Supported information

Zn_xCeO_2 nanorod as active catalyst for CO_2 conversion into carbamates

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In-situ DRIFTS

DRIFTS adsorption spectra of ethanolamine and CO_2 on the catalyst surface as a function of temperature were measured using thermo Nicolet iS50 equipment, with an infrared range of 400-4000 cm^{-1}. The catalyst pellet is placed inside the IR cell, which has two windows for infrared transmission. Before the measurement, subject the pellet to a vacuum at 350°C for 2 hours to eliminate any moisture. Upon cooling to 30 °C, the IR spectra were recorded as a background reference. The vapor of ethanolamine was thereafter introduced into the IR cell via the inlet port. After analyzing the IR spectra with an increase in temperature. In a similar manner, CO_2 gas was introduced to a catalyst pellet treated with ethanolamine for CO_2 adsorption. The IR spectrum is recorded at varying temperatures.

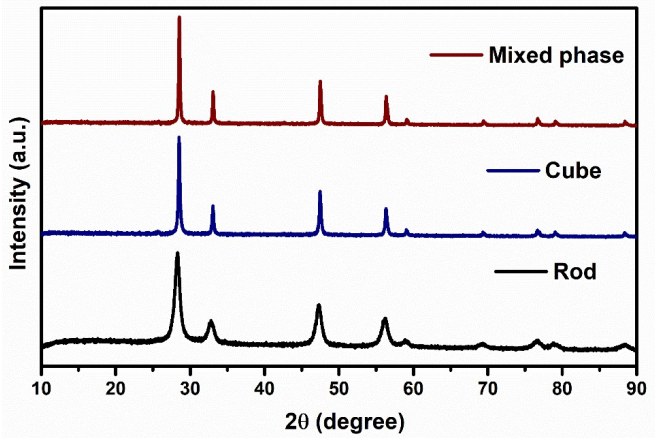

Fig. S1. XRD diffraction pattern of different morphology of CeO_2

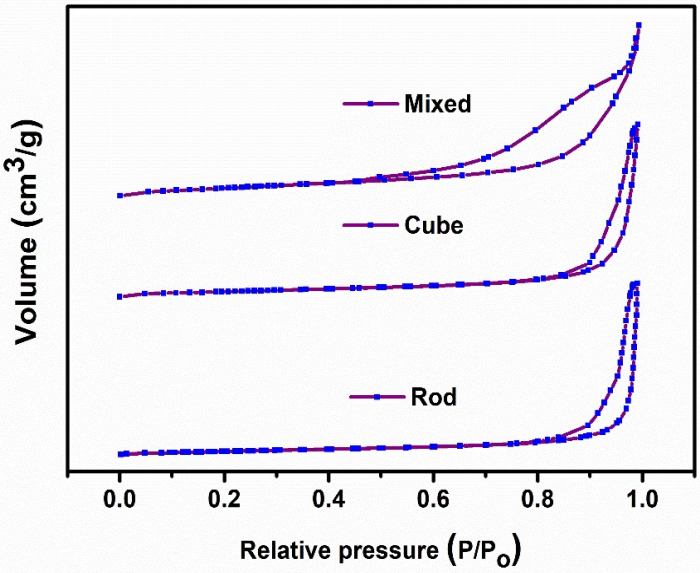

Fig. S2. N_2 adsorption-desorption isotherms of CeO_2

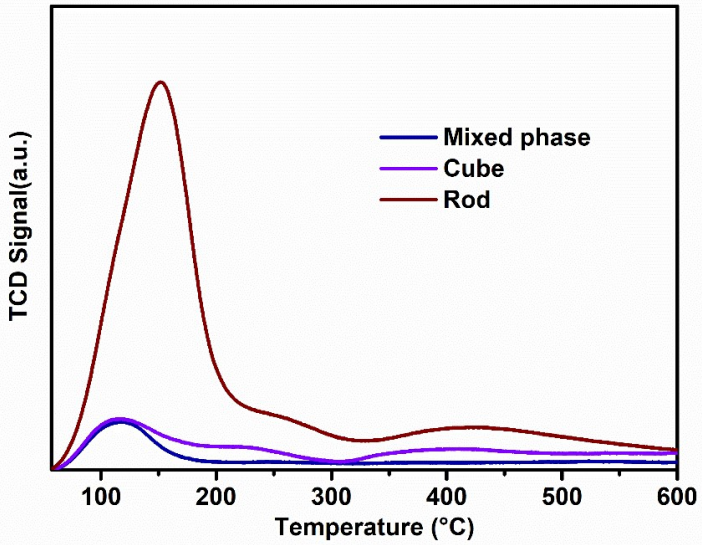

Fig. S3. CO_2 chemisorption profiles of CeO_2

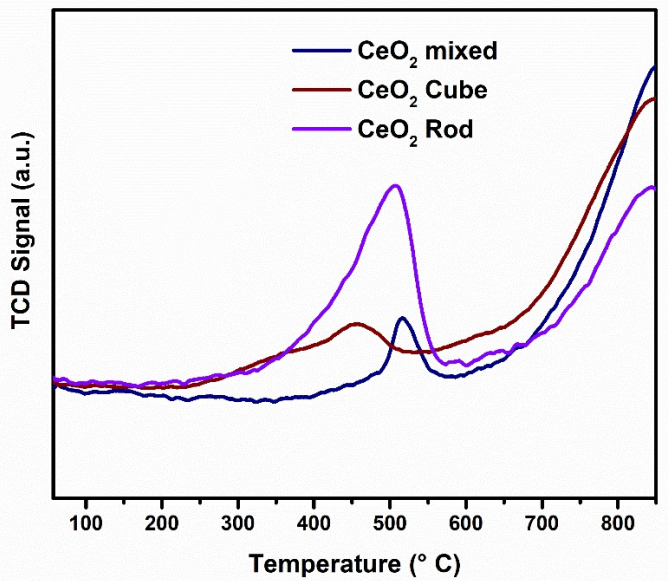

Fig. S4: H_2-TPR Profiles of CeO_2

Reusability studies

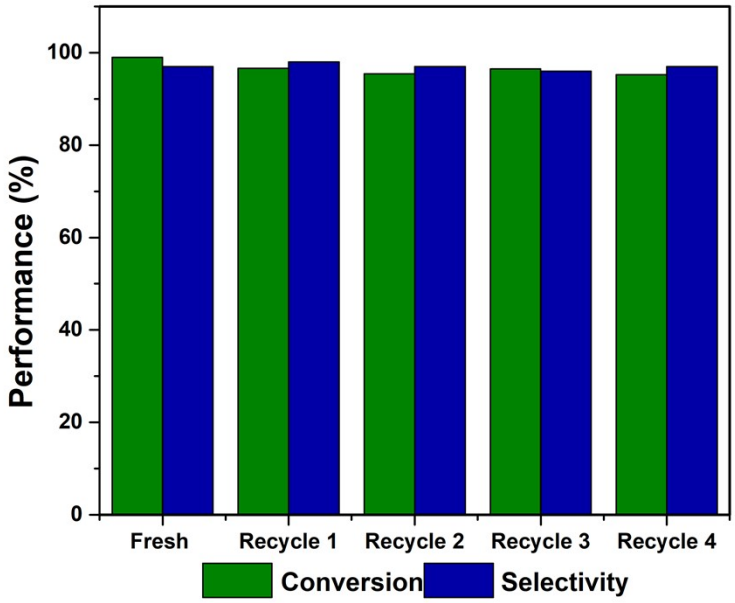

Fig. S5. a) Reusability studies; condition: 10 mmol of ethanolamine, 150 °C, 10 wt.% of catalyst, 40 ml of solvent, 35 bar CO_2 pressure, 4h.

The catalyst reusability experiments were conducted using a $Zn0.1CeO_2$ catalyst under reaction conditions of 150 °C, 35 bar CO_2 pressure, and a duration of 4 hours. The fresh catalyst exhibited an ethanolamine conversion of 99.0% and a selectivity of 97.0% for 2-oxazolidinone. After the reaction, the catalyst was recovered, washed with solvent, and dried overnight at 120 °C. To efficiently regenerate the active sites and maintain its catalytic activity in subsequent cycles, the catalyst was calcined at 600 °C. In the first reuse cycle, a slight decrease of 2.4% in ethanolamine conversion was observed, likely due to the partial deactivation of active sites that were not fully regenerated during calcination. However, the catalyst maintained stable performance up to the fourth cycle, with ethanolamine conversion remaining at 95.2% and selectivity for 2-oxazolidinone at 97.0%. These results demonstrate the excellent reusability of the $Zn_{0.1}CeO_2$ catalyst for the conversion of ethanolamine and CO_2 to 2-oxazolidinone.