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Ni/TiO2 - Low Cost Photocatalysts for Solar H2 Production

This work targets the development of efficient metal co-catalyst modified titania photocatalysts for alcohol photoreforming to H2 that function under direct sunlight. Conventionally, noble metals such as platinum, palladium or gold have been used co-catalysts to activate TiO2 for hydrogen production, though the use of such co-catalysts for industrial scale H2 manufacture is not feasible due to their high cost and low natural abundance, motivating the search for low cost alternatives. This study compares the performance of 3 different Ni/TiO2 photocatalysts for H2 production in alcohol-water mixtures, placing particular emphasis on the role of the TiO2 support and alcohol sacrificial reagent. P25 TiO2 (85% Anatase, 15% Rutile), isolate anatase from P25 TiO2, isolate rutile from P25 TiO2, commercial brookite and physical mixed P25 TiO2 were used as the support phase. XPS and Ni L-edge NEXAFS analyses verified that metallic Ni was the dominant nickel species in the near surface region of the photocatalysts. Ti L-edge NEXAFS spectra show L3-edge and L2-edge features with two sublevels (t2g and eg) which arise from crystal-field splitting caused by the octahedral ligand fields about the Ti4+ cations. The difference between the three TiO2 polymorphs (anatase, rutile and brookite) was seen in the eg feature at the L3 edge, which is split into two unresolved components (i.e. dz2 and dx2-y2 states). This change in the relative intensity of the dz2 and dx2-y2 peaks on going from anatase to rutile is explained by distortion of the Ti4+ site from D2h (in anatase) to D2d (in rutile). For brookite, the dz2 and dx2-y2 peaks have similar intensities. These observations are in good accord with Ti L-edge data reported for mineral and synthetic titanias (Fig. 1). The Ni/P25 TiO2 photocatalysts were very active for H2 production in 10 vol.% alcohol-water mixtures under UV excitation, with the optimal Ni loading being ~0.5 wt.%. Ni/anatase and Ni/physical mixed P25 photocatalysts showed a diminution in the photocatalytic H2 production performance, which confirmed the importance of interfacial electron transfer at the rutile:anatase interface.

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Keywords or phrases (comma separated)

H2 production; Ni/TiO2

Are you a student?

Yes

Do you wish to take part in</br>the Student Poster Slam?

No

Are you an ECR? (<5 yrs</br>since PhD/Masters)

No

What is your gender?

Female

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