AVAILABLE METHODS ENABLING CHEMICAL UTILIZATION OF ANTHROPOGENIC CO_2 FOR PRODUCTION OF CYCLIC CARBONATES USING HOMOGENEOUS NON-METALLIC CATALYSTS

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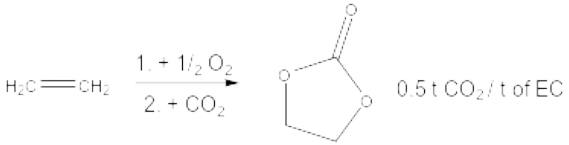
CCU technologies (CO_2 capture and utilization) has been recognized as the cost-effective way to significantly reduce worldwide greenhouse gas emissions. As mentioned North et al. have mentioned, only two reactions of CO_2: dry reforming of methane (for fuel production) and cyclic carbonate chemical production could consume up to 25% of the anthropogenic CO_2 produced annually [1]. The benignity and abundance of CO_2, which is simply available, nontoxic and nonflammable makes it a very attractive low-cost C1-synthon in organic technology.

Thermodynamically stable CO_2, however, needs activation and corresponding reactive agent for its possible fixation into the organic molecules. Three-membered heterocyclic rings such as oxiranes serve as ideal reactant for CO_2, fixation. The reaction of oxiranes and CO_2 to produce cyclic carbonates is attractive because cyclic carbonate formation is free of any side products (proceeds with 100% atom-economy, Scheme 1).



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Scheme 1. Production of ethylene carbonate consumes 500 kg of CO_2 per ton of product.

Cyclic carbonates are applied for polymer production, dialkyl carbonated production, as electrolytes in lithium-ion batteries, polar aprotic (ethylene or propylene carbonate) or protic solvents (glycerol carbonate, etc.) and as chemical intermediates in organic fine chemicals production. We will present in our communication that recent development of homogeneous organocatalysts facilitates performance of CO_2 cycloaddition with terminal epoxides even at CO_2 pressures of 1 bar and reaction temperatures less than around 50 °C.

References:

1. Guo, L.; Lamb, K.J.; North, M. Recent developments in organocatalyzed transformations of epoxides and carbon dioxide into cyclic carbonates. Green Chem. 2021, 23, 77-118. DOI: 10.1039/d0gc03465g.