

CO₂ HYDROGENATION TOWARDS LIGHT OLEFINS OVER IRON-BASED LDH-DERIVED CATALYTIC SYSTEMS

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ABSTRACT

The urgent need to address the increasing CO₂ emissions highlights the importance of innovative strategies to mitigate climate change and its detrimental effects on the environment and humanity. Concurrently, the intermittent nature of renewable energy sources poses the necessity for advanced energy storage approaches, capable of sustaining large-scale energy amounts for extended periods. In view of these aspects, the conversion of CO₂ industrial emissions into synthetic fuels and chemicals through a process commonly called as artificial photosynthesis is a promising pathway. This process involves the utilization of captured CO₂ and electrochemically produced green hydrogen to generate a variety of platform chemicals. Consequently, the focus on CO₂ hydrogenation to produce light olefins represents a sustainable and energy-efficient alternative to traditional petrochemical routes. This approach not only contributes to carbon neutrality by repurposing CO₂ emissions, but also supports the production of carbon negative raw materials for the polymer, automotive, and construction industries. Hydrogenation of CO₂ to light olefins (C₂-C₄) can be achieved through a multi-step process, which involves the modified Fischer-Tropsch synthesis (mFTS) route. However, the product distribution in the conventional Fischer-Tropsch mechanism follows the Anderson-Schulz-Flory (ASF) distribution, limiting light hydrocarbons selectivity to just 58%^[1]. To overcome this difficulty, recent efforts have been devoted on the development of multi-functional catalysts, which are able to overcome the ASF limitations, thus favoring the formation of olefins from a thermodynamic standpoint. Several studies have shown the benefits of using Layered Double Hydroxides (LDH) as catalyst precursors, including their uniform microstructure, thermal endurance, tunable redox and acid-base properties, and improved textural properties^[2]. In the current work, the effect of a second transition metal doping on the activity and selectivity of X-Fe-Al (X= Mn, Co, Cu, Zn) LDH derived catalysts for the CO₂ hydrogenation reaction towards C₂-C₄ was investigated, given that Fe catalysts are active in both the RWGS and FTS reactions. Various parameters, involving the temperature, pressure and WHSV were thoroughly investigated.

KEYWORDS: CO₂ hydrogenation; Light olefins production; Layered Double Hydroxides

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