GLOBAL MEET ON CLIMATE CHANGES AND SUSTAINABILITY

Cristina Italiano and Antonio Vita

CNR-ITAE "Nicola Giordano", Messina,Italy

Enhanced low-temperature CO_2 methanation over Ni-based catalyst: Effect of support and reaction mechanism

Abstract: The growing atmospheric concentration of CO_2 is considered one of the main causes of global warming. Power-to-gas (PtG) processes have the great potential to store the excess of H_2 generated from renewable energy, simultaneously reducing CO_2 emissions from the atmosphere. In the PtG technology concept, the renewable electricity is used to produce hydrogen by electrolysis of water, and subsequently hydrogen reacts with CO_2 to yield CH4via the Sabatier reaction. In this study, we focus on the catalytic behaviors of Ni catalysts supported on Y_2O_3, ZrO_2, CeO_2 and mixed oxides. A comprehensive understanding of the structure-activity correlations was provided to optimally design an effective catalyst for CO_2 hydrogenation. Ni-based catalysts were synthesized by the solution combustion synthesis (SCS) method and characterized by N_2-physisorption, XRD, CO-chemisorption, H_2-TPR, CO_2- TPD, XPS, and TEM. Methanation of CO_2 was investigated under atmospheric pressure, in the temperature range of 250-500°C, at constant stoichiometric reactants ratio of H_2/CO_2 = 4 and gas hourly space velocity(GHSV) of 30,000-120,000 NmL·g-1·h-1. Furthermore, the formation of intermediates was investigated by in-situ DRIFT tests. In general, the catalytic activity strongly depends on the nature of the Ni-oxide interactions. Based on DRIFT observations, the main reaction pathway involves the adsorption of CO_2 onto catalyst support as mono- or bi- dentate carbonate as well as the H_2 dissociation on metallic Ni sites. The adsorbed CO_2 was progressively hydrogenated to methane passing through the formation of formate species as active intermediate. However, the superior catalytic performance of Ni/CeO_2-ZrO_2 catalyst is mainly due to enhanced medium basicity as well as the relatively high Ni dispersion, as confirmed by CO_2-TPD and CO-chemisorption measurements. Finally, good anti-coking and anti-sintering ability after 100 h of lifetime test make Ni/CeO_2-ZrO_2 catalyst an effective catalyst to produce methane by CO_2 hydrogenation.

Biography: Cristina Italiano received her Ph.D. degree in "Chemical Technologies and Innovative Processes" at the University of Messina in 2013. She is a Researcher at National Research Council - Institute of Advanced Technologies for Energy (CNR-ITAE) since 2018. Authorand co-author of 54 papers in reputed journals. The main research projects concern catalysts development for energetic applications, mainly i) reforming processes for hydrogen production; ii) methanation reactions for synthetic natural gas production; iii) ammonia synthesis and decomposition for hydrogen storage.

ISBN: 978-1-0685851-8-0