A comparative study of the CO_2 methanation efficiency of dispersed Rh, Ru and Ir nanoparticles: Effect of metal nature and supporting material

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ABSTRACT

Energy needs of modern life inevitably keep high and unluckily increasing fossil fuels (coal, oil, and natural gas) utilization in order to address those. Among others, this leads to the emission of enormous quantities of CO_2 in the atmosphere. However, CO_2 is a greenhouse gas and its high and continuously increasing concentration in the atmosphere renters it as the determinant cause of global warming and the concomitant climate change. Therefore, control of CO_2 emissions is an urgent environmental need. Besides the direct efforts for partial -or even complete- replacement of carbon-based fuels with renewable energy sources, CO_2 capture and storage (CCS) and CO_2 utilization/recycling through its conversion to added-value products and fuels (e.g. methane, methanol) technologies are nowadays among the approaches that receive intense research and technological interest. Here we report on the CO_2 methanation efficiency of Rh, Ru and Ir, dispersed on a variety of mixed oxide supports with the characteristic of different oxygen storage capacity and mobility, namely γ-Al_2O_3 (AL), Al_2O_3-CeO_2-ZrO_2 (ACZ) and CeO_2-ZrO_2 (CZ). The effect of the active metal nature as well as of the oxygen storage capacity (OSC) of the supporting material on CO_2 conversion efficiency and methane production selectivity are comparatively addressed. It has been found that the activity of the noble metals investigated under the titled reaction follows the same order Ir<Rh<Ru on all the supports used. However, for each active phase supported on different supports a significant but non monotonic influence of the OSC of the support on CO_2 methanation output characteristics occurred; the support with intermediate value of OSC was found to be optimal for promoting CO_2 methanation on Ir, Rh and Ru, independently of the nature of the active phase. Tuning this characteristic of the supporting materials we might lead to the design of more efficient CO_2 hydrogenation towards methane catalytic formulations.

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