T_iO_2 – CATALYSTS DOPPED OR IMPREGNATED WITH P_t ON HYDROGEN PRODUCTION VIA WATER DISOCIATION USING HETEROGENEOUS PHOTOCATALYSIS

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Key Words: Hydrogen, Photocatalysis, Water, Titanium Dioxide, Platinum.

Alternative energies among them, hydrogen production via water dissociation using heterogeneous photocatalysis offers special promise [1]. Currently TiO_2 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 H_2 collector tank [2]. Ethanol 2 vol.% was employed as a renewable hole (h^+) scavenger. TiO_2 was doped with Pt using different loadings of Pt. The following methodologies were used: incipient impregnation, wetness impregnation and sol-gel. The prepared photo catalysts were characterized by BET, UV-Vis-diffuse reflectance, X-ray diffraction (XRD). The near UV lamp employed *was characterized with a* spectrophotoradiometer.

The semiconductor prepared with gol gel displayed the highest specific superficial area (125 54 m^2/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 $QY=[dN_i/dt]/P_a$ x 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, CO_2, formaldehyde and acetaldehyde species were formed. On the other hand when CO_2 was used in the hydrogen receiving chamber, ethanol concentration remained quai-constant. This was considered an indication that ethanol was also produced by.

$$2CO_2 + 12H^{\bullet} \rightarrow C_2H_5OH + 3H_2O$$

According to the proposed reaction network in [2], ethanol is consumed and produced due the formation and conversion of CO_2. As well, *OH* radicals balances also pointed towards the formation of hydrogen peroxide (H_2O_2), $2OH^{\circ} \rightarrow H_2O_2$. To clarify this,hydrogen peroxide was measured showing its concentration increasing steadly with irradiation time. As a result two addiitonal reactions are proposed to be included in the reaction scheme presented in [1]: conversion of CO_2 and formation of hydrogen peroxide.

$$2CO_2 + 12H^{\bullet} \rightarrow C_2H_5OH + 3H_2O \text{ and } 2OH^{\circ} \rightarrow H_2O_2$$

In summary, the following conclusions can be drawn: 1) The preparation of the various photo catalysts 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 photo catalyst 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 cuasi 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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