Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.28380

Understanding how microplastics' nature and morphology impact the sorption capacity of transformed ZnO nanomaterials

MIGUEL ANGEL GOMEZ GONZALEZ[1], HELISOA DERJEAN[1], NATHANIEL CLARK[2] AND JULIA E PARKER[1]

[1]Diamond Light Source Ltd.
[2]School of Health Professions, University of Plymouth

Plastic pollution poses a global environmental challenge, as its production has significantly overcome our capacity to recycle it responsibly. Larger plastic items can degrade or delaminate into smaller microplastic (MPs) fragments. These contaminants do not occur in isolation within the environment; the presence of other particles affects their bioavailability and toxicity. Recently, the production of engineered nanomaterials (ENMs), including zinc oxide (ZnO) has increased due to its advantageous properties (e.g., piezoelectricity, antibacterial). These ZnO particles can interact with MPs through surface sorption.

Nano X-ray fluorescence (XRF) and X-ray absorption near-edge structure (XANES) analysis at the I14 beamline (Diamond Light Source) have already demonstrated how ZnO ENMs transform under environmentally relevant conditions. Mixtures of Zn-sulfide and Zn-phosphate appeared in wastewater solutions within hours [1]. After allowing commercial ZnO ENMs to reach equilibrium in freshwater and seawater for 7 days, these were subsequently incubated with pristine polystyrene MPs. This process revealed identical Zn-species adsorbed onto the surfaces of the MPs [2].

To ensure the environmental relevancy of the study, a commercial sunscreen was used as a realistic source of ZnO ENMs, along with an exfoliating cleanser containing microbeads. This work shows that micro-Zn aggregates released from the sunscreen effectively adsorbed onto MPs following aging and incubation. The commercial ZnO ENMs were also identified adsorbed onto the microplastics leached from the exfoliating product, presenting a higher degree of transformation towards Zn-sulfide and Zn-phosphate.

In addition, different MPs' natures and morphologies have been evaluated in a holistic approach. Both polystyrene and polyethylene were aged through an accelerated weathering process using ultraviolet exposure, which has been shown to enhance the adsorption of organic contaminants [3]. Understanding how the physico-chemical changes experienced by pristine and weathered MPs may impact their capacity to sorb ZnO ENMs, as well as their associated speciation changes, is key to determining their potential environmental damage and addressing their impact on aquatic microorganisms and fish.

[1] Gomez-Gonzalez *et al.* ACS Nano 13 (2019), 11049–11061; 10.1021/acsnano.9b02866

[2] Gomez-Gonzalez *et al.* Glob. Challenges (2023) 2300036; **10.1002/gch2.202300036**

[3] Bhagat *et al.* Chemosphere 298 (2022) 134238, 10.1016/J.CHEMOSPHERE.2022.134238