An Experimental Study on Fischer-Tropsch Catalysis and Its Implications for Planetary Science

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The Fischer-Tropsch catalysis, which converts CO and H2 to hydrocarbons, such as methane, over iron and nickel catalysts, has been suggested to play a key role in impact phenomena and solar nebula chemistry. In this study, we conduct Fischer-Tropsch catalytic experiments at lower pressures (10^{-4} bar $\leq P \leq 0.3$ bar) and at a wide range of H2/CO ratios (0.25 to 1000). Such conditions are considered to be relevant to planetary science. We investigate the methane formation rate and analyzed the products of Fischer-Tropsch catalysis over iron and nickel powders. Our results indicate that methane formation rate over iron catalyst becomes very inefficient at low pressures and that metallic nickel stays efficient at lower pressures. This suggests that nickel is the main Fischer-Tropsch catalyst in impact phenomena and the solar nebula. Our results also suggest that the catalytic reaction steps of disproportionation of CO, hydrogenation of surface carbon, and poisoning of the catalysts control the overall reaction rate under the conditions relevant to impacts and the solar nebula.