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A large, stylized graphic of a green leaf, composed of several overlapping, semi-transparent layers of varying shades of green. The leaf is oriented vertically, with its tip pointing upwards and its base pointing downwards. It is positioned behind the main title and editor information.

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Influence of the Synthesis Method on the Photocatalytic Activity of TiO₂ Nanoparticles

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Abstract – The photocatalytic activity of aqueous-based and organic-based synthesized TiO₂ was compared to commercial TiO₂ (Degussa P25). The obtained photocatalysts were characterized by X-Ray Diffraction, Infrared Spectroscopy, Scanning Electronic Microscopy and BET isotherm. It was observed, by means of UV-visible spectroscopy, that the organic-based TiO₂ has the highest photocatalytic activity when compared by mass of photocatalyst. However, by using a simple kinetic model, it was demonstrated that the photocatalytic activity of the organic-based TiO₂ is, indeed, the lowest when compared in terms of surface-to-volume ratio. The kinetic model also showed that the aqueous-based TiO₂ nanoparticles presented the best performance. The hypsochromic shift observed during the photodegradation process was correlated with the adsorption modes of the dye on the photocatalyst surface.

Nowadays, the search for an adequate use of water is one of the main tasks to achieve a sustainable development. Several processes of water use implicate in the generation of toxic effluents, which are inappropriate for reuse in agricultural activities and/or human consumption. Recently, a catalyzed process that uses solar energy to promote breaking down of organic pollutants has been studied. In this process, a semiconductor inorganic material (usually TiO₂) is used as catalyst to promote the degradation/oxidation of organic molecules. As in any heterogeneous catalysis, the photocatalysts' surface plays an important role in the efficiency of the process.

In order to evaluate this surface effect on the photodegradation of a cationic dye (Rhodamine B), two TiO₂ chemical routes, named here as Aqueous-Based (AB) and Organic-Based (OB), were selectively chosen to provide samples with different surface characteristics. The OB method is based on the benzyl alcohol route developed by Niederberger et al. [1] and provides spherical nanoparticles with organic by-products attached on the surface (Figure 1A). In the AB method, titanium isopropoxide was used to form a Titanium-peroxo complex, which undergoes thermal decomposition providing anisotropic TiO₂ nanoparticles [2] (Figure 1B). The photocatalytic activity of these samples were compared to the commercial TiO₂ (P25, Degussa), which is commonly used as a standard for this reaction. The results showed that the OB TiO₂ presented the highest photocatalytic activity (Figure 2) when compared by mass of photocatalyst. However, a kinetic model was derived in order to report the photocatalytic activities in terms of available surface area, which revealed that the OB TiO₂ has, indeed, the lowest photocatalytic activity. The highest photocatalytic activity in terms of surface area was presented by the AB TiO₂, which was attributed to the exposure of a large number of active sites due to anisotropy. The hypsochromic shift observed in the spectroscopic measurements was correlated with the adsorption modes of the Rhodamine B on the TiO₂ surface, providing additional evidence of the difference in the photocatalyst surface.

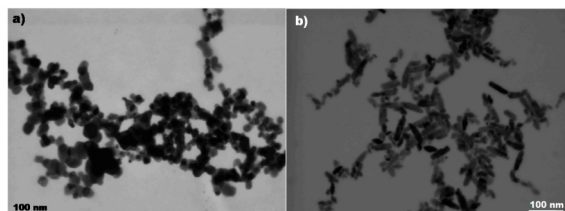


Figure 1: FE-SEM micrographs a) Organic-Based b) Aqueous-based.

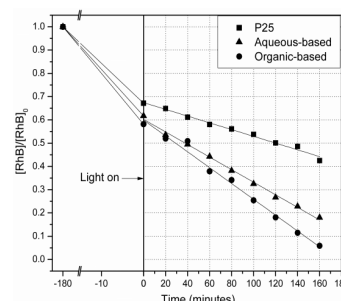


Figure 2: Rhodamine B photodegradation kinetics curves using the as-synthesized and the commercial photocatalysts.

References:

- [1] M. Niederberger et al. *Chem. Mater.*, 2002, 14, 4364-4370.
- [2] C. Ribeiro et al. *J. Phys. Chem. C*, 2007, 111, 5871-5875.