

## A Study on Hydrogenation of Carbon Dioxide to Hydrocarbons

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### DESCRIPTION

CO<sub>2</sub> hydrogenation to hydrocarbons is a promising approach of making waste to wealth and energy storage, which solves the environmental and energy issues brought about by CO<sub>2</sub> emissions. Much efforts and research are focused on the change of CO<sub>2</sub> via hydrogenation to different value-added hydrocarbons, like CH<sub>4</sub>, lower olefins, fuel, or long-chain hydrocarbons catalyzed by various catalysts with different methods [1]. The continuing consumption of fossil fuels has shown a rising CO<sub>2</sub> concentration in the atmosphere, and worldwide environmental change brought about by ozone-depleting substances has turned into a significant challenge.

Currently, CO<sub>2</sub> can be reduced in three ways: control of CO<sub>2</sub> discharges, CO<sub>2</sub> capture and storage, and chemical conversion and use of CO<sub>2</sub>. Carbon storage is significant for cutting CO<sub>2</sub> emission rapidly; however, it has an issue of expected leakage of CO<sub>2</sub>. CO<sub>2</sub> obtained by capture not just can give a pure carbon source to hydrogenation, yet additionally can stay away from the leakage issue brought about by CO<sub>2</sub> storage. Even the CO<sub>2</sub> in flue gas can be utilized as a feed for hydrogenation. CO<sub>2</sub> depletion can be catalyzed through electrocatalysis, photocatalysis, and thermal catalysis. Among them, thermal catalysis gets critical consideration because of its quick kinetics and flexible combination of active components [2,3]. The inclusion of more substances with higher Gibbs energy will make the CO<sub>2</sub> change better thermodynamically. But, electrocatalysis and photocatalysis have the disastrous flaw of low energy production. Thus, CO<sub>2</sub> hydrogenation utilizing H<sub>2</sub> produced with renewable energy sources is a promising analysis to create synthetic substances and a fuel, which reduces the CO<sub>2</sub> emissions, yet in addition, cover the shortage of fossil fuels.

Catalytic hydrogenation of CO<sub>2</sub> utilizing H<sub>2</sub> created with renewable energy is considered a potential path for the production of lower olefins, higher hydrocarbons, formic acid, methanol, and higher alcohols. With the depletion of fossil fuels, CO<sub>2</sub> hydrogenation to hydrocarbons is a promising way to cover CO<sub>2</sub> into fuel among other CO<sub>2</sub> hydrogenation. However, we want to go up against two challenges alongside it: (1) sustainable hydrogen source and (2) scattered product distribution. Much effort has been committed to addressing the

challenge, and researchers have proactively gained progress in water electrolysis to create H<sub>2</sub> utilizing electricity produced with sun-based or wind or other renewable energy, and water splitting using photocatalytic, photoelectrochemical, or other photochemical cycles [4]. But, the C<sub>2+</sub> hydrocarbons have a wide organization. For example, CH<sub>4</sub>, C<sub>2</sub>-C<sub>4</sub>, and C<sub>5+</sub> are targeted for production, while the selectivity was spread in a wide range, which turns into an obstruction to meet the necessity for applications in industry.

The basic factor for product selectivity is the surface H/C proportion changed by the use of catalysts. Moreover, DFT research propels are summed up according to the perspective of C-O bond cleavage and C-C bond development which gave a deep insight into CO<sub>2</sub> activation and conversion. Ecological issues have pushed the need to reduce CO<sub>2</sub> emissions caused by the utilization of fossil fuels. Heterogeneous thermo catalysis is a promising heading for application in CO<sub>2</sub> transformation. The catalyst performance can be impacted by many elements, for example, metal-support cooperation, metal molecule size, and promoters [5]. Ni-based catalysts are basically utilized in CH<sub>4</sub> production from CO<sub>2</sub> hydrogenation. Likewise, Co, Ru, Ir and Rh are additionally applied for CO<sub>2</sub> methanation. Fe is a functioning metal for CO<sub>2</sub> hydrogenation to C<sub>2+</sub> hydrocarbons through changed FTS or methanol-intervened course. Fe-metal bimetallic catalysts have shown particularly further developed performance. The arrangement of bi-functional catalysts combining metal oxides and zeolites is a powerful method for controlling the product selectivity for C1 conversion. A few trials and DFT estimations have given the encouraging result that CO<sub>2</sub> transformation can be catalyzed through the intermediate route which is neither the CO course nor the methanol course, which won't be restricted by the ASF distribution and the equilibrium conversion of CO<sub>2</sub> to methanol. The vital mechanisms of the underlying C-C bond formation and C-O bond cleavage are different between Fe-based catalysts and Cu-based catalysts in DFT calculations.

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