11th International Conference
on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

ICAM2009

UV-induced photocatalytic degradation of Rhodamine B by ZnO particles

G.V.F.Santos [(1)*], C.Ribeiro [(2)], T.R.Giraldi [(2)], I.T.Weber [(1)]

(1) Universidade Federal de Pernambuco, Recife, PE, Brazil, e-mail: georgiavirginia@yahoo.com.br
(2) Embrapa Instrumentação Agropecuária, S.Carlos, SP, Brazil
* Av. Prof. Luiz Freire, s/n Cidade Universitária, 50670-901, Recife-PE Phone: (81) 2126-8412/7472

Abstract – Semiconductor-assisted photocatalysis has attracted attention and photocatalytic activity depends on the particle size, crystalline and morphology, which is related to synthesis method. In this study ZnO samples were prepared using a simple precipitation method. Particles were characterized by XRD and photocatalytic degradation of dye Rhodamine B was investigated. UV-Vis spectroscopy results show that in presence of particles (without heat thermal) and light, 74% of dye was degraded at the irradiation time of 5h. This efficiency increased to 96% for samples treated at 500ºC. These results suggested a direct relationship between the efficiency of dye's degradation and the crystallinity of the nanoparticles.

Nowadays, the search for an adequate use of water is one of the main tasks to achieve a sustainable development. Several alternatives have been studied, among them; dye's degradation coming of textile industries, by photocatalysis systems such as a combination of a semiconductor (TiO_2, ZnO, etc) and UV light [1]. In this process, a semiconductor inorganic material in nanometric scale is used as catalyst to promote the degradation/oxidation of these organic dyes.

In this work, ZnO nanoparticles were obtained, in order to study the performance in degradation photocatalytic of Rodhamine B dye. The crystallinity, surface area and morphology are important factors that influence in the nanoparticles catalytic activity. The literature report several techniques to obtain ZnO particles such as alkali precipitation, thermal decomposition, hydrothermal synthesis and sol-gel method [2]. However, the simplicity of method could be an attractive in a production of the nanoparticles. In this sense, the present study shows a simple method for production of ZnO particles. Zinc acetate dehydrate was used as the raw material and ammonia hydroxide as employed to promote precipitation. Synthesis was performed at room temperature adjusting initial pH (up to 3) of a 0,025M zinc acetate solution with nitric acid. Afterwards, ammonia hydroxide was added to solution, yielding a white precipitate, which was centrifugated and washed for 3 times with distilled water. Powders were dried by liophilization and characterized by SEM, XRD and FTIR. Subsequent heat treatment, from 100ºC to 500ºC (for 2h) were carried out, in order to accomplish ZnO crystallization.

The X-ray diffraction obtained for the sample without heat treatment showed that it isn't characteristic of ZnO with hexagonal structure of wurtzita. The XRD pattern was comparable to the literature and suggested that the obtained material belongs to the family of the zinc hydroxyl-acetate $Zn_5(OH)_8(Ac)_2(H_2O)_2$, called Zn-HDS. Lubomir [3] suggested that Zn-HDS is preferentially formed in the presence of H_2O and hydroxyl ions and can be transformed into ZnO at higher temperatures. The presence of this compound can be observed of the characteristic XRD peak of the basal spacing situated at 2è $<10^o$. The acetate presents peak in $2\theta \sim 6^o$ [4].

In the present study, was observed a peak in $2\theta \sim 6{,}6^o$ and is conventionally called the ZOA. Hence, ZOA is considered the main initiator of ZnO particles. However, the samples with heat treatment from 200ºC to 500ºC yielded the final particles characteristics for crystalline zinc oxide.

Rhodamine B photodegradation tests were performed in batch reactor equipped with 3 mercury lamps Philips 15W (UV-C, 254nm). Dye concentration was determined by a spectrophotometer (UV-Vis Schimadzu 1601PC). The experiments demonstrated that both UV light and a photocatalyst were needed for the effective degradation of Rhodamine B. It can be observed that in presence of both ZOA and light, 74% of dye was degraded in the irradiation time of 5h. This was contrasted with 37% degradation for the same experiment performed in the absence of ZOA. The photodegradation efficiency increase when using nanoparticles submitted of a thermal treatment. This efficiency was 77% and 96% in an interval of 1h for samples treated at 200 and 500°C, respectively. These results indicate a direct relationship between the efficiency of dye's degradation and the crystallinity degree of the nanoparticles.

[1] R. Comparelli, E. Fanizza, M. L.Curri, P.D. Cozzoli, G. Mascolo, A. Agostiano, Applied Catalysis B: Environmental. 60 (2005) 1-11.
[2] S.D. Skapin, G. Drazic, Z. C. Orel, Materials Letters. 61 (2007) 2783-2788.
[3] L. Spanhel, J Sol Gel Sci Techn. 39 (2006) 7-24.
[4] F. Grasset, O. Lavastre, C. Baudet, T.Sasaki, H. Haneda, Journal of Colloid and Interface Science. 317 (2008) 493-500.