Hollow Porous Silica Nanoreactors Encapsulating VO_x-decorated Pt Nanoparticles for the Reverse Water-Gas Shift Reaction

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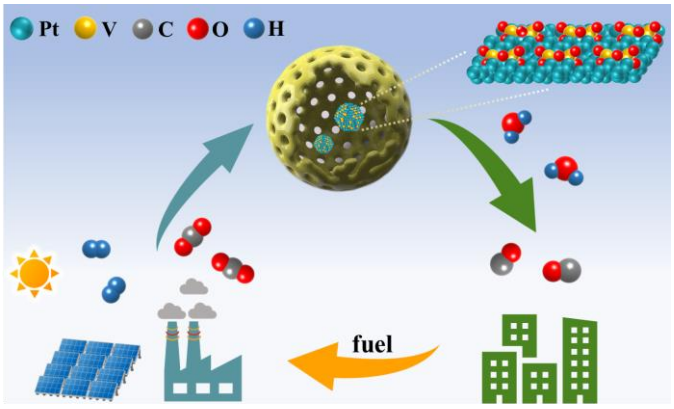
Reverse water-gas shift (RWGS) reaction is a desirable strategy for achieving CO_2 utilization and enhancing CO production. Due to the endothermic nature of this reaction, the reaction is typically conducted at high temperatures (300~500 ºC). However, high temperatures conditions lead to the sintering of the catalyst, resulting in a catalyst deactivation.

Herein we report the synthesis[1,2] of a Pt and metal oxide (V and Mo oxide) encapsulated in hollow porous silica nanoreactors[3] (HPSNs) which shows high activity and stability in RWGS performance at 500 ºC. The HPSNs encapsulating VO_x-decorated Pt nanoparticles (Pt-VO_x@HPSNs) achieve a 1.8-fold increase of activity compared with Pt@HPSNs for the RWGS reaction with a net CO production rate of 1140.3 mmol/g-cat/h and with nearly 100 % CO selectivity. In situ V K-edge XAFS measurements reveal that the redox ability of V species confers the catalyst enhanced adsorption and activation capability of CO_2. Besides, the interplay of Pt and V oxide, which simultaneously activate H_2 and CO_2, respectively, leads to a lowering of the activation energy and a faster CO production rate. Furthermore, the Pt-VO_x@HPSNs catalyst retains over 92 % activity after 50 h of continuous operation with the help of a protective silica shell. This work offers a strategy for the design and development of an efficient and stable heterogeneous catalyst for RWGS reactions.



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