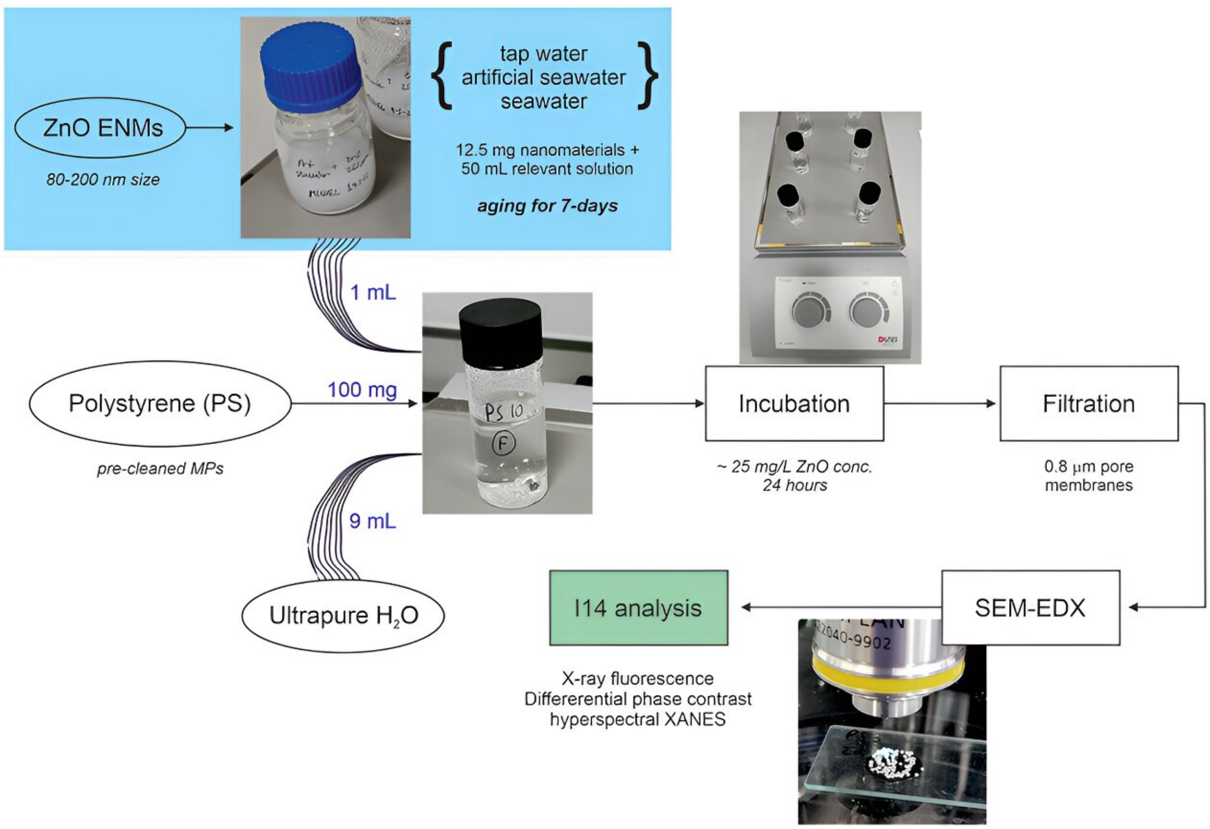
Microplastics are adsorbing zinc oxide from sunscreens and microbeads from cleansers

August 17 2023



Summary of the experimental steps involving the ZnO engineered nanomaterials (ENMs) and the polystyrene (PS) microplastics, including the analysis carried out afterward. In brief, the ZnO ENMs were aged for 7-days in relevant environmental media (blue-squared region, Section 2.2), prior to mixing 1 mL of this solution with 100 mg of the polystyrene microplastics, together with another 9 mL of ultrapure water for incubation. Credit: *Global Challenges* (2023). DOI: 10.1002/gch2.202300036

A new study by a research team from Diamond Light Source looks at how microplastics wastes may interact with zinc oxide (ZnO) nanomaterials in freshwater and seawater scenarios. It also evaluated, a ZnO-based sunscreen and an exfoliating cleanser with microbeads in its composition under the same conditions.

Their results confirm that mixtures of Zn-aggregates/micro-polymers were naturally leached/released from the commercial products revealing worrying environmental implications for fish and other aquatic organisms in the food chain which could swallow these microplastics and ingest zinc particles at the same time.

Called "Toward understanding the environmental risks of combined microplastics/nanomaterials exposures: Unveiling ZnO transformations after adsorption onto polystyrene microplastics in environmental solutions" the work was published in *Global Challenges*. The team from the UK's national synchrotron, included a student, Tatiana Da-Silva Ferreira, who was at Edinburgh University on Diamond's 12 week 'Summer Placement' scheme.

This allows undergraduate students studying for a degree in Science, Engineering, Computing or Mathematics (who expect to gain a first or upper-second class honors degree) to gain experience working in a number of different teams at Diamond. Lead author, Miguel Gomez Gonzalez, Diamond Beamline Scientist, praised Tatiana, now studying for a Ph.D. in Switzerland, for her key contribution to the start of this environmental project.

Explaining the impetus for the research, Miguel said that they had all seen how in recent decades, there has been a dramatic increase in the manufacture of engineered nanomaterials (tiny, tiny particles about 1000 times thinner than a human hair), which has inevitably led to their environmental release.

Similarly, zinc oxide (ZnO) is among the more abundant nanomaterials fabricated due to its advantageous use in electronics, semiconducting, and for antibacterial purposes. At the same time, plastic waste has become ubiquitous and may break down into smaller pieces called microplastics.

These also are tiny, but ~100 times bigger than the nanomaterials. Because both these elements are getting disposed more often, they decided to study their fate when they are potentially being combined in freshwater and oceans and to help make environmental risk assessments more accurate.

To make their study more relevant to the real world, the team tested a sunscreen containing zinc oxide which is commonly used to block UV-radiation. They let the sunscreen incubate in the different environmental solutions for a week and then added the microplastics for a day. The objective was to check if the zinc oxide could come out of the sunscreen and stick to these microplastics.

They also followed the same procedure with a facial scrub containing tiny plastic beads. The results clearly showed that the zinc oxide (either pure or leached from the sunscreen) did stick to the microplastic in both cases, revealing that it could potentially happen in our rivers and oceans too.

Gonzalez comments, "The ability of zinc oxide, both pure nanomaterials and those released from a sunscreen, to stick to very small pieces of plastic has big implications. These plastics can even come from everyday items like exfoliating facial cleansers. In this study, we found the microplastics can carry even smaller particles of zinc from place to place. As a consequence, fish or other aquatic organisms could swallow these microplastics, ingesting zinc particles at the same time."

"We need to understand how this engineered zinc oxide changes when it gets into freshwaters and how much of it can stick to small plastic wastes. This is important for making everyone aware, from people who make these products to those who regulate them, about the potential harm they could do to our environment. Better rules for managing waste are needed, especially related to tiny particles like these."

"As we continue to produce more and more of these micro- and nanoparticles, their effect on our environment is going to keep growing. Because they are so long-lasting, they can pose a risk to different organisms, and ultimately even make their way into our food. This is something we simply cannot afford to ignore."

Talking about the contribution of 2021 Summer Placement Student Tatiana Miguel highlighted the huge opportunities afforded to students by Diamond study programs.

"Tatiana did a great job in optimizing the conditions for the 7-days stabilization of nanomaterials, followed by the 24-hours incubation of microplastics and nanomaterials. In addition, she improved the filtering protocol and isolation of the microplastics after the incubation period. Likewise, she performed the very preliminary scanning electron microscopy analysis which revealed nanomaterials adsorption into the plastic surfaces. Therefore, her contribution was key for the overall success of this environmentally relevant project," Gonzalez added.

Miguel thanked Gonzalez and Diamond saying, "This experience really deepened my interest in environmental chemistry and academic research. It also gave me enough background and confidence to pursue my Masters and now my Ph.D. I'm really happy I got to work on such an interesting project, and even happier you chose to look deeper into it."

The team took some pure zinc oxide particles (ranging from 80 to 200 nm size) and incubated them in different kinds of environmental solutions for a week, allowing their natural stabilization. They then mixed them with small polystyrene microspheres (~900 mm diameter, about the size of a grain of sand) and stirred them together for a day.

After washing and rinsing the microplastics, they found that the zinc oxide got adsorbed to the plastic surfaces. This was seen by scanning electrical microscopy, using a very powerful microscope. This confirmed that microplastics and zinc oxide can interact in our water bodies, which might affect how they impact the environment.

The team then examined these zinc oxide-covered microplastics using X-rays generated at Diamond Light Source, an electron accelerator facility. Diamond's I14 beamline can shape the X-rays into a nanometric size, making it one of the best in the world for this kind of detailed work. Fast scanning of the samples around the nanometric X-rays beam, enabled detailed pictures of each element contained in their samples to be captured by the fluorescence detector.

Alongside this work, another X-ray technique called X-ray absorption near-edge structure spectroscopy (XANES) was applied to check what kind of chemical changes had happened to the zinc oxide when adsorbing to the microplastics and after a week's incubation in freshwaters.

Gonzalez adds, "We found out that the zinc oxide had transformed into different types of zinc-related particles. Some of these new particles (Zn-sulfide) were formed quickly, while others formed more slowly but were more stable (Zn-phosphate). This reveals valuable information about how zinc oxide behaves when it is in the environment."

More information: Miguel A. Gomez-Gonzalez et al, Toward Understanding the Environmental Risks of Combined

Microplastics/Nanomaterials Exposures: Unveiling ZnO Transformations after Adsorption onto Polystyrene Microplastics in Environmental Solutions, *Global Challenges* (2023). DOI: 10.1002/gch2.202300036

Provided by Diamond Light Source Ltd