CHAPTER ELEVEN

CO_2 photoreduction to hydrocarbons and oxygenated hydrocarbons

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11.1 Introduction

The increasing emissions of greenhouse gases (GHG) such as carbon dioxide (CO_2) in the atmosphere have caused global warming and climate change. Carbon capture and storage (CCS) such as precombustion capture, oxy-fuel process, and post-combustion capture are the methods used to reduce the effect of GHG. These strategies are usually coupled with compression and geological sequestration which are expensive and energy consuming. The reduction of CO_2 to valuable fuels or chemicals using solar energy and photocatalysts is considered as one of the promising alternatives to solve energy shortage and global warming. This artificial photosynthesis process converts CO_2 to hydrocarbons and oxygenated hydrocarbons (CH_4, CO, CH_3OH, HCOOH and others) by using photocatalyst in the presence of reductant (H_2 or H_2O) and sunlight [1]. During the CO_2 photoreduction process, multielectrons are involved, forming different products and selectivity. Photoreduction of CO_2 has drawn great attention from researchers since the foremost discovery of photoelectrocatalytic reduction of CO_2 in aqueous semiconductor suspension by Inoue et al. [2].

Photoreduction of CO_2 can be realized using different techniques including TiO_2 suspended in CO_2-saturated aqueous solution [3], TiO_2 suspended in isopropyl alcohol for high pressure CO_2 system [4], and CO_2 and H_2O in gas phase [5]. Among these methods, the gas phase conversion of CO_2 and H_2O is more favorable due to its viability, such as zero recovery of catalyst from aqueous phase and overcoming the low solubility of CO_2. In the past decades, various photocatalysts especially TiO_2 and g-C_3N_4 have been developed in different forms, such as composite [6], amorphous [7], metal-doped [8], nonmetal doped [9], morphology control [10,11], carbon-based

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