Title: Effective synthesis of ethylene urea from CO_2 adsorbed cerium doped Mg–Al layered double hydroxide

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Abstract: The steady increase in CO_2 levels in the atmosphere is the leading cause of climate change and global warming and is now a global concern. To reduce the impact of CO_2, various novel routes have been proposed to capture, utilize, and convert it into valuable chemicals. In this study, a noble Ce-doped Mg–Al layered double hydroxide (Mg–Al LDH) [Mg/Al molar ratio = 3 and Ce/Al molar ratio = 0.1, 0.5, 1.0] were synthesized using co-precipitation and sol–gel method and used as an adsorbent for CO_2 gas and later on efficient source of CO_2 in the synthesis of ethylene urea (EU). The specific surface area of the Ce-doped Mg–Al LDHs prepared by sol-gel method (96.1–333 m^2/g) were higher than co-precipitation method (0.5–10.6 m^2/g). Each Ce-doped Mg–Al LDHs were successfully adsorbed CO_2, where first desorption occurred at around 50–250 °C temperature. The comparative adsorption of CO_2 was observed increase with decreasing the Ce/Al molar ratio. Adsorption of CO_2 was found to be 0.05, 0.04, 0.04 mmol/g for co-precipitation method and 0.62, 0.42, 0.37 mmol/g for sol-gel method, where Ce/Al molar ratio was 0.1, 0.5, 1.0 respectively. The EU produced from the reaction between ethylenediamine (EDA) and CO_2 adsorbed Ce-doped Mg–Al LDHs, where a comparative amount of EU was observed in the order of Ce/Al molar ratio = 1.0 > 0.5 > 0.1. According to the temperature effect, EU production was increased with an increase in temperature from 120 °C to 160 °C. At 160 °C, the production of EU by co-precipitation method was found to be 0.03, 0.04, 0.07 mmol/g and by sol-gel method was found to be 0.06, 0.07, 0.16 mmol/g, where Ce/Al molar ratio was 0.1, 0.5, 1.0 respectively. A much higher production was found in all the Ce-doped Mg–Al LDHs compared to pristine Mg–Al LDH at all the temperatures. The performance of Ce-doped Mg–Al LDHs synthesized by the sol-gel method was observed to be better than that of the co-precipitation method in terms of both adsorption of CO_2 and production of EU. In this study, Ce-doped Mg–Al LDH introduced as a successful CO_2 adsorbent, a source of CO_2 and an effective promoter in the ethylene urea production.

Keywords: Ce-doped Mg–Al layered double hydroxides (LDHs) Sol–gel synthesis Co-precipitation method Ethylene urea (EU) production

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