Accepted Manuscript

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

Praveen Kumar, Patrick With, Vimal Chandra Srivastava, Roger Gläser, Indra Mani Mishra

PII: S0925-8388(16)33430-2

DOI: 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.

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

Praveen Kumar [a,c*], Patrick With[b], Vimal Chandra Srivastava[a], Roger Gläser [c], Indra Mani Mishra[a,d]

[a]Department of Chemical Engineering, Indian Institute of Technology Roorkee, Roorkee 247667, Uttarakhand, India
[b]Leibniz-Institutes für Oberflächenmodifizierung e. V. (IOM), Permoserstr. 15, D-04318 Leipzig, Germany
[c]Institute of Chemical Technology, Universität Leipzig, Linnéstraße 3, 04103 Leipzig, Germany
[d]Department of Chemical Engineering, Indian Institute of Technology (Indian School of Mines), Dhanbad - 826004, Jharkhand, India

***Corresponding Author:** Phone: +91–1332–285889; fax: +91–1332–276535. **E–mail addresses**: praveen.zon@gmail.com, praveen.singh@daad-alumni.de (P. Kumar)

Abstract

In this study, ceria-zirconia based catalysts (CeO_2, ZrO_2 and $Ce_{0.5}Zr_{0.5}O_2$) 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, $Ce_{0.5}Zr_{0.5}O_2$ and ZrO_2 were found to be 88, 117 and 70 $m^2\ g^{-1}$ 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. $Ce_{0.5}Zr_{0.5}O_2$ 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 $Ce_{0.5}Zr_{0.5}O_2$ 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