Boosting Dimethyl Carbonate Production from CO_2 and Methanol using Ceria-Ionic Liquid Catalyst

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Towards our endeavor to produce sustainable aviation fuels from biomass, all carbon co-products, including biochar and carbon dioxide (CO_2) are valorized. This is crucially needed to develop circular bioeconomy systems, and attain a more sustainable future. Having achieved significant progress in biochar production, we will demonstrate our specific endeavors with the direct synthesis of dimethyl carbonate (DMC) from renewable CO_2 and methanol (MeOH) studied using CeO_2 nanoparticles modified with1-butyl-3-methylimidazolium hydrogen carbonate ([BMIm][HCO_3]) devoid of stoichiometric dehydrating agents. The synthesized CeO_2@[BMIm][HCO_3] catalyst with high thermal stability harnesses the unique physicochemical properties of CeO_2 and the ionic liquid to exhibit a DMC yield of 10.4% and a methanol conversion of 16.1% at optimal conditions (pressure of CO_2= 5 MPa; temperature = 130 °C). The catalytic behavior of CeO_2@[BMIm][HCO_3] investigated by XRD, XPS, CO_2 and NH_3-TPD, Raman spectroscopy, TGA, FTIR, SEM and TEM suggests that the synergy between the two catalytic components originating from an increased surface oxygen vacancies boosts the overall catalytic performance. After several recycling tests, the catalyst demonstrated no significant reduction in DMC yield and methanol conversion. As a crucial bulk chemical, DMC is currently produced using highly toxic phosgene or carbon monoxide. Our approach is an attractive pathway to synthesize thermally stable nanoparticle@ionic liquid that retains and merges the physical attributes of both materials for producing valuable bulk chemicals from readily available chemical resources.