

Accepted Manuscript

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PII: S0925-8388(16)33430-2

DOI: [10.1016/j.jallcom.2016.10.293](https://doi.org/10.1016/j.jallcom.2016.10.293)

Reference: JALCOM 39462

To appear in: *Journal of Alloys and Compounds*

Received Date: 1 May 2016

Revised Date: 13 September 2016

Accepted Date: 29 October 2016

Please cite this article as: P. Kumar, P. With, V.C. Srivastava, R. Gläser, I.M. Mishra, Efficient ceria-zirconium oxide catalyst for carbon dioxide conversions: Characterization, catalytic activity and thermodynamic study, *Journal of Alloys and Compounds* (2016), doi: 10.1016/j.jallcom.2016.10.293.

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Efficient ceria-zirconium oxide catalyst for carbon dioxide conversions: characterization, catalytic activity and thermodynamic study

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Abstract

In this study, ceria-zirconia based catalysts (CeO_2 , ZrO_2 and $\text{Ce}_{0.5}\text{Zr}_{0.5}\text{O}_2$) catalysts were synthesized by hydrothermal method and characterized by N_2 -sorption, X-ray diffraction (XRD), scanning electron microscopy (SEM) and transmission electron microscopy (TEM). Acidity and basicity of synthesized catalysts have been investigated by NH_3 - and CO_2 - temperature-programmed desorption (TPD). Brunauer-Emmett-Teller (BET) surface area of CeO_2 , $\text{Ce}_{0.5}\text{Zr}_{0.5}\text{O}_2$ and ZrO_2 were found to be 88, 117 and $70 \text{ m}^2 \text{ g}^{-1}$ and average crystalline sizes was 9.48, 7.09 and 9.45 nm, respectively. These catalysts were further used for direct conversion of CO_2 with methanol for the synthesis of dimethyl carbonate (DMC). DMC yield was found to be highly dependent upon the both basicity and acidity of catalysts. $\text{Ce}_{0.5}\text{Zr}_{0.5}\text{O}_2$ catalysts showed better activity as compared to CeO_2 and ZrO_2 catalyst. Effect of reaction conditions (such as catalysts dose, reaction temperature and reaction time) and catalyst reusability was studied with $\text{Ce}_{0.5}\text{Zr}_{0.5}\text{O}_2$ catalyst. The optimum operating condition for direct conversion of CO_2 into DMC at constant pressure 150 bar, reaction time=24 h, catalyst dose=1.25 g and temperature=120 °C. Moreover, chemical

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