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STUDY OF PHOTOACTIVITY OF SENSITIZED TITANIUM DIOXIDE USING CONGO RED AND VISIBLE LIGHT

HAZIM Y. ALGUBURY*, QASIM Y. MOHAMMED and HEDEAR H. ALSAADY

Chemistry Department, College of Science for Women, Babylon University, BABYLON, IRAQ

ABSTRACT

In this work, sensitized titanium dioxide powders was prepared using different weight of azocaramine G dye (0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7 and 1) g. Each weight of dye mixing with 1 g of titanium dioxide using a Pyrex reactor (100 cm^3), irradiated with tungsten lamp at 298 K with 10 cm^3/min air flow. Different experiments were carried out at various conditions to reach the optimum condition in which the degradation of Congo red dye was studied. These experiments include the alternate concentration of Congo red, on fixed mass of sensitized titanium dioxide, change the dosage of sensitized titanium dioxide and the effect of light intensity.

Key words: Photodegradation, Sensitizer, Congo red, Azocaramine.

INTRODUCTION

Recently, many researchers intense on improving the semiconductors using different ways, one this is using organic dyes as sensitizer[1]. Many of the researchers succeeded to improve it.

Photoactivity of semiconductors such as ZnO, TiO_2, etc. with large band gap is less. These dyes adsorbed on the surface of semiconductors and absorb light then promote from valance band on the dye surface to the conduction band of dye the injection photoelectron into the conduction band of semiconductors, to produce photoelectron in the conduction band of semiconductor leaving positive hole in the valance band of dye[2-3].

The aim of present work was modification of TiO_2 surface to extend the range

*Author for correspondence; E-mail: h.yahya40@yahoo.com, qyahya@yahoo.com

of photocatalytic degradation process to visible region with longer wavelength (400-700) nm by adsorption of congo red on its surface[4].

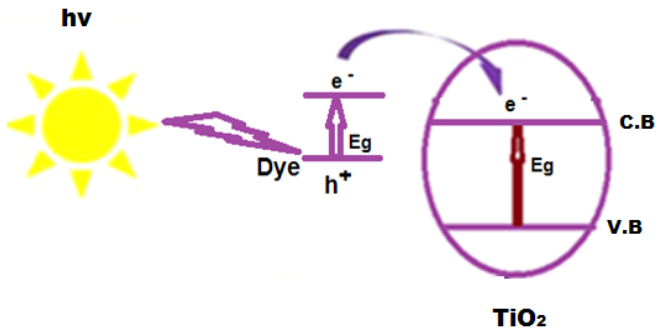

Fig. 1: Charge transfer processes

EXPERIMENTAL

Materials and methods

Chemicals

1. Titanium dioxide (TiO_2): The bang gap of zinc oxide (3.3 eV), purity (99%), particle size (100) mesh, supplied by Fluka AG.
2. Azocaramine G: supplied by Sigma-Aldrich.
3. Congo red, supplied by Fluka AG.

All chemical were used without further purification.

Preparation of sensitized TiO_2

The sensitized TiO_2 with azocaramine G were prepared by mixing of 1 g of TiO_2 and different weight 0.1, 0.2. 0.4, 0.6, 0.8, 1.0 g of azocaramine G aqueous suspension solution. The process is accompanied by continuous stirring for 3 hrs in photolysis cell supplied with tungsten lamp and an air current with rate flow 10 mL/min at 298 K.

Photo reactor and procedure

Experiments were carried out in glass photochemical reactor. The cylindrical annular – type reactor consisted of two parts. The first part was an outside thimble, running water was passed through the thimble to cool the reaction solution. Owing to the continues cooling,

the temperature of the reaction solution was maintained of room temperature. The second part was aninside thimble and the reaction solution (volume 100 cm^3) was put in the reaction chamber.

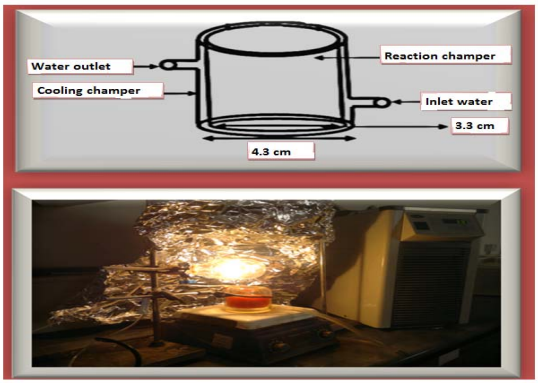

Fig. 2: Main parts of the photocatalytic cell used in photocatalytic degradation of Congo red dye in presence of sensitized TiO_2

RESULTS AND DISCUSSION

The effect of congo red concentration on photocatalytic degradation process

Serval experiment were studied to reach the best concentration to obtain optimum degradation of pollutant. In all experiments 0.11 g/100 $cm^3$of sensitized titanium dioxide with 10 cm^3/min flow rate of babble, at 298k. Different concentration of Congo red were used range (1-10) ppm. From the Table (1) and Fig. 3 photocatalytic degradation process decreases with an increase in the initial Congo red concentration. The concentration 1 ppm represent the optimum concentration of dye, after 1 ppm when the dye concentration increased and the catalyst amount is still constant. The photocatalytic degradation decreases because decreasing of active sits on the surface of sensitized. This behaviour due to the dye molecules increases the solution became more intense coloured and penetration of photons to the solution decreased therefore the degradation process decrease[5-8].

The effect of sensitized titanium dioxide masses on photcatalytic degradation of Congo red dye

The effect of dosage mass of sensitized titanium dioxide range (0.01-1.00 g) on photocatalytic degradation of Congo red dye was tested at 1 ppm of Congo red dye, flow rate of air 10 cm^3/min, and room temperature = 298 K. Table 2 and Fig. 4 indicate that the photocatalytic degradation of dye increases with increase of sensitized titanium dioxide.

Gradually increases the dosage masses of sensitized titanium dioxide causes to increase the photocatalytic degradation rate of dye, until reach to (0.11 gm/100cm^3 then gradually decreases the degradation rate of day, as in Fig. 4. This behaviour could be explained that the dosage masses of sensitized titanium dioxide (0.11 g/100 cm^3) was provided the highest absorption of light on the surface of sensitized titanium dioxide. The decreases in the reaction rate of photocatalytic degradation process at the dosage masses of sensitized titanium dioxide higher than (0.11 g/100 cm^3), because the strong absorption of light through the first successive layers of solution and prevent light from passing through all other layers in the reaction vessel[9-11] .

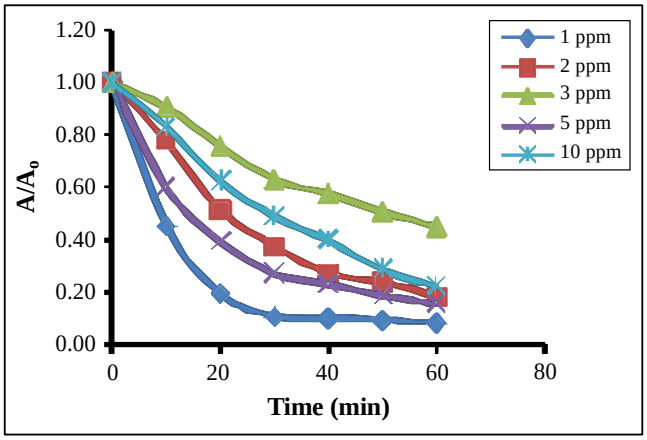

Fig. 3: The change of (A_t/A_0) with irradiation time for different concentration of Congo red

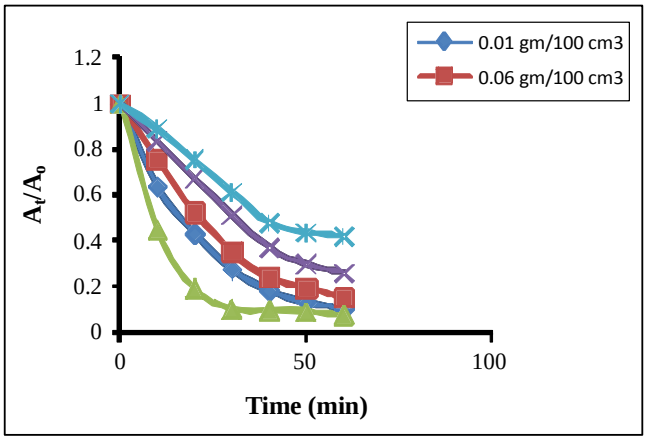

Fig. 4: The effect masses of sensitized titanium dioxide on photcatalytic degradation of Congo red dye

The effect of light intensity on photodegradation of Congo red using sensitized titanium dioxide it was also studied.

Several experiments were carried out using deferent intensities of light range 2.15-8.22 mW/cm^2. The rate of photodegradation of Congo red was measured at fixed mass of sensitized titanium dioxide (0.11 g/100 cm^3) with 1 ppm of Congo red dye, and 10 cm^3/min flow rate of air babble. Table 3 and Fig. 5, illustrate the effect of light intensity on the photocatalytic degradation of Congo red[12-15].

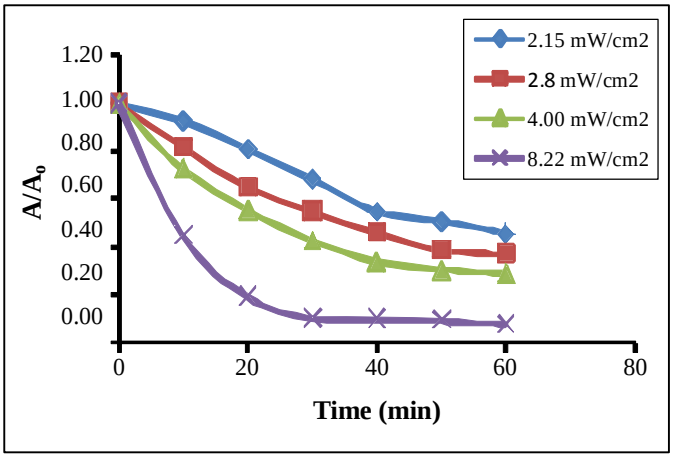

Fig. 5: The change of (A_t / A_0) with irradiation time at different light intensity with 0.11 g/100 cm^3 of TiO_2 on photocatalytic degradation of Congo red

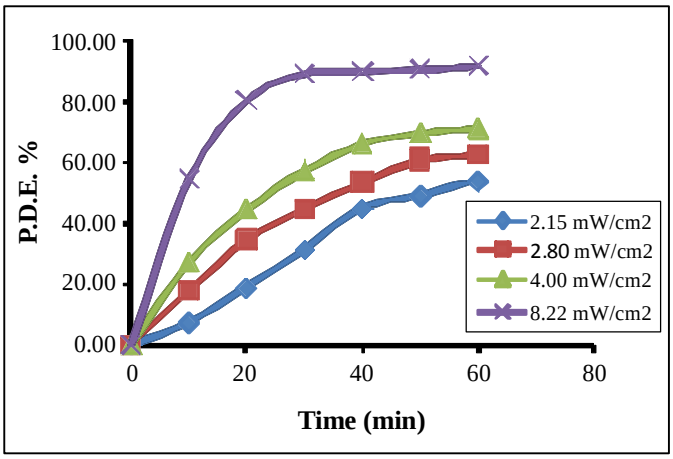

Fig. 6: The change of photocatalytic degradation efficiency with irradiation time and different light intensity

The results indicate that the photocatalytic degradation of Congo red increases with the increase of light intensity, because increasing in the number of photons cause to generate of electrons in the conduction band of sensitizer and injected in the conduction band of TiO_2. The light intensity 8.5 mW/cm^2 gives the optimum photodegradation efficiency, which is equal to 91.82 %. The results of the change in photocatalytic degradation efficiency (P.D.E) with light intensity is plotted in Fig. 6.

CONCLUSION

(i) The Congo red dye has been successfully degraded when used the sensitized TiO_2 catalyst with the light.

(ii) The optimum condition for the photocatalytic degradation of Congo red dye by using sensitized titanium dioxide obtained was (0.11 g/100 cm^3, and the mass of sensitized titanium dioxide and 1 ppm concentration of Congo red dye.

(iii) The photocatalytic degradation efficiency obtained as 91.82%.

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REFERENCES

1. N. Y. Fairooz and H. Y. Al-gubury, J. Applicable Chem., **2**, 1 (2013).
2. C. Tang and V. Chen, Water Research, **38**, 7 (2004).
3. Hazim Y. AL-Gubury, National J. Chem., **33**, 54 (2009).
4. Z. Jeirani, A. Sadeghi, J. Soltan, B. Roshani and B. Rindall, Separation and Purification Technology, **149**, 65 (2015).
5. A. Maria, S. Solano, C. Alberto, M. Huitle, S. Garcia-Segura, A. El-Ghenymyb and E. Brillas, Electrochimica Acta,**197**, 17 (2016).
6. P. Hu and M. Long, Appl. Catal. B: Environ., **181**, 89 (2016).
7. H. Y. Al-Gubury, Int. J. ChemTech Res., **9**, 2 (2016).
8. H. Y Al-gubury, E. S. Almaamory, H. H. Alsaady and G. S. Almurshidy, Res. J. Pharmaceut., Biological Chem. Sci., **6**, 3 (2015).

9. H. Y. AL-gubury, N. Y. Fairooz, A. M. ALjeboree, M. B. ALqaraguly and Ayad F. ALkaim, Int. J. Chem. Sci., **13**, 2 (2015).

10. H. Y. Al-gubury and H. H. Alsaady, Int. J. Multidisciplinary Curr. Res., **3**, 104 (2015).

11. H. Y. Al-Gubury and G. S. Al-Murshidy, Int. J. PharmTech Res., **8**, 2 (2015).

12. Q. Y. Mohammed, S. R. Taher and H. Al-Jubury, AIJCSR, **2**, 2 (2015).

13. H. Y. Algabury Mouhannad M. AL-Hachamii A. Al-Fatlawy, **307**, 17 (2008).

14. N. Y. Fairooz and H. Y. Al-gubury, J. Applicable Chem., **2**, 2 (2013).

15. M. B. Alqaragully, H. Y. Al-Gubury, A. M. Aljeboree, F. F. Karam and A. F. Alkaim, Res. J. Pharmaceut., Biological and Chem. Sci., **6**, 5 (2015).

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