

Direct CO₂ hydrogenation over FeAlO_x catalyst to produce high-yield C₅₊ gasoline- and diesel-range fuels

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Liquid hydrocarbons, such as olefins and paraffins, are indispensable chemicals that are widely used as transportation fuels and feedstocks in the synthesis of numerous commodity chemicals. Industrially, liquid hydrocarbons are produced by the distillation of crude oil in petroleum refineries. Recently, carbon dioxide (CO₂) has been recognized as a potential source for the production of liquid hydrocarbons. However, the high kinetic barrier and inherent inertness of CO₂ limit its C–C coupling reactions, consequently reducing the selectivity of CO₂ conversion for C₅₊ hydrocarbons. Herein, we present a single-type, bifunctional sodium-promoted iron aluminum oxide (FeAlO_x) catalyst that promotes the formation of high-yield C₅₊ hydrocarbons with high selectivity for C₅₊ linear alpha olefins. The FeAlO_x catalyst provides a high C₅₊ yield of 19.7% (including CO), with suppressed CO (7.2%, selectivity in the total product) and CH₄ (12.1%, selectivity in hydrocarbons only excluding CO) formation and a CO₂ conversion of 36.8%. In addition, an overall LAO selectivity of 52.4% (excluding CO) was achieved. The catalyst is highly stable for up to 450 h on-stream with negligible variations in the product composition, demonstrating its immense potential for practical applications. Reaction mechanisms and the origin of the excellent catalytic performance are discussed with reference to operando diffuse reflectance infrared Fourier transform spectroscopy (DRIFTS) analyses for CO₂ and CO hydrogenation. Lastly, reaction results over Fe-based catalyst with different types of metal oxide promoters are presented.