

Chapter 22

Electrophoretical Deposition of Nanotube TiO_2 Conglomerates Detached During Ti Anodizing Used for Decomposing Methyl Orange in Water

C. Y. Torres López

*Centro de Investigación y Desarrollo
Tecnológico en Electroquímica, S.C., Mexico*

J. J. Pérez Bueno

*Centro de Investigación y Desarrollo
Tecnológico en Electroquímica, S.C., Mexico*

I. Zamudio Torres

*Centro de Investigación y Desarrollo
Tecnológico en Electroquímica, S.C., Mexico*

M. L. Mendoza-López

Instituto Tecnológico de Querétaro, México

J. E. Urbina Álvarez

*Centro de Investigación y de Estudios
Avanzados del Instituto Politécnico Nacional,
Unidad Querétaro, México*

A. Hurtado Macías

*Centro de Investigación en Materiales
Avanzados, S.C., Mexico*

ABSTRACT

This chapter shows the experimental findings on preparing TiO_2 nanotubes by anodizing titanium into an organic medium for an intended use as a photocatalytic active electrode in treating water polluted with organic contaminants. The substrates were grit blasted in order to obtain mechanical fixation of the generated nanotubular TiO_2 structure. This was successfully achieved without diminishment of the nanotubes order and with a self-leveled outer surface. A new phenomenon occurred when detached fragments from the modified layer were electrophoretically deposited. They were ordered and grow as deposits. In addition, they maintain their nanotubular shape conferring a homogeneous size in the porous structure.

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INTRODUCTION

TiO₂ (titanium dioxide or titania) is a compound widely researched, in the reported literature is possible to find it in many applications, including degradation of organic compounds and bacteria, both in water and in air, power generation, in prosthetic, among others. The main characteristics of this compound are its high oxidizing capacity, the super-hydrophilicity, chemical stability, durability, corrosion resistance; it is transparent to visible light, non-toxic making it environmentally friendly.

Titanium dioxide does not absorb light in the visible region (400-700 nm). However, it does with UV light (100-400 nm). It is responsible for the generation of electron-hole pairs (charge carriers), which induce chemical reactions at the surface. Thus, the property of photochemistry is the most important feature of TiO₂, which confers catalytic activity. This is the main reason for its so extensive study.

This class of compounds has been synthesized both micro- and nano- sizes. However, it is in the latter scale, where researchers have paid more attention, especially for acquired properties, which may depend on their different morphologies as well. TiO₂ has been synthesized in different forms, such as: spheres, rods, sheets, wires and tubes. The nanotubes have been obtained by different methods, such as: hydrothermal, sol-gel template-assisted methods, and electrochemical methods.

Comparing with other morphologies of TiO₂, nanotubes may have lower rates of recombination of charge carriers, electron-hole pair (e⁻/h⁺). In part, this is a consequence of a short diffusion distance into the walls of nanotubes.

This chapter considers the formation of TiO₂ nanotube surfaces by means of anodizing Ti plates. These structures will be discussed in two applications, catalytic and photocatalytic treatments for the decomposition of organic molecules. There were an experimental setup with UV exposure and other without UV.

BACKGROUND

The growing demand of the society for the decontamination of polluted waters from diverse sources, embodied in increasingly stringent regulations, has driven in the past decade to the development of new purification technologies. In practice, the application of the treatment methods primarily considers the nature and physicochemical properties of the water or effluent to be treated.

The water contaminated by human activity can generally be processed efficiently by biological treatment plants, by adsorption with activated carbon or other adsorbents, or by conventional chemical treatments (thermal oxidation, chlorination, ozonation, potassium permanganate, etc.). However, in some cases, these procedures are inadequate to achieve the degree of purity required by law or by the subsequent use of the treated effluent.

In general, dye-containing effluent is treated by biological means, adsorption, membrane, coagulation-flocculation, oxidation-ozonation and advanced oxidation processes (AOPs). The AOPs have been developed for non-biodegradable pollutants to degrade harmful species in water for human consumption and industrial effluents. The combination of heterogeneous photocatalysis on semiconductors and UV light is considered one of the most promising AOPs for degradation of water-soluble organic compounds (Esquivel, Ariaga, Rodríguez, Martínez, & Godínez, 2009; Grabowska, Reszczyńska, & Zaleska, 2012; Jardim, Moraes, & Takiyama, 1997; Michael, Hapeshi, Michael, & Fatta-Kassinos, 2010).

The following summarizes the advantages of the AOPs against conventional methods:

- Not only change the contaminant phase (as in the activated carbon treatment), but it is chemically transformed.
- Generally, complete mineralization (destruction) of the contaminant is achieved. However, conventional technologies do not

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