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Hybrid multifunctional materials for CO_2 photoredcution by Artificial Photosynthesis

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An interesting route for the valorization of CO_2 and H2 production consists on its photocatalytic conversion into fuels and/or chemicals in the presence of water and suited photocatalysts [1]; this process is also known as Artificial Photosynthesis (AP). This is a quite challenging process since CO_2 and H_2O are highly stable compound and their transformation involves a series of multi-electron reactions in combination with light management. In this sense, extensive efforts have been made to develop efficient catalytic systems capable of harvesting light absorption and reducing CO_2 to valuable products especially when using water as the electron donor. However, this process suffers from very low quantum yields and non-selective product distributions, due to the complexity of the involved multi-step reactions.

The design of efficient photocatalysts aims at achieving an expanded light absorption and a better charge separation to improve the overall photocatalytic performance. [1-3].

Herein, we report different strategies and modifications photocatalysts to increase process performance. Among them, an interesting approach to improve charge separation in photocatalytic systems is the use of heterojunctions.

Results and conclusions

In order to clarify the effect of different parallel and competitive reactions in the activity and products distribution, a series of photocatalytic experiments were performed varying the feeding flow. For the AP experiments using bare TiO_2, the main products were CO and H_2, with low concentrations of CH_4 and CH_3OH. The use of different spectroscopies reveals that the CO_2 reduction mechanism is related to the formation of carbonate/bicarbonate species.

On the other hand, the introduction of SP NPs as co-catalyst leads to changes in the conversion and enhanced selectivity to higher demand electron products, such as CH_4, while the CO and H_2 concentrations decrease [4].

In the case of organo-inorganic hybrid materials, Hybrid material also show a dramatically reactivity improvement in CO_2 photoreduction. The variation of the proportion of polymer reveals that a maximum of efficiency obtained with IEP-1@T-10.

Hybrid material also has a great influence in the selectivity enhancing the relative production of methane vs. carbon monoxide, and largely promoting selectivity towards hydrogen.

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