

# Role of a TiO<sub>2</sub>/ZnPc composite and of the sacrifice reagent concentration on gaseous hydrogen production by heterogeneous photocatalysis.

**Antonio E. H. Machado (PQ)<sup>a</sup>; Samuel M. de Oliveira (PG)<sup>a</sup>; Antonio O. T. Patrocínio (PQ)<sup>a</sup>; Carla E. Hori (PQ)<sup>b</sup>.**

<sup>a</sup> Universidade Federal de Uberlândia, Instituto de Química, Laboratório de Fotoquímica e Ciência de Materiais. Av. João Naves de Ávila, 2121 – Campus Santa Mônica, 38400-902, Uberlândia, Minas Gerais.

<sup>b</sup> Universidade Federal de Uberlândia, Faculdade de Engenharia Química. Uberlândia, Minas Gerais.

\*e-mail: aehmachado@gmail.com

Keywords: H<sub>2</sub>, heterogeneous photocatalysis, TiO<sub>2</sub>/zinc phthalocyanine, TiO<sub>2</sub>, sacrifice reagent.

## Introdução

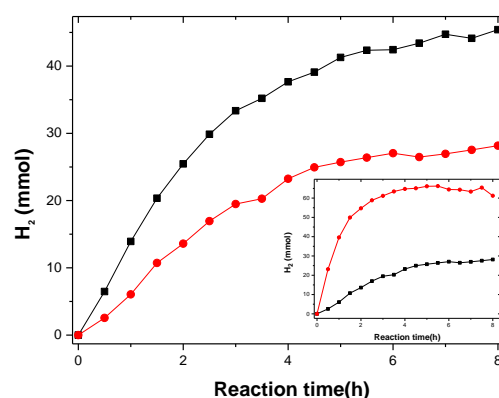
In the present communication we present partial results concerning to the optimization of the process involved in obtaining gaseous hydrogen through heterogeneous photocatalysis.

The experiments were done using a photocatalytic reactor previously reported,<sup>1</sup> using as photocatalysts the TiO<sub>2</sub> P25 Degussa-Evonick and a composite formed by the association of TiO<sub>2</sub> P25 and zinc phthalocyanine (TiO<sub>2</sub>/ZnPc 2.5%)<sup>2,3</sup>, both containing 0.5% m/m of metallic Platinum, used as electron trap, deposited on their surface via photoreduction of hexachloroplatinic acid. The reactions occurred in atmosphere of N<sub>2</sub> using methanol as sacrifice reagent (SR). The pH of the reaction medium was adjusted to 4.5.<sup>3</sup> Samples of the gases produced were collected every 30 minutos of reaction and analysed by gas chromatography.

## Resultados e Discussão

The ability of TiO<sub>2</sub> P25 and the TiO<sub>2</sub>/ZnPc composite<sup>2,3</sup> in catalyzing the production of H<sub>2</sub> in water/methanol solutions, was evaluated. In comparison with TiO<sub>2</sub> P25 (5.3 mmol h<sup>-1</sup>), the result for the composite implies an increase of 38% (9.5 mmol h<sup>-1</sup>) in the production of H<sub>2</sub> in 8 hours of reaction, for a concentration of SR equal to 4.9 mol L<sup>-1</sup> in both cases. This increase may be related to injection of electrons from electronically excited zinc phthalocyanine to the conduction band of TiO<sub>2</sub>, favoring the reduction of H<sup>+</sup> in H<sub>2</sub>, **Figure 1**. An increase in the concentration of SR results in a higher rate of H<sub>2</sub> production, **Figure 1 – Insert**. An increase of 266% in the rate of H<sub>2</sub> production catalyzed by TiO<sub>2</sub> P25 was observed when the concentration of SR varied from 4.9 mol L<sup>-1</sup> to 12.4 mol L<sup>-1</sup>. This improvement can be explained by the decrease in electron/hole pair recombination in TiO<sub>2</sub>, once the SR reacts with the vacancies, giving rise to oxidized species.

**Figure 1.** H<sub>2</sub> production ([CH<sub>3</sub>OH] = 4.9 mol L<sup>-1</sup>) mediated by: (■)TiO<sub>2</sub>/ZnPc and (●) TiO<sub>2</sub> P25. **Insert:** Role of CH<sub>3</sub>OH concentration on H<sub>2</sub> production by photocatalysis induced by TiO<sub>2</sub> P25: (■) 4.9 mol L<sup>-1</sup> and (●) 12.4 mol L<sup>-1</sup>.



## Conclusões

The combination of TiO<sub>2</sub> and ZnPc as well as the increase of proportion of sacrificial reagent are important in improving the process of H<sub>2</sub> production by heterogeneous photocatalysis.

## Agradecimentos

To CAPES, FAPEMIG, CNPq and RQ-MG. A.E.H. Machado, A.O.T. Patrocínio and C.E. Hori thank to CNPq for providing their Research Productivity Scholarships. S.M. de Oliveira is grateful to CAPES by granting his Master's Degree Scholarship.

<sup>1</sup> Oliveira, S.M. et al. Resumo publicado no XXVIII ERSBQ/MG – Papel do pH na produção fotocatalítica de hidrogênio, **2014**.

<sup>2</sup> Machado A. E. H. et al. International Journal of Photoenergy, **2008**, v.2008.

<sup>3</sup> Machado, A. E. H. et al. In: Solar Radiation, Intech, **2012**, Chap 19, 339-378, Croatia.