165f Development of Highly Active Porous Tio_2-P25 Composite Thick Films for Water Purification

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TiO_2 has been proven to be an excellent and efficient photocatalyst for the degradation and complete elimination of numerous toxic contaminants in water and air. In water purification, systems based on immobilized TiO_2 films exhibit certain advantages compare to those utilizing TiO_2 powder in suspension. This is mainly because immobilized-based systems do not require filtration of the effluent to remove TiO_2 particles, usually of nanosize dimensions. Therefore, more and more studies are currently focused on immobilized TiO_2 photocatalysis aiming at its further development and optimization for large-scale environmental applications.

Sol-gel method is considered as an effective approach for the preparation of immobilized TiO_2films on various substrates including stainless steel, glass, ceramic and composite fibers. In general, one dip coating layer of TiO_2film synthesized using sol-gel methods has small film thickness, which can have advantages in certain applications (i.e., membranes). However, in many cases, films made of conventional sol-gel methods may also have low crystallinity and poor light absorption properties. As a result, the photocatalytic activity of these TiO_2 films is usually low. In many cases, an increase in the number of coating layers (usually up to 10) made by conventional sol-gel methods leads to an increase in photocatalytic activity but this is accompanied with longer and more costly synthesis process. Moreover, increased film thickness often causes marocrack formation, which has detrimental effect on the long-term mechanical stability of the film. This may be a critical problem, especially in applications dealing with water purification. Therefore, there is an urgent need to develop highly active TiO_2 photocatalytic films with optimum thickness and porosity as well as excellent mechanical stability, while minimizing the number of dip-coating/heat-treatment cycles.

This study deals with the preparation of novel porous thick TiO_2-P25 composite films by a modified sol-gel method that incorporates the use of P25 as a filler, a template material, and other solvent additives. The as-prepared films can be used in efficient water purification systems. This modified sol-gel procedure concerns incorporating highly active P-25 TiO_2 powders during the formation of the titanium alkoxide precursors. The final films possess higher surface area with porous structure, high crystallinity (high film thickness), high photocatalytic activity, good mechanical stability and durable performance. Details will be discussed on the (i) loading of TiO_2 powder as filler, (ii) templating agent type and concentration, (iii) type of solvent, and (iv) calcination temperature for the crystallization of porous TiO_2 films immobilized on certain support materials. Recent results on the morphology, crystallinity, crystal size, film thickness, specific surface area, pore volume, pore size, surface chemical composition, adhesion to the substrates, and photocatalytic activity of these films will be presented. Compared with other porous TiO_2 films prepared by certain existing sol-gel methods, the films prepared by the method employed in this study show enhanced photocatalytic activity and good structural properties.