

TiO₂ – CATALYSTS DOPPED OR IMPREGNATED WITH Pt ON HYDROGEN PRODUCTION VIA WATER DISSOCIATION USING HETEROGENEOUS PHOTOCATALYSIS

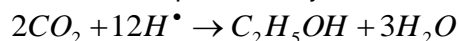
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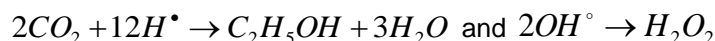
Alternative energies among them, hydrogen production via water dissociation using heterogeneous photocatalysis offers special promise [1]. Currently TiO₂ is the most widely used photocatalyst. In the present study, experiments of hydrogen production via water splitting were developed using a Photo CREC Water II Reactor, with a specially adapted with H₂ collector tank [2]. Ethanol 2 vol.% was employed as a renewable hole (h⁺) scavenger. TiO₂ was doped with Pt using different loadings of Pt. The following methodologies were used: incipient impregnation, wetness impregnation and sol-gel. The prepared photocatalysts were characterized by BET, UV-Vis-diffuse reflectance, X-ray diffraction (XRD). The near UV lamp employed was characterized with a spectrophotometer.

The semiconductor prepared with sol gel displayed the highest specific superficial area (125.54 m²/g) and a reduced band gap (2.7 eV versus the 3.2 eV for DP25). The quantum yield reactor efficiency (QY) for hydrogen production was calculated, using $QY = [dN_i/dt]/P_a \times 100$. In all the cases, at pH = 4, the hydrogen profiles were linear. and produced with a 1.7% Pt loading and a 17% QY. QYs were constant throughout the experiment, as a result of the zero order hydrogen formation.

During the various experiments with argon in the receiving chamber, a small ethanol amount of was consumed. Methane, ethane, CO₂, formaldehyde and acetaldehyde species were formed. On the other hand when CO₂ was used in the hydrogen receiving chamber, ethanol concentration remained quasi-constant. This was considered an indication that ethanol was also produced by.



According to the proposed reaction network in [2], ethanol is consumed and produced due the formation and conversion of CO₂. As well, OH radicals balances also pointed towards the formation of hydrogen peroxide (H₂O₂), $2OH^\bullet \rightarrow H_2O_2$. To clarify this, hydrogen peroxide was measured showing its concentration increasing steadily with irradiation time. As a result two additional reactions are proposed to be included in the reaction scheme presented in [1]: conversion of CO₂ and formation of hydrogen peroxide.



In summary, the following conclusions can be drawn: 1) The preparation of the various photocatalysts does not affect the zero reaction order for production hydrogen at pH=4.0, 2) Hydrogen production increases with platinum loading showing the role played by Pt as an electron trap, 3) Quantum yields reached 17% when using the photocatalyst produced via sol-gel catalyst, 4) Carbon dioxide atmosphere in the hydrogen receiving tank reacts with OH free radicals, producing ethanol. 5) Hydrogen peroxide is produced through the dimerization of OH free radicals. 6) The high and quasi constant values for QYs shows the high utilization of photons absorbed on the photocatalyst and the high performance of the Photo CREC Water II for hydrogen production.

References

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