

Supported TiO₂ Catalysts for Photocatalytic Degradation of Aqueous Rhodamine 6G Organic Contaminants in Aqueous Samples: A Model for Removal

Sara Brown*

Editorial Office, Nanoscience & nanotechnology: An Indian Journal, UK

***Corresponding author:** Sara Brown, Editorial office, Nanoscience & nanotechnology: An Indian Journal, UK. E-mail: info@tsijournals.com

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Comment

For the oxidation of numerous organic contaminants, photocatalysis has emerged as a promising new method that is environmentally friendly.

The heterogeneous photocatalytic degradation of Rhodamine 6G was investigated utilising TiO₂-derived catalysts, included in water as suspension as well as supported in Raschig rings, as a model for the removal of complex organic pollutants from industrial water effluents. We investigated the photo-degradation mechanism under UV and visible light.

When a substance comes into contact with photons with a high enough energy level, free radical processes begin to operate, activating the chemical reaction known as photocatalysis.

Production

TiO₂ catalysts were created using the methodology of acid synthesis and contrasted with samples of commercial TiO₂ catalysts (Degussa P25 and Anatase). The bandgap (E_g) of the TiO₂ catalysts was measured, and values of 2.97 and 2.98 eV were found for the material produced under acidic and basic conditions, respectively. Degussa P25 had an E_g of 3.02 eV, and commercial TiO₂ samples anatase had an E_g of 3.18 eV.

Even though a significant portion of the TiO₂ material's surface area is lost during support, Raschig rings-supported TiO₂ catalysts exhibit good photocatalytic performance when compared to equal amounts of TiO₂ in aqueous suspension. The fact that the characteristics (XRD, RD, E_g) and observed photodegradative performance of the synthesised catalysts are in good agreement with the commercial TiO₂ samples and that the differences in Rh6G photodegradation observed with the light sources under consideration are negligible in the presence of TiO₂ catalysts makes this especially clear.

Particularly when white light is used, the addition of additives changes the kinetics and effectiveness of TiO₂-catalyzed Rh6G photodegradation, pointing to a complex phenomena. However, in the presence of the investigated additives, the stability of the supported photocatalytic systems is satisfactory. As a result, the chemical oxygen demand demonstrates that, despite the numerous intricate photophysical processes at play, the intermediate products of the under study photocatalytic systems appear to be comparable. Hydrogen peroxide has the ability to act at nanomolar concentrations as an electron scavenger from the conduction band of TiO₂, facilitating charge separation and the production of hydroxyl radicals, which may aid in the accelerated degradation of Rh6G. Our system, however, exhibits a decrease in photodegradation efficiency, suggesting that at the H₂O₂ concentrations examined, the electron and/or hydroxyl radical scavenging properties of hydrogen peroxide may be pertinent.

A 22% degradation rate is seen when Rh6G solution is exposed to UV light (365 nm), which is further boosted in the presence of supported TiO₂ catalysts, with Anatase and AS-TiO₂ degradation efficiencies exceeding four times the degradation. Degussa P25 degradation efficiencies exceed 70%.

Diverse pollutants have been successfully degraded using heterogeneous photocatalysis. This technique uses radiant energy, such as visible and ultraviolet light from the sun or artificial light sources, which, when interacting with a catalyst (semiconductor), causes charge separation through charge transfer processes, leading to the formation of reactive oxygen species (hydroxyl radicals,

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superoxide anion, hydrogen peroxide, and so on), which are necessary for the oxidation and subsequent mineralization of organic contaminants.

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