Reduced graphene oxide and TiO_2-coated polyurethane foams: integrated photocatalytic adsorbents for water decontamination

ANNA DOTTI[1,2,*], ANDREA BASSO PERESSUT[1], ALBERTO BLAZQUEZ-MORALEJA[2], ROBERTO MATARRESE[3], FRANCISCO BOSCA[2], MARIA LUISA MARIN[2], SAVERIO LATORRATA[1]

[1]Dipartimento di Chimica, Materiali e Ingegneria Chimica "G. Natta", Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133, Milano, Italy
[2]Instituto de Tecnología Química (UPV-CSIC), Universitat Politècnica de València-Consejo Superior de Investigaciones Científicas, Avda. de los Naranjos s/n, 46022, València, Spain
[3]Laboratory of Catalysis and Catalytic Processes, Dipartimento di Energia, Politecnico di Milano, via La Masa 34, 20156 Milano, Italy

**Corresponding author: anna.dotti@polimi.it*

Abstract

Water decontamination is one of the most challenging urgencies of our times. In this context, integrated photocatalytic adsorbents represent an innovative sustainable alternative to traditional sorbent materials. They allow not only to capture pollutants, but also to mineralize the organic ones through photodegradation. Composite materials of TiO_2 and reduced graphene oxide (rGO) have already been proven effective for water decontamination (Luna Sanguino et al., 2020). TiO_2 is the most widely studied photocatalyst, while rGO is known for its excellent adsorption capacity of inorganic and organic pollutants. Their combination, besides providing the double functionality of photocatalyst and adsorbent, contributes to overcome some TiO_2 limitations, such as high energy gap and fast recombination of photogenerated carriers (Luna Sanguino et al., 2020). Nevertheless, the research on rGO/TiO_2 composites is mainly restricted to slurry systems, which are hardly employable in real applications. In this study, we propose a low-tech approach to immobilize rGO and TiO_2 in a binder-free coating onto polyurethane (PU) flexible foams, exploiting the self-assembling properties of rGO. The coating only contains commercial non-toxic components, namely an aqueous dispersion of GO, ascorbic acid as reducing agent, and TiO_2 P25 (Basso Peressut et al., 2023). The deposition method is low-energy consuming and involves dip coating, blowing of compressed air, and drying at 40 °C. The obtained rGO/TiO_2-coated foam is shown in Figure 1A.

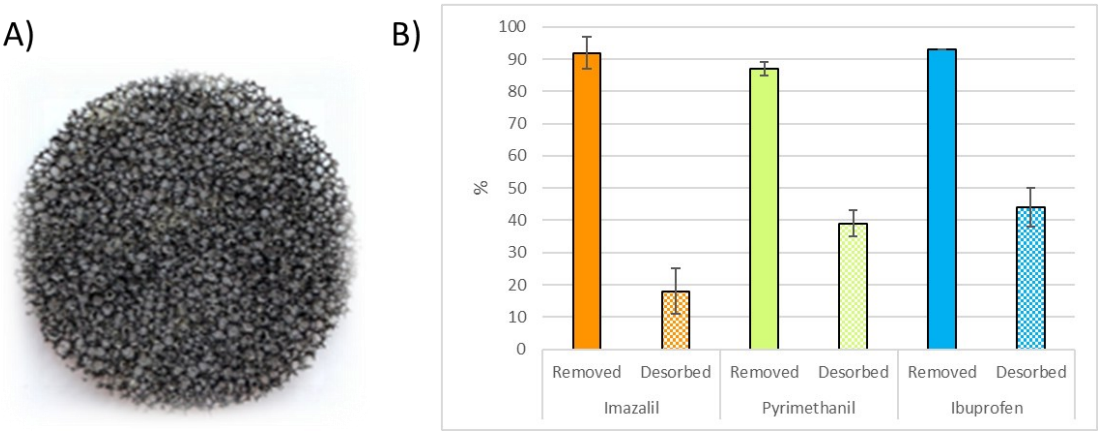

Figure 1. A) rGO/TiO_2-coated PU foam, B) removal after 3 h exposure to UV light and desorption efficiencies toward different pollutants.

Samples (2.5 cm diameter, 0.5 cm thickness) were separately tested for the decontamination of 21 mL of $5x10^{-5}$ M aqueous solutions of imazalil, pyrimethanil and ibuprofen, classified as emerging contaminants. Experiments were carried out both in dark and UV light conditions for 3 h. Then, used foams were immersed in ethanol to desorb contaminants. For all molecules, foams removed about 90% of the initial pollutant concentration after 3 h exposure to UV light (Figure 1B), as a result of the combined effect of adsorption and photodegradation. Considering the different amounts of contaminant removed and desorbed, it is possible to estimate a photodegradation efficiency, which results to be higher (~70%) for imazalil. Foams reusability was confirmed up to five times in the same conditions. Given these successful results, rGO/TiO_2-coated foams will be tested in continuous flow experiments.

References

- Luna-Sanguino, G., Ruíz-Delgado, A., Tolosana-Moranchel, A., Pascual, L., Malato, S., Bahamonde, A., & Faraldos, M. (2020). Solar photocatalytic degradation of pesticides over TiO_2-rGO nanocomposites at pilot plant scale. *Science of The Total Environment*, *737*, 140286.
- Basso Peressut, A., Cristiani, C., Dotelli, G., Dotti, A., Latorrata, S., Bahamonde, A., Gascò, A., Hermosilla, D., & Balzarotti, R. (2023). Reduced graphene oxide/waste-derived TiO_2 composite membranes: preliminary study of a new material for hybrid wastewater treatment. *Nanomaterials*, *13*(6), 1043.