Floating photocatalysts as key players in reshaping sustainable wastewater treatment: a green transition towards future society

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Climate change is reshaping water access, causing droughts and floods: there is not enough water, and the available amount is usually tainted with pollutants [1]. So, treating polluted surface water urgently requires fast and efficient solutions. Heterogeneous photocatalysis has emerged to degrade mixtures of pollutants without adding chemical oxidants under mild conditions [2]. However, photocatalytic processes are scarcely effective when used to treat large volumes of contaminated matrices due to large reactor sizes, limited light penetration, high energy costs, and difficulties in recycling/reusing the photocatalysts. To facilitate pollutants degradation, different composites combine high adsorption capacity and photoreactivity [2]. However, they are nano-sized materials that, although common, raise concerns about nanotoxicity. The ideal photocatalyst should be active, selective, stable, sustainable and easy to handle.

At present, floating photocatalysts are interesting alternatives to be exploited, since they maximize light utilization and surface aeration, enhancing pollutants abatement performance and decreasing post-treatment costs [2]. If properly developed to be sustainable and efficient, they could reshape sustainable wastewater treatment for future societies.

Herein, we present our results related to the development of sustainable photoactive materials obtained by immobilizing innovative photocatalysts (i.e., bismuth oxyhalides) on eco-friendly floating supports (alginate spheres, sponges, and Lightweight Expanded Clay Aggregates). Bismuth oxyhalides can concentrate different pollutants (dyes, drugs, polyphenols) on their surface in the dark and quantitatively degrade them after exposure to solar light. A targeted study on the role of the water matrix, catalyst dosage, and recycling tests, approaching actual application, will provide insights into the potentialities and limitations for real-world application, opening the view toward the future use of these innovative systems, and acting as a bridge between environmental protection and sustainability.

[1] https://www.who.int/news-room/fact-sheets/detail/drinking-water.
[2] Galloni, M.G. *et al.*, Adv. Sust. Syst. 2024, 8, 2300565.