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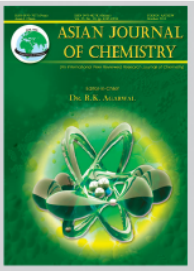

Synthesis and Characterization of Visible-Light Active Nitrogen-Doped TiO_2 Photocatalyst

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Nitrogen-doped titania (N-doped TiO_2) has been synthesized through the hydrolysis of N-substituted titanium isopropoxide precursors followed by annealing treatment in air at desired temperatures. The resulting N-doped TiO_2 were characterized using TGA, XRD, BET, XPS, TEM and UV-VIS spectrophotometer. The XRD result showed that the structure of N-doped TiO_2 was anatase. The crystallite size of N-doped TiO_2 increased with the increase of N/Ti proportion. The pore properties were investigated from nitrogen gas sorption analyzer, showing a mesoporous structure of its N-doped TiO_2 with a high specific surface area and a sharp pore radius distribution. The substitution of oxygen sites with nitrogen atoms in the TiO_2 structure was confirmed by X-ray photoemission spectroscopy (XPS). The doping of nitrogen could extend the absorption edge into the visible-light region leaded to a clear decrease in the band gap on N-doped TiO_2 (compared to pure titania and Degussa P25). The adsorption capacity and adsorption equilibrium constant were also improved by the doping of nitrogen. Catalytic application on methylene blue photodegradation under visible-light irradiation indicated that N-doped TiO_2 provide better activity comparing to the pure ones.

Key Words: Photocatalyst, Nanosize, Optical absorption.

INTRODUCTION

Photocatalysis has been thought to be a fascinating approach for resolving the embarrasments of energy, environment and resource for several decades[1,2]. Anatase type TiO_2 semiconductor is very often used photocatalyst for water purification and other environmental problem solutions because of its stability, nontoxicity, a relatively satisfied activity, low cost, high oxidation potential and chemically favourable properties[3]. However, anatase has a high energy of the band gap ($E_g > 3.2$ eV) and therefore could be excited by UV radiation only ($\lambda < 380$ nm). Therefore, developing a modified visible-light sensitive TiO_2 photocatalyst plays an important role in increasing the utilization rate of solar energy and promoting the application of photocatalysis technology and is the most important and challenging research subject in the photocatalysis field[4].

Early attempts for shifting of TiO_2 absorption into visible-light region mainly focus on the transition metals doping[5,6] but shortcomings of metal doped TiO_2 such as thermally instability, its tendency to form charge carrier recombination centers[7], as well as the expensive ion implantation facilities make metal-doped TiO_2 impractical[8]. Recently, nonmetal-ion-doping has been proposed to be an efficient method for preparation of modified TiO_2.[9,10] Asahi *et al*[9]. were successfully intrigued the interest in the anion doping (such as N, C, S, P and F) of TiO_2. Among these anion dopants, nitrogen seems to be the most effective dopant due to its similar size to oxygen and small ionization energy[10]. Therefore, nitrogen doped TiO_2 becomes the most studied material relating to its synthesis, characterization and application.

N-doped TiO_2 has been prepared by hydrolytic process[11], mechanochemical technique[12], reactive DC magnetron sputtering[13,14], solvothermal process[15], high temperature treatment of TiO_2 under nitrogen atmosphere[9,16] and sol gel method1[17,18]. However, all these processes either required a special apparatus for synthesis or require tight control of experimental conditions. It seems that the sol gel method is the most successful method to prepare N-doped TiO_2 nanoparticles, because it affords simplicity in controlling the nitrogen doping level and particle size by simple variations in experimental condition, such as hydrolysis rate, pH of the solution and solvent systems[17].

In this paper, we report a one step simple sol gel method to synthesize nanometer-sized visible-light N-doped TiO_2 photocatalyst through the hydrolysis of N-substituted titanium isopropoxide precursors. The elemental nitrogen was derived from dodecylamine. The photocatalytic activity of resulted material was estimated in the system of aqueous solution of methylene blue under visible-light, respectively. The contribution of nitrogen doping into titania to the adsorption