Effect of Calcination Temperature on Surface Properties of Cerium Oxide Nanorod Catalyst for Non-Reductive Conversion of Carbon Dioxide to Dimethyl Carbonate

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Abstract

Owing to increasing anthropogenic CO_2 emissions, the conversion of carbon dioxide (CO_2) into value-added chemicals *via* catalytic processes have received much concern. Among all catalytic processes, the non-reductive conversion of CO_2 with alcohols to yield dialkyl carbonate is appealing due to relatively lower energy requirement and higher value of products than those of the reductive conversion of CO_2. Cerium oxide nanorod (CeO_2-NR) has been proved highly active and selective for the non-reductive conversion of CO_2 with CH_3OH to produce dimethyl carbonate (DMC). In this study, we have prepared CeO_2-NR through the template-free hydrothermal method, and examined the effect of calcination temperature (from 300 to 700 °C) on CeO_2-NR in an attempt to correlate their surface properties with catalytic performance on DMC synthesis. It found that as the calcination temperature is increased, the crystallinity of CeO_2-NR is improved, while the specific surface area and the concentration of oxygen vacancy both reduce. Oxygen K-edge and cerium M-edge X-ray absorption near edge structure (XANES) spectra obtained at beamline BL20A reveal that the amount of oxygen vacancies and Ce(III) ions in CeO_2-NR decreases with the increase in calcination temperature. Reaction testing shows that CeO_2-NR calcined at 500 °C displays the highest DMC yield among the calcined CeO_2-NRs.

Keywords - Ceria nanorod, CO_2 adsorption, Calcination, XANES, Dimethyl carbonate