Metal-Organic Framework-Derived Cobalt Photothermal Catalysts for Sustainable CO2 Conversion

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Current thermal and electrochemical green conversion methods are unsustainably powered by fossil fuels, necessitating a greener approach. Consequently, Researchers have turned to photothermal catalysis for carbon dioxide (CO_2) conversion. Still, the quest for efficient photothermal catalysts remains an obstacle. Metal-organic frameworks (MOFs), specifically MOF-derived materials, have attracted a great deal of attention for their structural and compositional tunability. The purpose of this work is to investigate how subjecting cobalt-based ZIF-67 and MOF-74 to high temperature pyrolysis affects the CO_2, conversion rate (%), product selectivity (%), and photothermal conversion efficiency (%) of the resulting photothermal catalysts. In a one-pot approach, Co-ZIF-67 and Co-MOF-74 were pyrolyzed to obtain cobalt nanoparticles embedded in a porous carbon matrix. Through microstructural and compositional characterization, high porosity and surface area, excellent thermal stability, and evenly dispersed cobalt nanoparticles of high loadings were observed. Both catalysts were tested for their catalytic performance under illumination. Co@C--ZIF-67 showed impressive stability, moderate CO_2 conversion rates of 22%, high carbon monoxide (CO) selectivity, and low methane (CH_4) selectivity. Co@C--MOF-74 displayed overall high catalytic performance, with CO_2 conversion rates reaching 34% and high selectivity for both CO and CH_4. Traces of ethane (C_2H_6) were also found, confirming the catalyst's ability to form C2 products. This study not only demonstrates the potential of MOF-derived materials and photothermal catalysis, but it also helps to bridge the gap between them, taking the world a step closer to decarbonizing the chemical industry.

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