Ain Shams University

Faculty of Science

Removal of Metal ions from Industrial Wastewater by photocatalysis

A DISSERTATION

Presented to
Chemistry Department
Faculty of Science
Ain Shams University

By

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B.Sc.(2004); M. Sc.(2010) (Cairo University)

For

The Degree of
Doctor of Philosophy in *Science, PhD (Chemistry)*

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PhD Thesis

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Abbreviations

A	Acceptor
APHA	American Public Health Association
ASTM	American Society for Testing and Materials
BET	Brunauer-Emmett- Teller
cb	Conduction Band
COD	Chemical Oxygen Demand
D	Donor
e^-	electron
E_g	Band gap Energy
EPA	Environmental Protection Agency
FTIR	Fourier Transform Infrared spectroscopy
h^+	hole
HM	Heavy Metals
ICSD	Inorganic Crystal Structure Database
JCPDS	Joint Committee on Powder Diffraction Standards
NIST	National Institute of Standards and Technology
pH_{pzc}	Point of Zero Charge
SC	Semiconductor
TEM	Transmission Electron Microscopy
TP	Total Phosphrous
UV	Ultraviolet
UV–vis	UV - visible light
vb	Valance Band
V_{fb}	The flat band potential
XRD	X-ray Diffraction (XRD)

ABSTRACT

Name: Shimaa Mohamed Abdel Moniem Mohamed

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Removal of metal ions from industrial wastewater by photocatalysis using simulated sun light as a source of green energy are the main aim of research study. It involves detoxification of metal ions in order to reduce their contamination into the environment and recovery of precious metal from industrial wastewater. Commercially available TiO_2 was used in comparing with new prepared nano-structured photocatalysts such as simonkolleite-TiO_2 photocatalyst with different Zn contents and metal-free graphitic carbon nitride (g-C_3N_4) photocatalyst. The used photocatalysts were characterized by X-ray diffraction (XRD), transmission electron microscopy (TEM), FT-IR, Raman and UV–Visible diffuse reflectance spectroscopy (DRS). The DRS confirmed that both the new prepared photocatalysts have narrower bandgap energy comparing with that of TiO_2. Formic acid was used as a holes scavenger in order to improve the photocatalytic reduction mechanism. Under simulated sunlight, the best efficiency of Cr(VI) photoreduction has been achieved using 1000 ppm simonkolleite-TiO_2 photocatalyst of 5% Zn/TiO_2 weight ratio, 100 ppm g-C_3N_4 photocatalyst, when pH of the medium was set at 2-2.5 comparing with only 47.3% reduction efficiency at 1500 ppm TiO_2. Furthermore, the best efficiency of Ag^+ photoreduction has been achieved using 200 ppm simonkolleite-TiO_2 photocatalyst of 5% Zn/TiO_2 weight ratio, 100 ppm g-C_3N_4 photocatalyst, at pH 4, comparing with only 38.3% reduction of silver ions using TiO_2 photocatalyst. Integrated management of wastewater generated from a hard chrome metal plating workshop were applied through waste minimization, maintenance of the industrial facilities led to reducing the consumption of hazardous chemicals during two shift (16h) by 83.3%., and achieving a rinse-water reduction of 99.8%. (about 41.56 m^3 of water was reduced). Furthermore, implementation of solar photocatalytic reduction process for the discharged wastewater at the optimum operating reaction conditions was very effective in complete detoxification of Cr(VI) ions into Cr(III).

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