

Synthesis, Characterization and Photocatalytic Activity of M-TiO₂

L. M. Bautista-Carrillo¹, O. Vázquez-Cuchillo^{1*}, A. Cruz-López¹, J.F. Sánchez-Ramírez², L. Torres-Martínez¹

¹ Departamento de Ecomateriales y Energía, Facultad de Ingeniería Civil, Universidad Autónoma de Nuevo León, Av. Universidad y Av. Fidel

Veldáquez S/N Cd. Universitaria, San Nicolás de los Garza Nuevo León, 66451 México

³ CICATA-IPN, Legaria #, Col. Irrigación, 11500 México D.F., México

*Corresponding author: odilon_vazquez_c@hotmail.com

Introduction

Environmental pollution on a global scale, as well as the lack of sufficient clean energy sources have drawn much attention to the need for develop ecologically clean chemical technology, materials and process [1,2]. In this way, the photocatalytic processes have special attention because that can make use the abundant solar energy for transformer the organic and inorganic molecules by the redox reaction in water or air. In fact, the TiO₂ is the most widely used semiconductor oxide for such applications because of its suitable flat band gap and chemical stability. However, the high photocatalytic activity is limited under ultraviolet irradiation [3-5].

Materials and Methods

The TiO₂ was prepared by sol-gel method using a molar rate 1:100 of tetrabutoxytitanium (Aldrich 97 %) and water respectively. First, the starting material (tetrabutoxytitanium) was added to one acid solution (1:0.14) in order to hydrolyse slowly the precursor of titanium. For arrive it, HNO₃ (DEQ, 65%), the solution was magnetically stirred and heating at 80° C for 2 hrs. Then, the gel was dried in air at 100° C for 12 hours. Finally, the solids were calcined at 400°C for 4 h, using a heating rate of 1°C/min.

In the case of the catalysts M-TiO₂ synthesized with different rapports of doped (1.0 % M). Firstly, an aqueous solution of M acetate was prepared with molar rate of 1:100 at room temperature. Then, the pH of the solution was adjusted at 9 by adding drop to drop NH₄OH (DEQ) under vigorous stirring. In order to assure the homogenous solution the mixed has been stilled 30 minutes after. Finally this solution was mixed with the precursor solution of TiO₂ described in the previous paragraph.

Results and Discussion

The composite were annealed at different temperature and characterized by different spectroscopic and superficial techniques. Seeking change their optical, estructura and catalytic properties Seeking change their optical, estructura and catalytic properties

In general, the diffraction patterns (not showed) of the fresh samples of TiO₂ synthesized with different acids were identical and corresponding to the amorphous phase of anatase. The same samples calcined at 400°C. It can be seen the characteristics reflection of anatase.

The specific surface areas were determined from nitrogen adsorption-desorption isotherms using the BET method. The semiconductor prepared with HNO₃ (90 m².g⁻¹). On the other hand, when the incorporation of M into TiO₂ was studied using HNO₃ as catalyst

The photocatalytic activity of TiO₂ and TiO₂ doped with M was studied for the degradation of 2, 4-dichlorophenoxyacetic acid in aqueous solution, under UV radiation and using the same mass of catalyst. The goal is identify, if there is a positive effect when a doped agent was added into TiO₂. So that, In this work has been analyzed the evolution of the 2, 4-dichlorophenoxyacetic acid concentration in a dark box in presence of catalyst to assure that the pesticide compound has not been absorbed. As well as, the photolysis test has been done in order to determine the level of photoactivity of the organic compound,

Table 1. Summarizes the first order constants, $t_{1/2}$, with respect to the 2,4-dichlorophenoxyacetic acid for the different catalysts

Sample	P25	TiO ₂			
		HNO ₃	1% Ge	1%Ga	1%Zn
Synthesis Conditions			HNO ₃		
Surface Area (m ² .g ⁻¹)	53	90	83	119	117
Eg(eV)	3.2	3.0	3.2	3.2	3.2
t _{1/2} (min)	198	36	28	31	43

Conclusions

In the case the doped catalysts, the presence of small quantities of M still the Eg values near to 3.3 eV. However, the presence of doped agent into the TiO₂ increase the activity as follow 1%Ge-TiO₂ > 1Ga-TiO₂ > 1%Zn-TiO₂ > TiO₂ in the photocatalytic activity of 2, 4-dichlorophenoxyacetic acid.

References

1. K. Iino, M. Kitano, M. Takeuchi, M. Matsuoka, and M. Anpo, Applied Physics, 6 (2005) 982-986.
2. F.-L. Toma, G. Bertrand, S. O. Chwa, D. Klein, H. Liao, C. Meunier, C. Coddet, , Materials Science and Engineering A, 417 (2006) 56-62.
3. L. M. Torres-Martínez, A. Cruz-López, L. L. Garza Tovar, K. Del Angel and I. Juárez Ramírez, Chem. Intermed., 34-4 (2008) 403-416.
4. Chen and S. S. Mao, Titanium Dioxide Nanomaterials, Chemical Reviews, 107 (2007) 4698-4795.
5. S. Li, Z. Ma, J. Zhang and J. Liu, , Catalysis Communication, 9 (2008) 1482-1486.