Commercial TiO_2 mixtures for photocatalytic hydrogen production

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1. Introduction – The work on water-photo-splitting of Fujishima and Honda in 1972 [1] inspired subsequent researchs to obtain hydrogen in eco-friendly way. The heterogeneous photocatalysis using TiO_2 can be an alternative [2]. If Pt nanoparticles are added to the TiO_2 surface, hydrogen production is highly favored [3] with respect to that from unmodified TiO_2. In this work, we used mixtures of the most productive commercial photocatalysts (Aeroxide P25 and Kronos) with 1%wt. photo-deposited Pt with in order to study if there is a synergistic effect between both catalysts.

2. Experimental - Mixtures of Kronos and P25 catalysts were prepared with different weight percentages (80-20, 60-40, 40-60 and 20-80). A borosilicate reactor was then filled with [methanol] 6.17 M, [photocatalyst] 1 $g \cdot L^{-1}$ and the calculated amount of hexachloroplatinic acid to obtain 1%wt Pt loading. The generated hydrogen was carried by a He continuous flow at 20 $mL \cdot min^{-1}$ to a gas chromatographer to be quantified. The radiation was supplied by a fluorescent emitting between 200 and 400 nm with a maximum at 365 nm.

3. Results and Discussion - The mixtures were characterized by XRD, SEM-EDX and DRS. The XRD showed that the Pt deposition process did not modify the crystalline structure. The SEM-EDX studies confirmed that the amount of deposited Pt corresponded to that theoretically calculated. The DRS spectra showed a shift to a larger wavelength compared to that of bare catalysts. The most productive photocatalyst was pure P25 (3767 μmol·h-1). The mixtures exhibited slightly lower maximum productions and these were between those of the bare catalysts. However, maximum production was reached faster for 40-60 and 60-40 mixtures. The intermediates detected were, in gas phase, CH_4 and CO_2 and in the liquid phase HCHO and HCOOH.

4. Conclusions – The presence of Kronos in a 40 and 60%wt. decreased significantly the time necessary to reach the *plateu* of maximum production.

5. References

[1] A. Fujishima, K. Honda, Electrochemical photolysis of water at a semiconductor electrode, Nature 238 (1972) 37-38.

[2] E. Pulido Melián et al., Efficient and affordable hydrogen production by water photo-splitting using TiO_2-based photocatalysts, International Journal of Hydrogen Energy 38 (2013) 2144-2155.

[3] E. Pulido Melián et al., Hydrogen production using Pt-loaded TiO_2 photocatalysts, International Journal of Hydrogen Energy 38 (2013) 11737-11748.