

Peroxo method for the preparation of photocatalytically active titania spheres for emerging micropollutant degradation

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Emerging micropollutants, proceeding from cosmetics and chemical industries, are undesirable compounds most likely to be encountered in water or wastewater and defined as harmful for human health and for the environment. The principal difficulty for the removal of such compounds is the low concentrations, at which they are present in aqueous solutions. Photocatalytic process has been chosen to tackle this challenge, as its application results in decomposition of organic pollutants to H₂O and CO₂ avoiding heating, high pressure, and not requiring toxic chemicals or additives. Among the photocatalytic materials, titanium dioxide has several advantages such as chemical stability, non-toxicity and availability.

In this work 2-(4-methylphenoxy)ethanol (MPET) has been chosen as a model substrate. It is usually found in fragrances used in decorative cosmetics, fine fragrances, shampoos, toilet soaps, and other toiletries as well as in non-cosmetic products such as household cleaners and detergents. To the best of our knowledge, this is the first study of photocatalytic degradation of MPET with a focus on the intermediate formation and their degradation.

We have extended our previously applied method for the preparation of TiO₂-based photocatalysts, utilizing environmentally benign water-soluble titanium peroxo complexes as precursors [1]. The as-prepared materials as well as the those calcined have been characterized using XRD, N₂ physisorption, SEM, TEM analysis. Both the prepared TiO₂ materials and commercial Aeroxide P25 have been studied in the reaction of photodecomposition of MPET under UV irradiation. The evaluation of MPET concentration and determination of its decomposition products have been carried out by means of GC-MS analysis.

The proposed method for preparation of titania spherical particles proves to be the promising alternative to the widespread template and alkoxide-based procedures. It has been shown that the porosity of TiO₂ spheres can be easily controlled by manipulating the synthetic conditions (e.g. solvent, thermal treatment technique, calcination temperature). The photodegradation of the commonly used fragrance MPET goes through the formation of toxic p-cresol, but both the substrate and undesirable intermediates are completely decomposed by the commercial P25 and the photocatalysts prepared by the proposed peroxo method. The titania spheres exhibit high photocatalytic activity and demonstrated good recyclability, making their utilization preferable to the unrecoverable commercial TiO₂ nanoparticles.

References

1. I. Krivtsov, M. Ilkaeva, V. Avdin, Z. Amghouz, S. Khainakov, J. R. García, E. Díaz, S. Ordóñez, *RSC Adv.*, 5 (2015) 36634–36641.