SYNTHESIS COMPOSITE OF TIO_2/CHITOSAN AND TIO_2/ BENTONITE FOR REMOVING TURBIDITY FROM ISMAILIA CANAL AS WATER TREATMENT PLANT

A. Marey
Department of Basic Science
The Valley Higher Institute for Engineering and Technology, Cairo, Egypt.
Email: Amera_Muhammad@hotmail.com

ABSTRACT

The conditions of water in Ismailia canal (Mostorod refinery site) are alarming now because it looks more cloudy and dirty. Water was contaminated not only organic trashes, but also inorganic. The adsorption capacity of clays is often used to remove undesirable substances from aqueous solutions. Chitosan is widely used in biological applications due to its biocompatibility and biodegradability. The aim of the present study is to review the possible applications of the nanotechnology for the removal of pollutants from wastewater by TiO2/Bentonite and TiO2/Chitosan, when added this composite to wastewater and when exposed to visible light they will generate OH radical compounds that can degrade organic pollutants and compounds superoxide, at pH 2. *[African Journal of Chemical Education—AJCE 10(1), January 2020]*

INTRODUCTION

Water has a widespread impact on all aspects of human life including health, food, energy, and economy. Along with environmental, economic, and social effects of poor water supply and sanitation [1], the supply of fresh water is indispensable for the safety of human beings. It is estimated that billions of people in the world don't have access clean water within couple of decades the current water supply and resources will decrease to one-third. There is very narrow chance of an increase in the supply of fresh water due to challenging demands of ever increasing populations all over the world. A major problem in developed countries is drinking water that is contaminated with bacteria and viruses, which are the main reasons of water diseases. ever-increasing pollution, clean water will become scare, additionally, in these countries, available water is unsafe to drink [2].

Wastewater is the water containing superfluous substances that adversely affect its quality and thus making it not suitable for use. Common constituents of wastewater are inorganic substances like solutes, heavy metals, and metal ions, ammonia along with gases, plant remains, and organic matter. When left untreated these constituents may pose threat to living beings.

The traditional materials and old water treatment processes are not able to remove toxic chemicals, organic materials and microorganisms which appear in raw water. Nano- scale materials are structures ranging from 1 to 100 nm; Nanotechnology has been studied by researches which offer advantages like low cost, reuse in removing and recovering the pollutants. This technology is one of the methods used for wastewater treatment. Continuous oxidation process is based on the formation of hydroxyl radicals (OH) which is a strong oxidizing agent that can promote total mineralization on persistent organic pollutants [3, 4].

TiO_2 has excellent photo-catalytic performance and stable in acidic and alkaline solvents, it has a high broad applicability to drinking water and industrial waste water to remove organic contaminants. industrial waste water to remove organic contaminants, but not completely solve the increasing serious water pollution problems of heavy metal ions. TiO_2 catalyst must be activated using energy photon with low wavelength. TiO_2 is a dioxide compound that has white color, which is rust resistant and non-toxic. Besides that, the titanium dioxide is one of the stable catalysts [5, 6]**.** From some advantages of TiO_2 photo-catalytic method, it still has some weakness in degrading the waste, to cover up this weakness, photo- degradation process by TiO_2 started with adding the carrier material with good adsorption capability. Carriers used in this study are chitosan and bentonite. Chitosan is regarded as an excellent carrier material because it can eliminate a variety of organic and inorganic waste, beside that it also has some advantages such as non-toxic, antibacterial, biodegradable [8]. While Bentonite is one type of clay with (85%-95%) mineral montmorillonite (an aluminum-rich clay mineral containing some sodium and magnesium. Bentonite has the ability to swell, and can be intercalated [9].

EXPERIMENTAL

Materials and Equipment

The waste water used in this study was obtained from the Ismailia Canal (Mostourd refinery site): Turbidity (TSS) is (100.7) NTU, PH= (8.32), Temperature= (24.04^{o}C). Samples of canal water were taken in one gallon container and transported to the laboratory.1 M NaOH, acetic acid , 1%, TiO2(PH: 3.5 - 4.5) ,Bentonite, Chitosan. The characterization was done by Scanning Electron Microscope (SEM) (JEOL (JSM-5300)), FTIR Shimadzu.

Synthesis of TiO_2-Chitosan

2 grams of TiO_2 dissolves in 100 mL of acetic acid 1% for 2 hours stirring at a constant speed, then added 1 gram of chitosan and stirring quickly for 2 hours to obtain clear solution, finally added 1M NaOH solution into these solutions drop wise until solution reaches PH= 10. Then put in oven at 100^{o}C for 4 hours and calcined at 450^{o}C for 2 hours, TiO_2-Chitosan composite material is ready to use [10].

Synthesis of TiO_2-Bentonnite

5 grams of purified Bentonite was dispersed in 500 mL of distilled water and stirred for 3 hours until the lumps of clay was lost .2 grams of TiO_2 dispersed in 100 mL distilled water and then stirred at 300 rpm at 70^{o}C and added to Bentonite,TiO_2-Bentonite composite material is ready to use.

Photo degradation and removing turbidity from Ismailia canal as a water reservoir using a composite of TiO2/Chitosan and TiO2/ Bentonite.

Photo degradation was done by dispersing 0.5 gram of TiO2-bentonite and 0.5 gram of TiO2-Chitosan into 500 ml waste water followed by stirring for 30 minutes at 300 rpm at room temperature.

RESULTS AND DISCUSSION

Fourier Transform Infrared (FTIR)

TiO_2 spectroscopic analysis between the ranges 400-700 cm^{-1}, here the peak appears in 478.35 and 594.08 [11]. The absorption peak of Bentonite at wavenumber 3626.17 cm^{-1} which shows the stretching vibration of O-H. TiO2-Bentonite didn't indicate any shift in absorption at a wavenumber 3448.72 cm^{-1} which O-H bond is weakened because the presence of TiO2 in between the layers of Bentonite.

In Fig (2) shows the absorption peak at 3350 cm^{-1}, indicate combined peaks of NH2 and OH group stretching vibration [12] which Fig (3) shows strong peak moved to lower wave number at 3300 cm^{-1} that indicated the strong interaction between these groups and TiO2[13]. It appears peaks at 1647 and 1078 cm^{-1} which indicates the presence of $–NH_2$ group and C-O stretching group, when we make a comparison between it and Chitosan we found that in Chitosan there are new absorption peaks at 671 cm^{-1} and 385 cm^{-1} due to the attachment of amide group of TiO2.Fig (3) shifted from wide peak at 3350 cm^{-1} to lower wavenumber 3300 cm^{-1} this means the formation of nanocomposites.

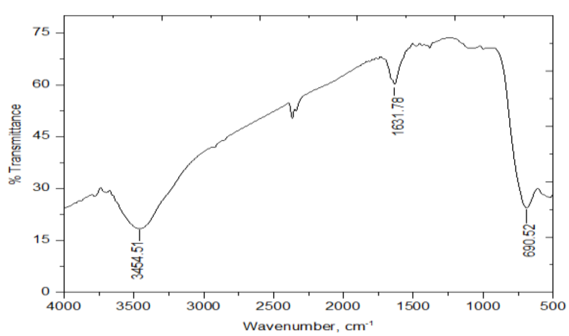
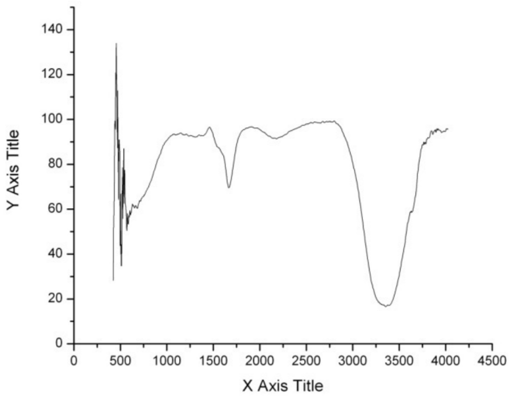


Fig (1): FTIR- Spectrum of TiO2 [14].



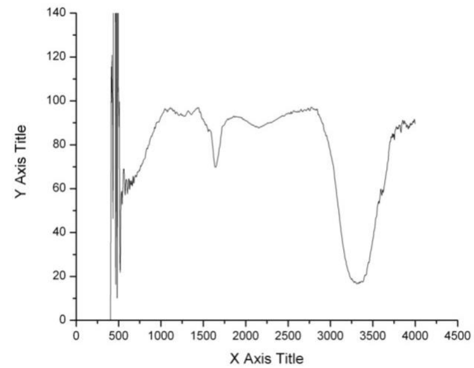


Fig (3): FTIR pattern of Chitosan/TiO_2 nanocomposites. [14]

Fig (2): FTIR pattern of Chitosan. [14]

Scanning electron microscopy (SEM)

It used to investigate the dispersion of TiO2 in the Chitosan matrix and Bentonite matrix the various amount of TiO2 (0.3, 0.5, 1, 2) and 5 wt % of chitosan and 5 wt% of Bentonite which added in Chitosan solution and Bentonite solution. The interactions between the TiO2 surfaces and Chitosan molecules due to vander-waals force, which is weaker than the interactions between the chitosan-chitosan molecules. Bentonite possesses a layer structure and large surface areas which used to disperse TiO2 and adsorb pollutants. Then we investigate the surface morphology of Chitosan/TiO2, and Bentonite/TiO2 which shows aggregated particle structures, and the SEM of TiO2 and Chitosan are uniform which the native Chitosan film revealed smooth and flat surface.

The poor distribution of TiO2 particles in the Chitosan film caused by the deficiency of attractive forces, there is no attractive force between Chitosan and TiO2, when we analysis the surface morphology of non-modified and modified Bentonite. The natural Bentonite shows massive, aggregated, some flakes. After modification with TiO2 the Bentonite surface resulting in a large number of small particles, when we compare between the activities of TiO2/Chitosan, TiO2/Bentonite for removing gravels and turbidity from polluted water (Ismailia canal), TiO2/Bentonite composite has a great ability greater than TiO2/Chitosan which give with TiO2/Bentonite composite efficiency for removing turbidity 55% NTU but TiO2/Chitosan efficiency is 18% NTU. When TiO2 exposed to visible light, the electrons in the valence band of the semiconductor be excited into the conduction band will generate (e) electrons or (h^+) then reacts with hydroxide radicals which will oxidize water reservoir (Ismailia canal)(mostourd refinery site), then degraded the (TSS).

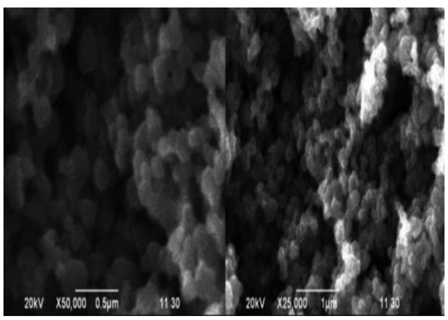


Fig (4) (a) SEM OF TiO2 [15].

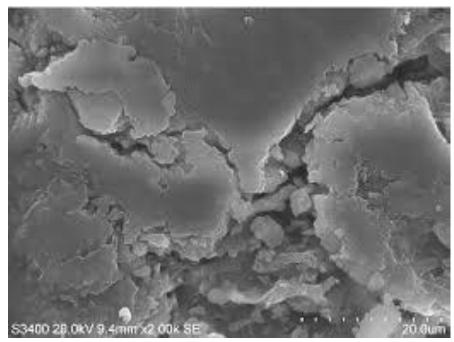


Fig (4) (b) SEM OF Chitosan/TiO2 nanocomposite [15].

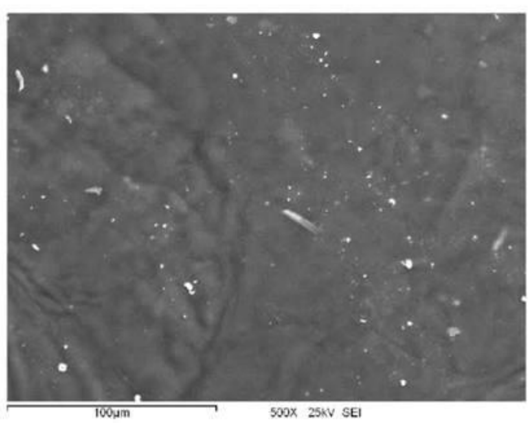


Fig (4) (c) SEM of native Chitosan [15].

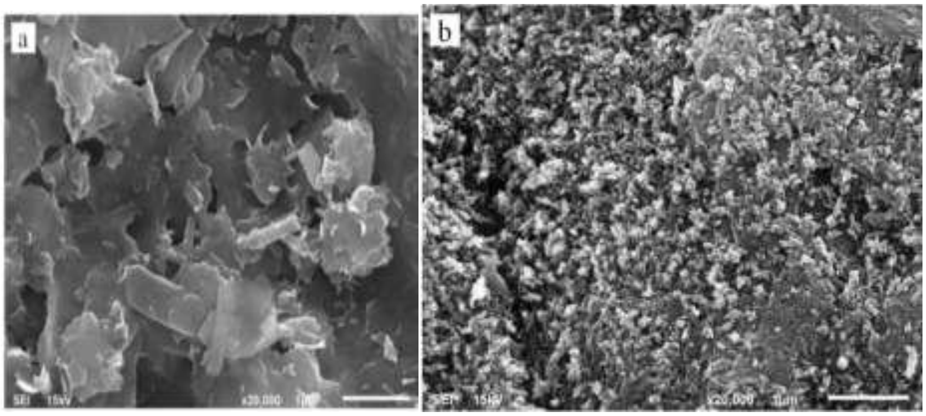


Fig (5) SEM image of a. Natural Bentonite and b. TiO2/ Bentonite composite [16].

Effect of pH:

Wastewater containing various contaminants, generally the pH between (6.0-9.0) in water reservoir (Ismailia canal) (mostourd refinery site), Therefore, it is important to study the role of the pH on the degradation of specific pollutants ranges from (2, 5, 7, 9, and 10). Indeed, the performance of TiO2 photo- catalysis may differ in different types of pH medium, due to the amphoteric behavior of the metal oxides The degradation and adsorption of TiO2 decreased as the PH increased because of the negative charge of TiO2 in basic solution but in acidic solution TiO2 give positive charge, at high PH values, the surface site of Bentonite is negative and occur electrostatic repulsion, the suitable PH is =2 which achieved highest activity of TiO2/Bentonite for removal turbidity and TSS from water reservoir.

PH acid (PH<7): $Ti\text{-}OH + H^+ \rightarrow TiOH_2^+$

PH base (PH>7): $Ti\text{-}OH + OH^- \rightarrow TiO^- + H_2O$

CONCLUSION

Synthesis and characterization of Chitosan/TiO2, Bentonite/TiO2 nanocomposites, for removal of turbidity and TSS from water reservoir ((Ismailia canal) (mostourd refinery site), were studied by using FTIR, Scanning electron microscope and Effect of PH. The FTIR results the formation of nan- composites, which increase the efficiency of removal, the images of SEM revealed that TiO2-Bentonite (55% NTU) composites decreasing the turbidity than TiO2-Chitosan (18% NTU).

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