Carbon Dioxide Capture and Thermochemical Conversion to Oxygenates

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This study presents the synthesis and use of alkali nitrate salt-promoted MgO-based sorbents that exhibit good performance and excellent cyclability under high-temperature CO_2 capture. In situ TEM studies were conducted to directly observe the surface phenomenon under experimental conditions and to derive the $MgCO_3$ nucleation and formation mechanisms of the sorbents. Initially, EM-MgO sorbents were found to achieve high sorption capacities but with poor cyclability due to the rearrangement and migration of EM after multiple uses. Several techniques such as the use of stabilizers, supports, and employing a core-shell morphology were thus employed to achieve stable cyclic performances. Furthermore, the thermochemical conversion of CO_2 to oxygenates was investigated. Mechanistic and kinetic studies on a $ZnO-CeO_2$/MMT catalyst along with experimental quantification for acetic acid production were performed to demonstrate the direct conversion of CO_2 and CH_4 to acetic acid. A class of bismuth oxyhalide catalysts was also investigated for the formation of oxygenates. Lastly, the application of electric-field assisted reactions were explored for advance CO_2 capture and conversion.