Title: Effective conversion of CO_2 to ethylene urea using zirconium-containing Mg-Al layered double hydroxide

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Abstract: Excessive emission of greenhouse gases, such as CO_2, from industries and the resulting global warming, has forced mankind to investigate the conversion of CO_2 into commercially valuable chemicals and achieve a sustainable carbon cycle. Therefore, various approaches have been used to uptake, harness, and transform CO_2 into valuable chemical compounds. In this study, novel Zr-containing Mg-Al layered double hydroxides (LDHs) with two distinct compositions, namely, Mg2AlZr LDH and MgAlZr2 LDH, were created using sol–gel technique. These compounds served as the adsorbent for CO_2 and an effective CO_2 source during ethylene urea (EU) production. The Mg2AlZr and MgAlZr2 LDHs exhibited specific surface areas of 171 and 197 m^2/g, respectively. Increasing the Zr content played a crucial role in enhancing the generation and dissemination of zirconium hydroxide in the Mg-Al LDHs, thus resulting in an augmented surface area. The synthesized Zr-containing Mg-Al LDHs demonstrated effective CO_2 adsorption capabilities. The comparative CO_2 adsorption increased from 0.62 to 0.98 mmol/g with increasing molar content of Zr. The desorption of CO_2 occurred in the 50–250 °C temperature range from pores and surfaces. EU was successfully produced by reacting the CO_2-adsorbed Zr-containing Mg-Al LDHs with ethylene diamine (EDA). The yield using MgAlZr2 LDH (0.06 mmol) was higher than that using Mg_2AlZr LDH (0.02 mmol) at 160 °C. Consequently, the synthesized Zr-containing Mg-Al LDHs exhibit promising applications as efficient CO_2 gas adsorbents, CO_2 sources for further reactions, and effective accelerators to produce valuable EU.

Keywords: CO_2 conversion Layered double hydroxides (LDHs) Zr-containing Mg-Al LDH Sol–gel synthesis CO_2 adsorption Ethylene urea (EU) production

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