JWARP> Vol.2 No.3, March 2010

OPEN ACCESS

Photocatalytic Degradation of Isoproturon Pesticide on C, N and S Doped TiO2

PDF (Size:1514KB) PP. 235-244 DOI: 10.4236/jwarp.2010.23027

Author(s)

Police Anil Kumar Reddy, Pulagurla Venkata Laxma Reddy, Vutukuri Maitrey Sharma, Basavaraju Srinivas, Valluri Durga Kumari, Machiraju Subrahmanyam

ABSTRACT

TiO2 doped with C, N and S (TCNS photocatalyst) was prepared by hydrolysis process using titanium iso-propoxide and thiourea. The prepared samples were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), X-ray photo electron spectroscopy (XPS), BET surface area, FTIR and diffuse reflectance spectra (DRS). The results showed that the prepared catalysts are anatase type and nanosized par-ticles. The catalysts exhibited stronger absorption in the visible light region with a red shift in the adsorption edge. The photocatalytic activity of TCNS photocatalysts was evaluated by the photocatalytic degradation of isoproturon pesticide in aqueous solution. In the present study the maximum activity was achieved for TCNS5 catalyst at neutral pH with 1 g L-1 catalyst amount and at 1.14 x 10-4 M concentration of the pesticide solution. The TCNS photocatalysts showed higher phtocatalytic activity under solar light irradiation. This is attributed to the synergetic effects of red shift in the absorption edge, higher surface area and the inhibition of charge carrier recombination process.

KEYWORDS

Isoproturon, Pesticide Degradation, C, N and S Doped TiO2, Visible Light Active Catalysts

Cite this paper

P. Anil Kumar Reddy, P. Venkata Laxma Reddy, V. Maitrey Sharma, B. Srinivas, V. Kumari and M. Subrahmanyam, "Photocatalytic Degradation of Isoproturon Pesticide on C, N and S Doped TiO2," *Journal of Water Resource and Protection*, Vol. 2 No. 3, 2010, pp. 235-244. doi: 10.4236/jwarp.2010.23027.

References

[1] A. Fujishima, K. Hashimoto, and T. Watanabe, "TiO2 photocatalysis: Fundamentals and applications," BKC, Tokyo, 1999.

[2] L. Q. Wu, N. Xu, and J. Shi, "Leak growth mechanism in composite Pd membranes," Industrial & Engineering Chemistry Research, Vol. 39, pp. 342–348, 2000.

[3] R. Asahi, T. Morikawa, T. Ohwaki, K. Aoki, and Y. Taga, "Visible-light photocatalysis in Nitrogen-Doped titanium oxides," Science, Vol. 293, pp. 269–71, July 2001.

[4] T. Ohnoa, M. Akiyoshi, T. Umebayashi, K. Asai, T. Mit-sui, and M. Matsumura, "Preparation of S-doped TiO2 photocatalysts and their photocatalytic activities under visible light," Applied Catalysis A: General, Vol. 265, pp. 115–121, February 2004.

[5] X. Chen and S. S. Mao, "Titanium dioxide nano-mate- rials: Synthesis, properties, modifications, and appli- cations," Chemical Review, Vol. 107, pp. 2891–2959, 2007.

[6] H. Irie, Y. Watanabe, and K. Hashimoto, "Carbon-doped anatase TiO2 powders as a visible-light sensitive photo-catalyst," Chemistry Letters, Vol. 32, pp. 772–773, May 2003.

[7] W. Ho, J. C. Yu, and S. Lee, "Synthesis of hierarchical nanoporous F-doped TiO2 spheres with visible light photocatalytic activity," Chemical Communications, pp. 1115–1117, January 2006.

- Open Special Issues
- Published Special Issues
- Special Issues Guideline

JWARP Subscription

Most popular papers in JWARP

About JWARP News

Frequently Asked Questions

Recommend to Peers

Recommend to Library

Contact Us

[8] L. Lin, W. Lin, Y. Zhu, B. Zhao, and Y. Xie, “Phosphor- doped titania —A novel photocatalyst active in visible light,” Chemistry Letters, Vol. 34, pp. 284–285, Novem-ber 2004.

[9] T. Ohno, T. Mitsui, and M. Matsumura, “Photocatalytic activity of S-doped TiO2 photocatalyst under visible light,” Chemistry Letters, Vol. 32, pp. 364–365, January 2003.

[10] H. Irie, Y. Watanabe, and K. Hashimoto, “Nitrogen- con-centration dependence on photocatalytic activity of TiO2-xNx powders,” Journal of Physical Chemistry B, Vol. 107, pp. 5483–5486, January 2003.

[11] J. G. Yu, M. H. Zou, B. Cheng, and X. J. Zhao, “Prepara-tion, characterization and photocatalytic activity of in situ N, S-codoped TiO2 powders,” Journal of Molecular Ca-talysis A: Chemical, Vol. 246, pp. 176–184, December 2005.

[12] Y. Q. Wang, X. J. Yu, and D. Z. Sun, “Synthesis, charac-teri- zation, and photocatalytic activity of TiO2?xNx nano- catalysts,” Journal of Hazardous Materials, Vol. 144, pp. 328–333, October 2006.

[13] J. L. Gole and J. D. Stout, C. Burda, Y. Lou, and X. Chen, “Highly efficient formation of visible light tunable TiO2-xNx photocatalysts and their transformation at the nanoscale,” Journal of Physical Chemistry B, Vol. 108, pp. 1230–1240, September 2003.

[14] C. Burda, Y. Lou, X. Chen, A. C. S. Samia, J. Stout, and J. L. Gole, “Enhanced nitrogen doping in TiO2 nanoparti-cles,” Nano Letters, Vol. 3, pp. 1049–1051, June 2003.

[15] B. Chi, L. Zhao, and T. Jin, “One-step template-free route for synthesis of mesoporous N-doped titania spheres,” Journal of Physical Chemistry C, Vol. 111, pp. 6189– 6193, February 2007.

[16] X. W. Bao, S. S. Yan, F. Chen, and J. L. Zhang , “Prepa-ration of TiO2 photocatalyst by hydrothermal method from aqueous peroxotitanium acid gel,” Material Letters, Vol. 59, pp. 412–415, October 2004.

[17] T. Morikawa, R. Asahi, T. Ohwaki, K. Aoki, and Y. Taga, “Band-gap narrowing of titanium dioxide by nitrogen doping,” Japan Journal of Applied Physics, Vol. 40, pp. 561–563, April 2001.

[18] M. V. Phanikrishna Sharma, V. Durgakumari, and M. Subrahmanyam, “Solar photocatalytic degradation of isoproturon over TiO2/H-MOR composite systems,” Journal of Hazardous Materials, Vol. 160, pp. 568–575, March 2008.

[19] M. V. Phanikrishna Sharma, V. Durga Kumari, and M. Subrahmanyam, “Photocatalytic degradation of isopro- turon herbicide over TiO2/Al-MCM-41 composite sys- tems using solar light,” Chemosphere, Vol. 72, pp. 644– 651, April 2008.

[20] M. V. Phanikrishna Sharma, G. Sadanandam, A. Ratnamala, V. Durga Kumari, and M. Subrahmanyam, “An efficient and novel porous nanosilica supported TiO2 photocatalyst for pesticide degradation using solar light,” Journal of Hazardous Materials, Vol. 171, pp. 626–633, June 2009.

[21] Y. Ao, J. Xu, D. Fu, and C. Yuan, “Synthesis of C,N,S- tridoped mesoporous titania with enhanced visible light- induced photocatalytic activity,” Microporous and Mesoporous Materials, Vol. 122, pp. 1–6, November 2008.

[22] S. I. Shah, W. Li, C. P. Huang, O. Jung, and C. Ni, “Study of Nd3+, Pd2+, Pt4+, and Fe3+ dopant effect on photo reactivity of TiO2 nanoparticles,” Proceedings of the National Academy of Sciences, Vol. 99, pp. 6482– 6486, January 2002.

[23] J. Sun, L. Qiao, S. Sun, and G. Wang, “Photocatalytic degradation of orange G on nitrogen-doped TiO2 catalysts under visible light and sunlight irradiation,” Journal of Hazardous Materials, Vol. 155, pp. 312–319, November 2007.

[24] F. Peng, L. Cai, H. Yu, H. Wang, and J. Yang, “Synthesis and characterization of substitutional and interstitial nitrogen-doped titanium dioxides with visible light photocatalytic activity,” Journal of Solid State Chemistry, Vol. 181, pp. 130–136, November 2007.

[25] Y. Park, W. Kim, H. Park, T. Tachikawa, T. Majima, and W. Choi, “Carbon-doped TiO2 photocatalyst synthesized without using an external carbon precursor and the visible light activity,” Applied Catalysis B, Vol. 91, pp. 355–361, June 2009.

[26] F. Dong, W. Zhao, and Z. Wu, “Characterization and photocatalytic activities of C, N and S co-doped TiO2 with 1D nanostructure prepared by the nano-confinement effect,” Nanotechnology, Vol. 19, pp. 365–607, July 2008.

[27] I. C. Kang, Q. Zhang, S. Yin, T. Sato, and F. Saito, “Novel method for preparation of high visible active N-doped TiO2 photocatalyst with its grinding in solvent,” Applied Catalysis B, Vol. 84, pp. 570–576, May 2008.

[28] S. Sakthivel and H. Kisch, “Daylight photocatalysis by carbon-modified titanium dioxide,” Angewandte Chemie International Edition, Vol. 42, pp. 4908–4911, 2003.

[29] C. Gopinath, “Comment on photoelectron spectroscopic investigation of nitrogen-doped titania nanoparticles,” Journal of Physical Chemistry B, Vol. 110, pp. 7079– 7080, January 2006.

[30] S. Liu and X. Chen, “A visible light response TiO2 photocatalyst realized by cationic S-doping and its application for phenol degradation,” Journal of Hazardous Materials, Vol. 152, pp. 48–55, June 2007.

[31] J. Geng, D. Yang, J. Zhu, D. Chen, and Z. Jiang, “Nitrogen-doped TiO2 nanotubes with enhanced photo- catalytic activity synthesized by a facile wet chemistry method,” Material Research Bulletin, Vol. 44, pp. 146– 150, March 2008.