

Heterogeneous Titania-Based Photocatalytic Reduction of Tl(I) Ions: Novel Adsorption and Additive Effects

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The photocatalytic reduction of Tl(I) species to its metallic form is characterized by a negative reduction potential, located close to the conduction band potential of TiO₂ in aqueous media. Thus the direct reduction of Tl(I) by photogenerated electrons in UV-irradiated titania suspension is unfavorable unless additives are present.

In this paper we describe the photocatalytic reduction of Tl(I) with various types of additives (e.g., formate ions, acetate ions, and oxalate ions) in UV-irradiated TiO₂ suspensions. The extent of Tl(I) removed from water is dependent on the type and concentration of additives as exemplified by the data in Fig. 1.

The interfacial dark adsorption of Tl(I) on the surface of TiO₂ using different type of additives in aqueous media was also investigated. It was found that the capability of additives in helping Tl(I) adsorption on the surface of TiO₂ is as follows: oxalate ions > acetate ions > formate ions. The point of zero charge (pzc) of TiO₂ in the presence of different type of additives in Tl(I) aqueous solutions is also described. It is shown that, by increasing the concentration of additives, the interfacial pH becomes more basic. Thus the surface of TiO₂ is negatively charged and the point of zero charge is shifted to a higher value. Representative data will be presented.

Finally, Tl(I) is shown to be a sensitive probe of titania particle/aqueous solution interfaces in the dark and under UV-illumination. We show that experimental conditions can be chosen such that photocatalytic reduction or oxidation of this probe is avoided. Thus, any changes in the measured solution levels of this probe can be simply attributed to corresponding variations in its adsorption tendency on the TiO₂ particle surface. Data are presented on how this interfacial probe tracks modulations in the oxide surface charge induced by either variations in solution pH or by UV-irradiation.

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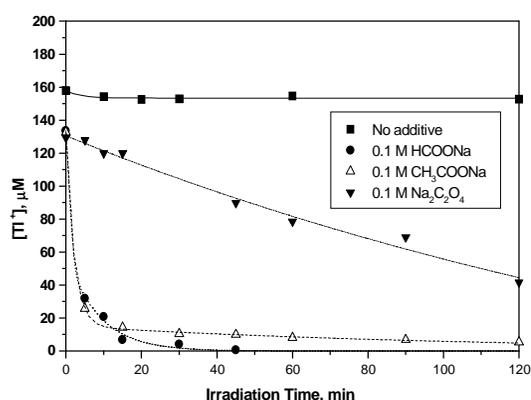


Fig 1. Photocatalytic reduction of thallium ions (200 μM) in titanium dioxide suspensions, pH 7, containing the additives shown.