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Green methane production from CO_2 and H_2 under solar light irradiation

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Energy is essential for economic growth and human prosperity. Currently, world primary energy consumption is mainly based on fossil fuels.[1] This massive consumption has paired the emissions of greenhouse gases where CO_2 is one of the principal component. From this perspective, the use of CO_2 as a feedstock in combination with renewable energy to produce fuels is a strategic way to change the actual energetic scenario into a low-carbon economy.[2] However, to become economically feasible, considerable research and developments in the catalyst activity and the process engineering are still needed. [3]

New Ru based catalyst has been synthetized for the reduction of CO_2 to CH_4 in presence of H_2 under solar light radiation. The catalyst was prepared by an impregnation reduction method with Ru loading of 3 wt% on ɣ-Al_2O_3 confirmed by ICP-OES elemental analysis. An average diameter particle size of 15nm was measured by transmission electron microscopy.

Ru/Al_2O_3 creates an efficient light harvesting to reduce the CO_2 selectively to CH_4 in presence of H_2. The methane production rate was studied at different temperatures, under isothermal heating and under solar light irradiation. Light experiments, were carrying out heating the reactor at the selected temperature and irradiating on top the photocatalyst with simulated solar light (AM 1.5). Figure 1 shows the methane production activities for dark and under solar light experiments at different temperatures. When the temperature increased above 150 ºC, CH_4 production was enhanced due to the light absorption of Ru NPs. Under solar light irradiation the methane production increased up to 12100 µmol/$g_{catalyst}$. at 190 ºC

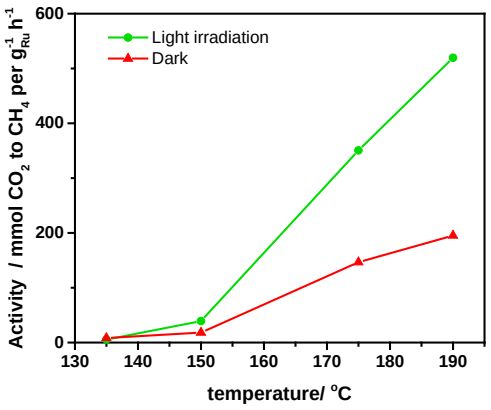

Figure 1. Methane production rate in function of temperature under isothermal conditions (Dark) and solar irradiation (Light). Reaction time 0.5 h. Reaction conditions: 500 mg catalyst. Mixture of CO_2 (16.6%) H_2 (66.8%) and N_2 (16.6%); irradiation source solar simulator AM 1.5).

The present study demonstrates that Ru supported on ɣ-Al_2O_3 is a promising photocatalyst for the photoassisted CO_2 methanation by H_2. Light irradiation of the Ru NPs can enhance the methane production almost 5 times rate 190 ºC compared to the same process in the dark. Under solar light irradiation, Ru-Al_2O_3 can promote selectively the methanation of CO_2.

Acknowledgments

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