From waste to value: CO_2 conversion into liquid chemicals

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Abstract

The use of CO_2 as a carbon source, along with renewable H_2, to synthetize fuels and value-added chemicals is a promising route for mitigating CO_2 emissions via carbon capture and utilization (CCU) strategies. While CO_2 hydrogenation is challenging, considerable progress has been made towards methanol (CH_3OH) synthesis, reaching a industrial level. CH_4 and CO are other molecules with one carbon (C1 products) that are concomitantly produced. Molecules with two or more carbons (C2+), such as hydrocarbons, olefins, and oxygenates, e.g. ethanol, possess high economic value and energy density than C1 products. They are versatile molecules with potential use as fuels and polymer precursors. Nevertheless, the C-C coupling reaction is difficult to control, and the reaction selectivity remains a daunting challenge when developing catalysts for C2+ synthesis. Another issue is how to minimize the formation of C1 products. The synthesis of C2+ products require the use of higher pressures (typically >20 bar). We have recently found that Ni catalysts with excellent selectivity toward CO at atmospheric pressure have the tendency to produce CH_4 when submitted to higher pressures, preventing the carbon chain growth. We have showed that the CO selectivity could be preserved at high pressure by designing a Ni_3ZnC catalyst phase. Later, we found that the in situ formation of the intermetallic nickel-zinc carbide phase also occurs when starting with Ni/ZnO, preserving the reaction selectivity towards the production of syngas at high pressures. The next step was the development of catalysts containing Fe, Cu, Co and K, following a similar approach to unlock the formation of C2+ products. The main results will be discussed in this talk.