# Direct production of gasoline from $CO_2$ and $H_2$

Converting $CO_2$ from a detrimental greenhouse gas into value-added liquid fuels not only contributes to mitigating $CO_2$ emissions, but also reduces dependence on petrochemicals. Unfortunately, the activation of $CO_2$ and its hydrogenation to hydrocarbons or other alcohols are challenging tasks because $CO_2$ is a fully oxidized, thermodynamically stable and chemically inert molecule. Most research to date, not surprisingly, is focusing on selective hydrogenation of $CO_2$ to short-chain products, while few studies on long-chain hydrocarbons, such as gasoline-range ($C_5$—$C_{11}$) hydrocarbons. The key to this process is to search for a high efficient catalyst.

With the support by the National Natural Science Foundation of China, the research team led by Dr. Sun Jian (孙剑) and Prof. Ge QingJie in Dalian Institute of Chemical Physics, has succeeded in preparing a highly efficient, stable, and multifunctional Na—$Fe_3O_4$/HZSM-5 catalyst for the direct production of gasoline from $CO_2$ hydrogenation. This catalyst exhibited 78% selectivity to $C_5$—$C_{11}$ as well as low $CH_4$ and CO selectivity under industrial relevant conditions, and the gasoline fraction is mainly isoparaffins and aromaticsthus favouring the octane number. Moreover, the multifunctional catalyst exhibited a remarkable stability for 1,000 h on stream, which definitely has the potential to be a promising industrial catalyst for $CO_2$ utilization to liquid fuels.

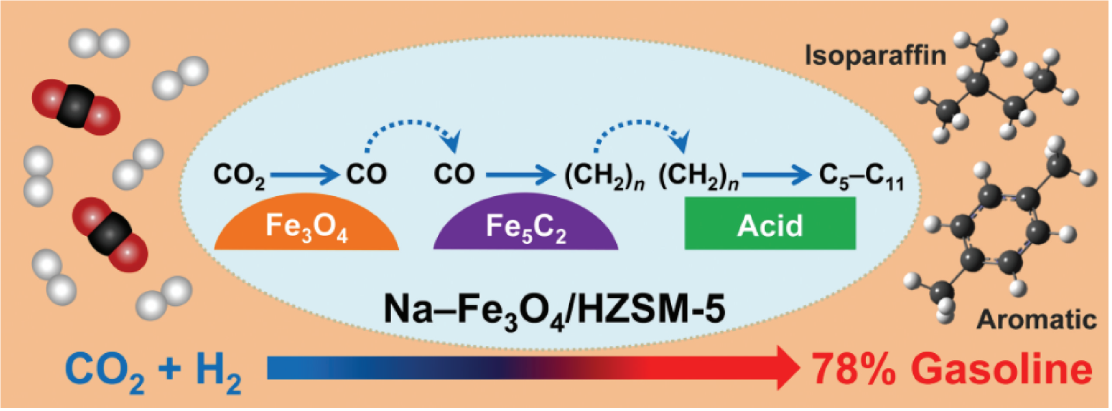


**Figure** A schematic of $CO_2$ hydrogenation to gasoline.

In-depth characterizations indicate that this catalyst enables RWGS over $Fe_3O_4$ sites, olefin synthesis over $Fe_5C_2$ sites, and oligomerization/aromatization/isomerization over zeolite acid sites. The concerted action of the active sites calls for precise control of their structures and proximity. It exhibited 78% selectivity to C5—C11 as well as low $CH_4$ and CO selectivity, and the gasoline fraction is mainly isoparaffins and aromatics thus favoring the octane number. Moreover, the composition of C5—C11 can be tuned by the choice of zeolite type and the integration manner of the multifunctional catalyst. In particular, this multifunctional catalyst and the process may allow use of the feed gas with a low $H_2/CO_2$ ratio, thus reducing the cost of hydrogen. This study paves a new path for the synthesis of liquid fuels by utilizing $CO_2$ and $H_2$. Furthermore, it provides an important approach for dealing with the intermittency of renewable sources (sun, wind, etc.) by storing energy in liquid fuels.

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