Photocatalytic degradation of endocrine disrupters under visible light action using nanostructured N-TiO₂

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Introduction

The environmental pollution of water systems and industrial wastewaters by endocrine disrupters of chemical anthropogenic origin (EDC) has raised concern among public opinion during last years due their strong nocice effect in living beings [1]. It is reported that BPA contamination routes include the effluents of waste-water treatment plants, landfills sites and also BPA migration coming from products that contain the chemical. In consequence, BPA dispersion in the environment has been generalized, since basic studies had reported human health risks, biological reproduction threats and also the perturbing effects in the endocrine system of aquatic organisms [2]. Therefore, it is required to develop an effective technology for substantially eliminate BPA at ng.L⁻¹ levels in water systems and avoid its proliferation in the environment. Photocatalysis emerges like a technological option to degrade this xenobiotic molecule. To the date, several papers had reported the study of TiO₂ and TiO₂ doped with anions (N, C and P) like photocatalyst to degrade organic molecules under visible light action [3,4]. Using this like reference, in this paper BPA will be studied using N-doped TiO₂ to decrease its toxic risk under visible light action.

Materials and Methods

The samples of TiO₂ and TiO₂ doped with nitrogen (1, 3 and 5% wt) were prepared by colloidal route under inert atmosphere. The solution was prepared slowly adding titanium butoxide (Aldrich) in ethylene glycol (EG Fischer) with a molar ratio 0.01 according to procedure reported [4]. The mixture was stirred during 20 h then an excess of HPLC acetone was added to promote fast hydrolysis and TiO₂ precipitation. Once this was achieved, the solid was rinsed with an excess of ethanol-water mixture (50% vol) and was dried at 110°C and finally calcinate at 400°C. The calcined solids were characterized by X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), UV-Vis Spectroscopy and X-Ray Photoelectron Spectroscopy (XPS).

The photocatalytic tests of BPA degradation were performed in batch reactor. A solution of 30 ppm of PBA with catalyst volume/reactant volume of 0.5 was placed in the reactor. The reaction development was controlled measuring dissolved oxygen and by UV electroscopy at a wavelength of 275 nm.

Results and Discussion

Figure 1a shows XRD characterization results of samples calcined at 400°C indicating the phase anatase when compared to card number 96-101-0943. SEM results show spherical nanoparticles around 0.2 micrometer of diameter regardless nitrogen concentration. The bandgap of different TiO₂ samples do not show significant changes with respect nitrogen doping (3.1eV) although such value is slightly lower with respect TiO₂ (3.2 eV). Previous studies by XPS had reported that nitrogen is inserted in the TiO₂ cell [5]. The photocatalytic activity of BPA was indirectly determined by means of dissolved oxygen. The results shown in figure 1b indicate that BPA degradation increases with the presence of photocatalysts with higher nitrogen content. The quantum efficiency of the reaction shows that 5%N-TiO₂ sample was the most effective in the first 120 minutes. The trend of these results corresponds with spectrophotometric analysis of BPA degradation at λ=275 nm that reports same time for half life time.

![Figure 1. X-Ray Diffraction pattern of photocatalysts prepared (N-TiO₂) and calcined at 400°C and their photocatalytic activity in Bisphenol A (BPA) degradation. a) DRX, b) Reaction comparison according to dissolved oxygen concentration.](image)

Significance

Show the potential of nanostructured photocatalysts (N-TiO₂) in BPA degradation under visible light action.

References