

## Production of Renewable Energy and Industrial Wastewater Treatment Using Different Titanium Dioxide Nanocomposites

**Thesis Submitted** 

## By Saad Mahmoud Abdel Aziz Asal

**B.Sc.**, 2000

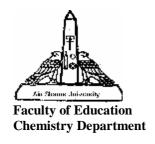
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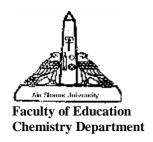
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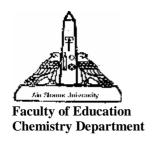
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# **ABSTRACT**

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### **ABSTRACT**

Pure and x mol%  $Ln^{3+}$  modified  $TiO_2$  nanomaterials ( $Ln^{3+} = Eu^{3+}$ or  $Sm^{3+}$  ions, x = 0, 0.007, 0.020, 0.050, 0.070 mol%) synthesizedby a sol-gel at pH = 2. Structure and surface properties of the photocatalysts were characterized by XRD, UV-vis/DR, FT-IR, XPS and N<sub>2</sub> adsorption–desorption at 77 K measurements. The prepared lanthanide doped TiO<sub>2</sub> nanomaterials have anatase phase and exhibit Ti-O-Ln bond. The absorption spectra of the prepared samples reflect the increasing photoresponse of doped samples to visible light over pure TiO<sub>2</sub> and commercially available P25. Surface area is remarkably increased due to lanthanide ion-doping. XPS analysis confirms the presence of Eu<sup>3+</sup> and Sm<sup>3+</sup> ions in the doped samples (Eu<sup>3+</sup>/TiO<sub>2</sub> and Sm<sup>3+</sup>/TiO<sub>2</sub>) in addition to the Ti<sup>4+</sup> and O. The prepared pure and Ln<sup>3+</sup> modified TiO<sub>2</sub> nanomaterials, as well as, commercially available P25 were applied for photocatalytic photobiogas/hydrogen from acetic acid under N<sub>2</sub> atmosphere. The main gaseous products of CH<sub>3</sub>COOH decomposition using these nanomaterials were CH<sub>4</sub> and CO<sub>2</sub>. Trace amounts of C<sub>2</sub>H<sub>6</sub> and H<sub>2</sub> were also detected in the reaction mixture. Moreover, it was observed that the quantities of all identified gases increased with elongation of irradiation time. The most active photocatalysts towards CH<sub>4</sub> and H<sub>2</sub> generation were Ln<sup>3+</sup>/TiO<sub>2</sub> containing 0.050 and 0.02 mol. % of Sm and Eu, respectively. In addition, these nanomaterials were also applied for photocatalytic degradation of ABSTRACT iv

textile dyes from water under atmospheric condition. Remazol red RB 132 (RR) and brilliant blue (BB) were selected as examples of textile dyes which already used for dying in many factors. The results show that the Ln doping brought about remarkable improvement in the adsorption efficiency and photocatalytic activity over pure TiO<sub>2</sub>. The optimal UV light reactivity of the photocatalysts for dyes decolorization was achieved for 0.02 and 0.05 mol% of Eu<sup>3+</sup> and Sm<sup>3+</sup> ions, respectively. The results revealed that the Ln<sup>3+</sup> modification can improve the effectiveness of the photocatalysts compared to pure and commercially available TiO<sub>2</sub> provided that a proper amount of modifying ions is Other important parameters which influenced effectiveness of photobiogas/hydrogen generation and textile wastewater purification in case of Ln3+ modified samples were high surface area and low crystallite size of anatase. Furthermore, the presence of lanthanide oxide on the surface of TiO<sub>2</sub> creates a charge imbalance. Therefore, the hydroxide ions would be adsorbed on the surface as we can see from XPS measurements. The hydroxide ions act as hole traps that inhibit electron/ hole pairs recombination as well.

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Arabic abstract

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