

Photo-Oxidation of Organic Pollutants on

**Polymer Films Supported Core- shell
Nanoparticles**

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By

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In the name of God, the Merciful , the Beneficent , ".....of knowledge it is only a little that is communicated to you."

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Contents

	Page
Acknowledgement	I
Contents	ii
List of Figures	v
List of Tables	x
Abstract	Xi
Chapter One	
Introduction and Literature Review	
1.1. General Introduction	1
I. What Nanotechnology offers the field of water treatment?	1
II. What is photocatalysis?	1
1.2. Solar Radiation	3
1.3. Metal Nanocatalyst	4
1.4. Magnetic Nanoparticles	5
1.4.1. Physics of Magnetic Materials	5
a. Magnetic Materials	5
b. Main Characteristics for Magnetic Materials	6
I. Magnetic Domains	6
II. Hysteresis Loop	8
1.4.2. Small-Particle Magnetism (Magnetism of nanoparticles)	9
1.4.2.a. Single-domain Particles	9
1.4.2.b. Coercivity of Single-domain Particles	10
1.4.3. Superparamagnetism	11
1.4.4. Magnetic Behavior of superparamagnetic (SPM) particles	12
1.4.5. Coercivity of small particles	13
1.5. Semiconductor Nanocatalyst	14
1.5.1. Structural Properties of Titanium Dioxide	14
1.5.2. Metal-Semiconductor Nanocatalyst	24
1.5.3. Semiconductor Magnetic hybrid nanocomposites	25
I-V) Literature Survey	25
1. Semiconductor Nanocatalysis	25
2. Metal Semiconductor Nanocatalysis	28
I-VI) Factor Affect the Photocatalytic Process	29
1. Light intensity	29
2. Nature of concentration of the substrate	30
3. Nature of Photocatalyst	30
4. Photocatalyst concentration	31
5. Effect of pH on the rate of photocatalytic activity	31
6. Reaction temperature	32
I-VII) Factor Affect the Photocatalytic Process	32
1. As a suspension	32
2. Embedded in Polymer	32
III. Film on Conducting Glass such as OTE & ITO	33

	Page
Chapter Two	
Experimental Work	
2.1. Materials	35
2.1.1. Solvents	35
2.1.2. Chemicals	35
2.2. Instrumentation	36
2.2.1. Solar simulator	36
2.2.2. Light fluence rate	36
2.2.3. Air Flow instrument	36
2.3. Methodology	36
2.3.1. Preparation of gold nanoparticles by CTAB method	36
2.3.2. Preparation of the polymer	36
2.3.3. Preparation of gold@TiO ₂ nanoparticles	37
2.3.4. Preparation of TiO ₂ nanoparticles	37
2.3.5. Preparation of magnetic @ TiO ₂ nanoparticles	37
2.3.6. Preparation of Rhodamine 6G (10 ⁻⁵)M/L	37
2.3.7. The polymer thin film preparation	38
1. TiO ₂ sheets	38
2. TiO ₂ and gold nanoparticles sheets	38
3. TiO ₂ magnetic nanoparticles sheets	38
2.4. Experimental Procedure	39
2.4.1. Photocatalysis experiment by using nature light	39
2.4.2. Photocatalysis experiment by using artificial light	39
2.5. Characterization Techniques	40
2.5.1. Optical properties measurements	40
2.5.1.1. UV-visible absorption spectroscopy	40
2.5.2. Size, shape and crystal structure investigations	40
2.5.2.1. Transmission electron microscopy (TEM)	40
2.5.2.2. X-ray diffraction (XRD)	43
2.5.2.3. Vibrating sample magnetometer (VSM)	44
Chapter Three	
Results and Discussion	
3.1. TiO ₂ Nanocrystals	46
3.1.1. Preparation of TiO ₂ Nanocrystals	46
3.1.2. Photodegradation on Rh6G using TiO ₂ Nanocrystals	46
3.2. Semiconductor-Metal Core shell nanoparticles	56
3.3. Photocatalytic activity of gold nanoparticles loaded into TiO ₂ nanoparticles embedded in polymer beads	64
1. The degradation under sunlight irradiation	66
2. Photodegradation of Trypan Blue using TiO ₂ and TiO ₂ -gold nanocatalyst	84
3. Effect of pHs	85
3.4. Core-shell Magnetic semiconductor nanoparticles (Fe ₃ O ₄ Coated TiO ₂ Nanoparticles)	92
3.4.1. TiO ₂ –Fe ₃ O ₄ core-shell nanoparticles Photodegradation of Rh6G as a dye	95
3.4.1.1. Comparing the catalytic activity of TiO ₂ and Fe ₃ O ₄ -TiO ₂ core-shell particles	95
3.4.1.2. Photodegradation on Fe ₃ O ₄ -TiO ₂ nanocomposites in presence of air	97
• Effect of the type of light: UV vs Visible light	100

	Pages
Conclusion	112
References	113

List of Figures

Figure		Page
Chapter One		
Figure (1.1):	Interfacial charge transfer processes in semiconductor Nanoparticle.	2
Figure (1.2):	Solar irradiance spectrum above atmosphere and at surface	4
Figure (1.3):	Scheme shows the surface plasmon resonance due to the interaction between the incident light and the small particles	4
Figure (1.4):	Types of magnetic materials	5
Figure (1.5):	Magnetic state of the elements at room temperature ($T = 20^{\circ}\text{C}$). Gadolinium becomes ferromagnetic at 16°C	6
Figure (1.6):	Schematic illustration of the breakup of magnetization into domains: (a) single domain, (b) two domains, (c) four domains and (d) closure domains.	7
Figure (1.7):	Schematic representation of a 180° domain wall	7
Figure (1.8):	Schematic representation of Hysteresis loop	8
Figure (1.9):	Schematic figure show types of coherent rotation of the atomic spins:- a) hysteresis loops for applied fields $\perp$ and $\parallel$ to the easy axis, b) hysteresis loops for fields applied to an ensemble of uniaxial single domain particles with random easy axes	10
Figure (1.10):	Schematics of coherent and fanning rotation of magnetization in particles initially upward with an applied field downward	11
Figure (1.11):	Diagram to illustrate and compare coherent and curling rotation of particle magnetization due to an applied field. Particle cross sections are shown initially the magnetization is out of and normal to the page. Then a field is applied into and normal to the page. The coherent (a) and curling (b) responses are illustrated.	11
Figure (1.12):	Particle coercivity versus size ($\sim$ diameter). D_{sp} is the superparamagnetic size; D_s is the single-domain size	13
Figure (1.13):	In the absence of a magnetic field, domains are random, but when a field is applied, the magnetic domains align to create a magnetic moment much greater than the sum of the individual unpaired electrons.	14
Figure (1.14):	(a) The fundamental structural unit and (b) the overall structure of rutile [48]	16
Figure (1.15):	(a), (b) The fundamental structural units and (c) the overall structure of anatase.[40,41]	16
Figure (1.16):	(a) The fundamental structural units and (b) the overall structure of brookite [41-43].	17

	Page
Figure (1.17): The conduction and valance band positions of selected metal oxide semiconductors at pH =0 .The left hand scale represent the internal energies to the vacuum level. The right hand side is the normal hydrogen electrode scale which allows predications based on reduction and oxidation.	17
Figure (1.18): Schematic photophysical and photochemical processes over photon activated semiconductor cluster (p) photogeneration of electron/hole pair, (q) surface recombination, (r) recombination in the bulk, (s) diffusion of acceptor and reduction on the surface of SC and (t) oxidation of donor on the surface of SC particle.	18
Figure (1.19): Primary processes involved in photomineralisation of organic compounds.	21
Figure (1.20): Synthesis of metal – capped oxide particles. The charge separation enhanced in metal-semicondutor nanoshells	24
Chapter Two	
Figure (2.1): Schematic diagram of UV-VIS double beam spectrophotometer	40
Figure (2.2): Schematic diagram of TEM	42
Figure (2.3): (A) Schematic diagram of X-ray diffraction system, and b. Geometry for diffraction of x-ray radiation	43
Figure (2.4): Shows the Vibrating Sample Magnetometer Block diagram	45
Chapter Three	
Figure (3.1): Absorption spectra of the as prepared TiO ₂ nanocrystals capped with PVA	46
Figure (3.2): images shows the size and shape of the prepared TiO ₂ nanocrystals	47
Figure (3.3): XRD pattern for TiO ₂ nanoparticles capped with PVA	47
Figure (3.4): Absorption Spectra of Rhodamine 6G	48
Figure (3.5): The absorption spectra of Rh6G at different time a) 10 mins, b) 20 mins, c) 30 min, d) 60 min, e) 90 min and f) 120 mins	49
Figure (3.6): The TiO ₂ particles assembled and annealed in glass substrate	50
Figure (3.7): show how to prepare polymer film doped with TiO ₂ nanoparticles	50
Figure (3.8): Shows TEM images of the prepared TiO ₂ nanoparticles in PMMA polymer matrix	51
Figure (3.9a): The phootdegradation of Rh6G over commercial TiO ₂ a) 10 min., b) 20 min., c) 30 min, d) 60 min, e) 90 min and f) 120 min	52
Figure (3.9b): The phootdegradation of Rh6G over prepared TiO ₂ nanocatalyst a) 10 min., b) 15 min., c) 20 min, d) 25 min, e) 30 min and f) 60 min.	52

	Page
Figure (3.10): The photodegradation of Rh6G using TiO ₂ embedded in polymer a) 10 min., b) 30 min., c) 50 min, d) 70 min, e) 120 min and f) 140 min	53
Figure (3.11): Effect of catalyst concentration on the photodegradation of Rh6G using TiO ₂ embedded in PMMA polymer A) 0.02 g of TiO ₂ nanocrystals , B) 0.1 g of TiO ₂ nanocrystals at the same time intervals	54
Figure (3.12): Normalized Curve show the effect of TiO ₂ concentration embedded in PMMA polymer on the photodegradation rate of Rh6G. 1) without any catalyst, 2) only polymer, 3) 2% TiO ₂ particles embedded in polymer, 4) 5% TiO ₂ particles embedded in polymer, 5) 10% TiO ₂ particles embedded in polymer	55
Figure (3.13): increasing charge separation due to presence of metal nanoparticles in direct contact with the TiO ₂ nanocrystal	56
Figure (3.14): scheme shows how to prepare core –shell TiO ₂ /gold particles	57
Figure (3.15): Absorption spectra of core-shell TiO ₂ /Au nanoparticles	58
Figure (3.16): Shows the full solar spectrum	58
Figure (3.17): TEM images of core-shell TiO ₂ coated with gold shell	59
Figure (3.18): XRD of core-shell TiO ₂ coated with gold shell	60
Figure (3.19): TEM image of Core-shell TiO ₂ coated with gold embedded in polymer matrix	61
Figure (3.20): Photodegradation of Rh 6G in presence of TiO ₂ alone. 93% of the dye decomposes in two hours of UV irradiation	61
Figure (3.21): Photodegradation of Rh 6G in presence of TiO ₂ -gold core shell nanoparticles. 93% of the dye decomposes in 50 minutes of visible irradiation	62
Figure (3.22): Photodegradation of Rh 6G in presence of TiO ₂ -gold core shell nanoparticles. 96% of the dye decomposes in 60 minutes of visible irradiation	63
Figure (3.23): Normalized Curve show the effect of the concentration core-shell TiO ₂ coated gold nanoparticles embedded in PMMA polymer on the photodegradation rate of Rh6G. 1) with gold only, 2) only TiO ₂ , 3) 2% TiO ₂ -Au core shell particles embedded in polymer, 4) 5% TiO ₂ -Au core shell particles, 5) 10% TiO ₂ -Au core shell particles embedded in polymer.	63
Figure (3.24): Optical absorption spectra of the gold nanoparticles produced by chemical method	65
Figure (3.25): Scanning electron microscopic photograph of polythene film (a), TiO ₂ bound on or embedded in the microporous of the fused polycrystalline polythene film x 500 (b), TiO ₂ bound on or embedded in the microporous of the fused polycrystalline polythene film x75000 (c) and TiO ₂ with gold nanoparticles bound on or embedded in the microporous(d).	66
Figure (3.26a): Absorption spectra of R-6G in aqueous solution after adsorption for 4h in polymer during irradiation in the sun	69

	Pages
Figure (3.26b): Absorption spectra of R-6G in aqueous solution after adsorption for 4h in polymer-TiO ₂ , in the dark	70
Figure (3.26c): Absorption spectra of R-6G in aqueous solution after adsorption for 4h in polymer-TiO ₂ -gold in the dark.	71
Figure (3.27a): Absorption spectra of showing the photobleaching of 1×10^{-5} mole dm ⁻³ Rhodamine-6G irradiated with sunlight at (280-600 W / m ²) in polymer-TiO ₂	72
Figure (3.27b): Absorption spectra of showing the photobleaching of 1×10^{-5} mole dm ⁻³ Rhodamine-6G irradiated with sunlight at (280-600 W / m ²) in polymer -TiO ₂ -gold	73
Figure (3-27c): Absorption spectra of showing the photobleaching of 1×10^{-5} mole dm ⁻³ Rhodamine-6G irradiated with sunlight at (280-600 W / m ²) in polymer -TiO ₂ -gold	74
Figure (3.28): Dependence of the normalized concentration of Rhodamine-6G on the irradiation time.	75
Figure (3.29a): Absorption spectra of crystal violet in aqueous solution after adsorption to 2.5 hours in polymer during irradiation in the sun	77
Figure (3.29b): Absorption spectra of crystal violet in aqueous solution after adsorption to 2.5 hours in polymer-TiO ₂ in the dark	78
Figure (3.30a): Absorption spectra of the photobleaching of 1×10^{-5} mol dm ⁻³ crystal violet irradiated with artificial light at (600 W/m ²) in polymer-TiO ₂ with filter.	80
Figure (3.30b): Absorption spectra of the photobleaching of 1×10^{-5} mol dm ⁻³ crystal violet irradiated with artificial light at (600 W/m ²) in polymer-TiO ₂ without filter	81
Figure (3.30c): Absorption spectra of the photobleaching of 1×10^{-5} mol dm ⁻³ crystal violet irradiated with artificial light at (600 W/m ²) in polymer-TiO ₂ in the presence of oxygen	81
Figure (3.31): Dependence of the normalized concentration of Crystal violet on irradiation	82
Figure (3.32a): Absorption spectra of 1×10^{-5} mol dm ⁻³ of trypan blue in aqueous solution after adsorption for 2.5h on polymer during irradiation in the sun	87
Figure (3.32b): Absorption spectra of trypan blue in aqueous solution after adsorption for 4h in polymer-0.08TiO ₂ , in the dark	88
Figure (3.33): Absorption spectra of showing the photobleaching of 1×10^{-5} mole dm ⁻³ trypan blue irradiated with sunlight at (280-600 W / m ²) in polymer-0.08 gmTiO ₂ .	89
Figure (3.34a): Absorption spectra of showing the photobleaching of 1×10^{-5} mole dm ⁻³ trypan blue at pH=2 irradiated with sunlight at (280-600 W / m ²) in polymer-0.08 gmTiO ₂	89
Figure (3.34b): Effect of different pHs on time change of residual concentration ratio of of trypan blue in the presence of polymer-0.08 gmTiO ₂ irradiated at (280-600 W / m ²)	90
Figure (3.34c): Absorption spectra of showing the photobleaching of 1×10^{-5} mole dm ⁻³ trypan blue at pH=2 irradiated with sunlight at (280-600 W / m ²) in polymer -0.08 gm TiO ₂ -gold.	90

	Page
Figure (3.34d): Dependence of the normalized concentration of trypan blue of different pH=2 on the irradiation time at (280-600 W / m ²) in polymer TiO ₂ and in polymer-0.08 gmTiO ₂ -gold	91
Figure (3.35): Absorption spectra of core shell Fe ₃ O ₄ nanoparticles coated with TiO ₂	93
Figure (3.36): TEM of core-shell Fe ₃ O ₄ –TiO ₂ nanocomposites	93
Figure (3.37): XRD data of core shell TiO ₂ –Fe ₃ O ₄ nanocomposites	94
Figure (3.38a): Photodegradation of Rh 6G in presence of Fe ₃ O ₄ -TiO ₂ core shell nanoparticles. 82% of the dye decomposes in 140 minutes of visible irradiation	95
Figure (3.38b): Photodegradation of Rh 6G in presence of TiO ₂ nanoparticles. 80% of the dye decomposes in 150 minutes of visible irradiation	96
Figure (3.39): Influence of the catalyst concentration on the photodegradation rate for the decomposition of Rh6G. Experimental condition: (dye concentration Rh6G, 1x10 ⁻⁵ mole dm ⁻³ ; V 100 ml) Spectra from top to bottom correspond to TiO ₂ concentrations a) 0 in dark, b) 0 in light, c) 0.02, d) 0.04, e) 0.06, f)0.08 and g)0.1 gm.	97
Figure (3.40): UV-vis spectral changes of the R6G dye in sun sheet (R6G, 1x10 ⁻⁵ mole dm ⁻³ as a function of the irradiation time. Spectra from top to bottom correspond to the irradiation times of 0, 30, 60, 90, 120,150, and 180 min, respectively.	98
Figure (3.41): Influence of the catalyst concentration on the photodegradation rate for the decomposition of Rh6G. Experimental condition: (dye concentration Rh6G 1x10 ⁻⁵ mole dm ⁻³ ; V 100 ml) Spectra from top to bottom correspond to nanoparticles concentrations a) 0 in dark, b) 0 in light, c) 0.2, d) 0.4, e) 0.6, f)0.8 and g)1.0 gm.	99
Figure (3.42): UV-vis spectral changes of the R6G dye using core –shell magnetic TiO ₂ nanoparticles. Spectra from top to bottom correspond to the irradiation times of 0, 30, 60, 90, 120,150, and 180 min, respectively.	100
Figure (3.43): UV-vis spectral changes of the R6G dye in UV light (a) and in visible light (b) as a function of the irradiation time. Spectra from top to bottom correspond to the irradiation times	101

List of Tables

Table		Page
Table (1.1):	Primary processes and time domains in titania-catalyzed mineralisation of organic pollutants	20

Summary

Nanotechnology allows us to design highly efficient photocatalytic nanocomposite which act as an efficient catalyst for reduction of global atmospheric pollution and purification of polluted water. This is very attractive area and one of the most desirable and challenging goals in the research of environmentally-friendly catalysts. TiO_2 photocatalysts have been attracting much attention in recent years, because TiO_2 photocatalyst can completely decompose toxic and non-biodegradable organic materials into CO_2 , H_2O , and inorganic constituents. Many researches have been undertaken to use TiO_2 photocatalyst for purification of polluted water. During the process of purification of polluted water, photocatalyst has to be separated from the treated water. To separate the photocatalyst from water, photocatalyst should be supported on bulk materials such as polymer which has been widely used.

In this study, visible light assisted degradation of colored organic pollutant using semiconductor nanoparticles or core-shell nanocomposite have been studied in air and the photodegradation rate have been determined. Rhodamine 6G has been used as a colored organic dye which has absorption spectra in the visible region. The photodegradation rate of the organic dye is monitored by the bleach of the absorption band as a function of time. TiO_2 nanoparticles were prepared via sol-gel method and the size of the obtained particles has been determined using TEM. Under 3 h of irradiation with a 150 W xenon lamp, over 70% degradation of pollutants has been observed. A working mechanism involving excitation of surface adsorbed dye, followed by charge

Injection into the TiO_2 conduction band and formation of reactive $\sqrt{\text{O}_2^-}/\sqrt{\text{HO}_2}$ radicals is proposed for the degradation of organics to carbon dioxide. In addition, Core-shell nanocomposite of TiO_2 coated with gold and TiO_2 coated with Iron oxide have been prepared and characterized via TEM and XRD. The photocatalytic activity of these nanocomposites has been compared to pure TiO_2 nanocrystals. Our results indicate that TiO_2 -gold core-shell particle is more active photocatalyst than TiO_2 alone because of the charge separation enhancement due to the presence of metal-semiconductor junction. In addition, the effect of the plasmonic gold absorption band enhances the number of photon absorbed per particle. Remarkable increase in the photodegradation rate in presence of sun light using core-shell TiO_2 -gold core shell particles, on the other hand, the rate of

photodegradation over core-shell TiO_2 -iron oxide nanocomposite does not change significantly compared to pure TiO_2 nanocrystal.

Chapter one

Introduction

1.1. General Introduction:

The problems which facing our society could rank as follow:

1-Energy 2-Water 3-Food 4-Envionment 5-Disease

Water is very serious problem, either we have it or we do not. Fortunately, there is plenty of water in our planet. In fact, we probably have more water than anything else. However, it has salt in it, and it is often thousands of miles away from, where we need it. Some of it contaminated with oil, fertilizers or factory wastes. We need it in vast amounts, hundreds of millions of gallons a day and so clean. We can take the salt out of the water. We can clean it up from impurities and wastes. There is no doubt some nanotechnology that will do it at 100 percent Efficiency or close to it.

i. What Nanotechnology offers the field of water treatment?

In recent years, heterogeneous photocatalysis has proved to be a useful tool for the degradation of water pollutants over the past 30 years. The heterogeneous photocatalysis for total oxidation of organic and inorganic water pollutants has been studied extensively [1,2]. Environmental purification using TiO_2 photocatalysts has attracted a great deal of attention with the increasing number of recent environmental problems in the world [3-6].

ii. What is photocatalysis?

Heterogeneous photocatalysis is a discipline which includes a large variety of reactions: organic synthesis, water splitting, photoreduction, hydrogen transfer, O_2^{18} - O_2^{16} and deuterium-alkane isotopic exchange, metal deposition, disinfection and anti-cancer therapy, water detoxification, gaseous pollutant removal, etc [7,8]. Among these appearances, titania-assisted heterogeneous photocatalytic oxidation has received more attention for many years as alternative method for purification of both air and water streams.

The basic photophysical and photochemical principles underlying photocatalysis are already established and have been reported [9,10]. Vinodgopal and Kamat [11] reported that the dependence of the rate of 1,3-diphenylisobenzofuran photodegradation on the surface coverage. In other words, only the molecules that are in direct contact with the catalyst surface undergo photocatalytic degradation.