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Stephanie D Lambert et al., J Adv Chem Eng 2018, Volume 8
DOI: 10.4172/2090-4568-C3-011

5th International Conference on

Advances in Chemical Engineering & Technology

October 04-05, 2018 | London, UK

Highly efficient low-temperature n-doped TiO_2 catalysts for visible light photocatalytic applications

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In this work, an aqueous titania sol-gel synthesis is doped with nitrogen precursor to extend its activity towards visible region. Three N-precursors are used: urea, ethylenediamine and triethylamine. Different molar ratios have been tested for each dopant. Results showed the formation of anatase-brookite TiO_2 nanoparticles of 6-8 nm with a specific surface area between 200 and 275 m2g-1 for the urea and triethylamine series. Concerning the ethylenediamine series, the formation of rutile phase is observed when the amount of ethylenediamine increases due to the addition of nitric acid in order to maintain the peptization process during the synthesis [1]. In this series, TiO_2 nanoparticles of 6-8 nm are also obtained with a specific surface area between 185 and 240 m2g-1.Combination of XPS and diffuse reflectance measurements suggests the incorporation of nitrogen in TiO_2 materials through Ti-O-N bonds allowing absorption in visible region. Catalytic tests showed a marked improvement of performance under visible radiation for all doped catalysts in the remediation of polluted water with p-nitrophenol. In this case, nitrogen doping can reduce the band gap by creating an intermediate band for the electrons below the conduction band or above the valence band, allowing activity in the visible range. The best doping, regarding cost, activity and ease of synthesis (urea precursor with a molar urea/Ti precursor ratio of 2), is up-scaled to a volume of 5 L and compared to commercial Evonik P25 material. This urea-doped large scale catalyst showed analogous properties as the lab-scale corresponding synthesis and a photoactivity 4 times higher than commercial Evonik P25 photocatalyst.

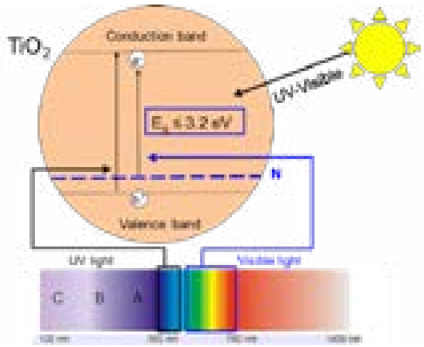

Figure 1: Decrease of the TiO_2 band-gap with the insertion of Ti-O-N bonds into the lattice.

Recent Publications

1. Mahy J G, Cerfontaine V, Poelman D, Devred F, Gaigneaux E, et al. (2018) Highly efficient low temperature N-doped TiO_2 catalysts for visible light photocatalytic applications. Materials 584.
2. Benhebal H, Benrabah B, Ammari A, Madoune Y and Lambert SD (2018) Structural and optoelectronic properties of SnO_2 thin films doped by group-1A elements. Surface Review and Letters 25:1850007-1-1850007-6.
3. Ghrab S, Benzina M and Lambert S D (2017) Copper adsorption from waste water using bone charcoal. Advances in Materials Physics and Chemistry 7:139–147.
4. Mahy J G, Claude V, Sacco L and Lambert S D (2017) Ethylene polymerization and hydrodechlorination of 1,2-dichloroethane mediated by nickel(II) covalently anchored to silica xerogels. Journal of Sol-Gel Science and Technology 81:59–68.
5. Claude V, Solís Garcia H, Wolfs C and Lambert S D (2017) Elaboration of an easy aqueous sol-gel method for the

synthesis of micro- and mesoporous γ-Al_2O_3 supports. Advances in Materials Physics and Chemistry 7:294–310.

Biography

Stephanie D Lambert is a FRS-FNRS research associate and an associate professor in the Department of Chemical Engineering (DCE) of the University of Liege (Belgium) since 2009. She obtained her Ph.D. in Applied Sciences in 2003. After an engineer position in a Belgian chemical company (Nanocyl) (2004-2005), and two postdoctoral stays at the DCE of the University of Illinois at Chicago in 2006, and at the Institute Charles Gerhardt in Montpellier in 2007, she joined the team "Nanomaterials, Catalysis, Electrochemistry" of the University of Liege, in which she develops heterogeneous catalysts for sustainable chemistry (tars reforming, treatments of chlorinated compounds, photocatalysis,..). She is vice-chair of the DCE since early 2016. SL has published over 80 publications, 12 book chapters, holds 1 patent and has an h-index of 19. She also received 16 Invited lectures. She is Member of Local Organizing Committee of SOL-GEL 2017, 3-8 septembre 2017, Liege, Belgium.

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