SYNTHESIS OF ZNO BY THE HYDROTHERMAL METHOD USING DIFFERENT PRECURSORS FOR THE DEGRADATION OF METHYLENE BLUE

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Abstract. Photo catalysis has become a very important area in the processes of wastewater treatment for the degradation of organic compounds. The most used photocatalytic are TiO2 and ZnO due to their low toxicity, chemically inert in the degradation processes, easy to obtain and relatively inexpensive. Although they have been widely used, methodologies for obtaining these materials to increase their photocatalytic activity are still being developed. Due to their nature, TiO2 and ZnO have a band gap of 3.2 approximately, which makes them activate only with energy that corresponds to the wavelength of ultraviolet light. The synthesis of ZnO it does by the hydrothermal method using different zinc precursors (acetate, nitrate and sulfate). The results show the obtaining of hexagonal crystalline phase in all cases with a variation in morphology. Its photocatalytic activity is evaluated in the degradation of methylene blue. ZnO obtained from zinc acetate shows greater photocatalytic activity by eliminating 66% of methylene blue. In this work the importance of the choice of the precursor in the synthesis of ZnO for specific applications is shown. In the case of the hydrothermal method, when using zinc acetate in the synthesis of ZnO, the material obtained has a greater photocatalytic activity for the degradation of methylene blue (25% more) compared to that obtained from zinc nitrate and zinc sulfate.

***Key words**: hydrothermal, photo catalysis.*

INTRODUCTION

In recent years, photo catalysis has become a very important area in the processes of wastewater treatment for the degradation of organic compounds. The most used photocatalytic are TiO_2 and ZnO due to their low toxicity, chemically inert in the degradation processes, easy to obtain and relatively inexpensive [1]. Although they have been widely used, methodologies for obtaining these materials to increase their photocatalytic activity are still being developed [2]. Due to their nature, TiO_2 and ZnO have a band gap of 3.2 approximately, which makes them activate only with energy that corresponds to the wavelength of ultraviolet light. Many efforts have been made to develop techniques to obtain materials that are active with wavelengths corresponding to visible light and thus take advantage of solar radiation [3].

EXPERIMENTAL PART

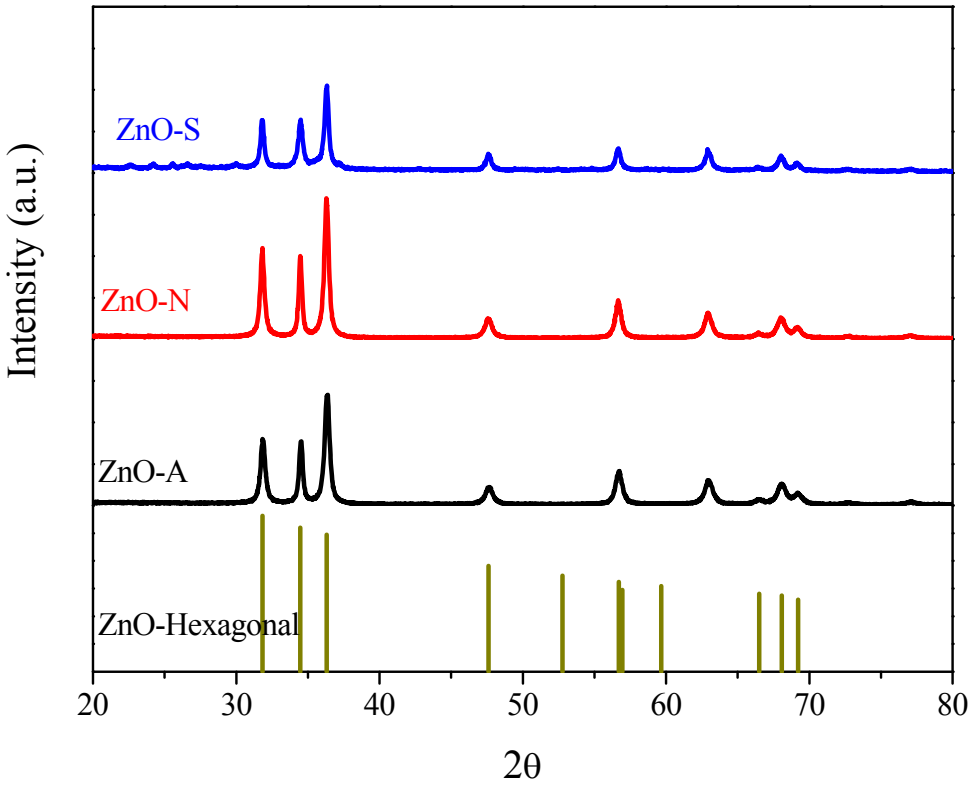
Synthesis of ZnO. The synthesis of ZnO was carried out as follows: in 50 mL of distilled water, 500 mg of the zinc precursor (acetate, nitrate and sulfate) were dissolved. The solution is placed in a ball flask and treated thermally at 80 ° C for 2 hrs. keeping the system closed. After the heat treatment the resulting powder is rinsed with water and dried at 80 ° C for 30 min. Finally, the photocatalytic powder is obtained. The materials were labeled as ZnO-S, ZnO-N and ZnO-A for the ZnO obtained from zinc sulfate, zinc nitrate and zinc acetate, respectively.

Tests of photocatalytic activity. Photocatalytic tests are performed in a system previously described [4]. For each test, 15 mg dispersed in 60 mL of a solution of methylene blue (10 ppm). The process is monitored by UV-vis aliquots at regular intervals of time for 90 min.

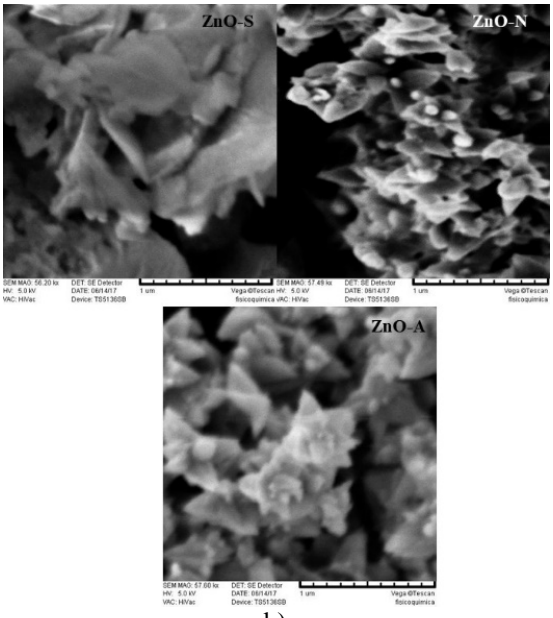
RESULTS

In Figure 1a the x-ray diffractogram of the synthesized materials shown. In all cases, ZnO presents a hexagonal crystalline phase according to the reference standard PDF 04-020-0364. The images obtained by SEM are shown in Figure 1b. In this figure we can see the great dependence that exists on the morphology and the precursor of ZnO. In the case of ZnO-N and ZnO-A, although both have flower-like morphology, the size of the ZnO-A structures is slightly larger. However, ZnO-S has a leaf type morphology of little more than 1 μm in size.

In Figure 2a the UV-vis absorption of the photocatalytic powders is shown. Although the three photocatalytic have a strong absorption below 400 nm (corresponding to the UV region), ZnO-A, unlike ZNO-S and ZNO-N, has a slight absorption around 500 nm (corresponding to the visible region).



a)



b)

Figure 1. a) XRD of synthesized materials. b) SEM of the photocatalysts obtained

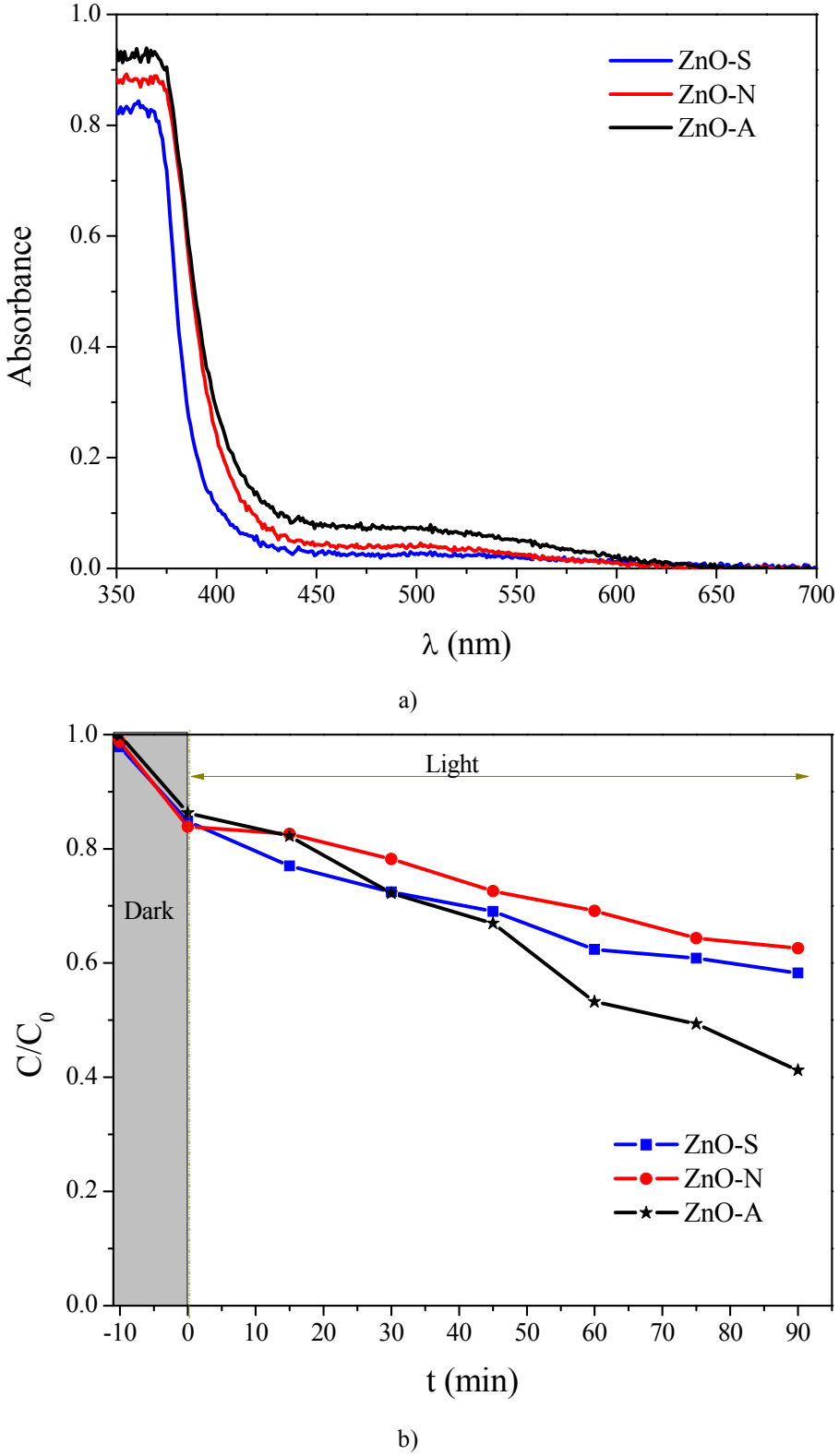


Figure 2. a) DRS for synthesized photocatalytic. b) Degradation of methylene blue using the different photocatalytic obtained

In figure 2b the photocatalytic activity in the degradation of methylene blue of the materials obtained is shown. In this figure we can distinguish two regions: the first one corresponding to the adsorption of the material (dark) for which, once the photocatalyst is dispersed in the methylene blue solution, it is placed in the reactor with air bubbling but with the lamp off, allowing the adsorption-desorption equilibrium to be reached. Once this process is reached (approximately 10 minutes for our material) the radiation source is turned on and the degradation stage begins (second stage). Despite the difference in morphology presented by the photocatalyst synthesized (Fig. 1b), all three absorb practically the same amount of dye (15%, approximately). However, in terms of material degradation, ZnO-A shows a greater percentage of

elimination of methylene blue (66%) in 90 min than ZnO-S (42%) and ZnO-N (38%). The increase in photocatalytic activity of ZnO-A can be deviated from the slight absorption present in the visible region as can be seen in figure 2a.

CONCLUSIONS

In this work the importance of the choice of the precursor in the synthesis of ZnO for specific applications is shown. In the case of the hydrothermal method, when using zinc acetate in the synthesis of ZnO, the material obtained has a greater photocatalytic activity for the degradation of methylene blue (25% more) compared to that obtained from zinc nitrate and zinc sulfate.

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