Relationship between Basicity and Activity in CO_2 hydrogenation using Mesoporous Metal Oxide Spinels

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The study of the conversion of CO_2 to other materials (e.g., CO, CH_3OH, CH_4, hydrocarbon) has been attracting great interest to many scientists. In this study, we carried out the CO_2 hydrogenation in the presence of H_2 using mesoporous bimetallic aluminum spinel oxide (i.e., $ZnAl_2O_4$, $CuAl_2O_4$, $CoAl_2O_4$, $MgAl_2O_4$) as heterogeneous catalysts. Most catalysts produced CO as the major product (> 80%). We carried out the reaction at 300 – 400 °C for each catalyst, and as a result, $CuAl_2O_4$ showed the highest CO_2 conversion. Correlating with the CO_2-TPD profiles of all catalysts, the relationship shows that the larger the amount of the strong basic site, the higher the CO_2 conversion. We suggested that the sufficiently strong basic sites could bind CO_2 efficiently. In addition, due to the high surface area of the mesopores of the catalysts, the catalyst has high catalytic activity. We obtained the activation energies of all catalysts through the Arrhenius plot. The results demonstrated that $CuAl_2O_4$ presented the lowest activation energy.