Photo-selective Methanol Synthesis over Supported Cu Catalysts

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Abstract

Increasing global CO_2 emissions have resulted in more and more severe greenhouse effects, causing environmental problems and climate changes, especially since CO_2 concentration will continuously grow.[1] One appealing solution is to upconvert CO_2 into methanol (MeOH).[2] MeOH is a highly valuable chemical with a worldwide demand of more than 110 million metric tons in 2023.[3] It can be considered a clean fuel, an excellent liquid energy carrier for fuel cells, and an crucial building block for about 30% of other commodity chemicals, such as dimethyl ether, formaldehyde, methyl formate, acetic acid, methyl tert-butyl ether, or lower olefins.[4] Cu-based catalysts have been widely used in MeOH synthesis due to the high activity of a Cu surface. Recently, various “photo-enhanced effects” over Cu-based catalysts have proven to be beneficial for CO_2 conversion and product yields, which makes photothermal catalysis an attractive alternative to thermal catalysis.[5] Here we report a finding that the light wavelength governs the selectivity and reactivity of an unmodified commercial Cu catalyst in MeOH synthesis. It is found that visible light irradiation (400-500 nm) could lead to the promotion of carbon monoxide (CO) production. Conversely, a significant photo-enhancement for production of MeOH was found under the UV light irradiation (365 nm). This work provides hints for understanding of the key elementary processes occurring on the surface of the Cu-based catalyst under light-heat synergistic activation.

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