Catalytic Continuous-flow Cyclic Carbonate Synthesis with Gaseous and Supercritical CO_2

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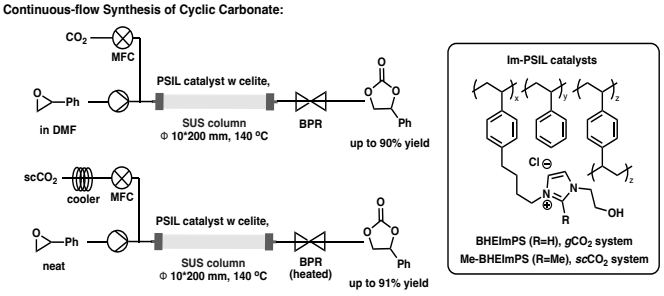
CO_2, a common waste gas massively emitted in industrial and agricultural production as well as daily activity, is on the other hand counted as the most ideal and valuable C1 source for the production of organic chemicals as well. Recently, Carbon Capture and Utilization (CCU), as a significant strategy with large-scale emission reduction potential to achieve the goal of carbon neutrality, has been developed worldwide. Notably, supercritical CO_2 ($scCO_2$) exhibits characteristics which make it widely utilized in organic synthesis, especially CO_2 conversions where it can function as both reactant and solvent. As well as nontoxicity and incombustibility, both its high thermal conductivity enabling systems free from the interference from reaction heat and the powerful capability on mass transfer ascribed to its low viscosity in porous solid catalysts consequently make it surpass conventional organic solvents.[1,2] As one of well-developed applications, the synthesis of cyclic carbonates from epoxides has drawn increasing interest due to their promising industrial uses, such as aprotic polar solvents, benign intermediates for polymer synthesis, etc. In view of high energy barriers of the reaction between CO_2 and epoxides, efficient catalyst design allowing the activation of cycloaddition is the essence of the work. Polymer-supported ionic liquids (PSILs), with exceptional chemical stability, designability and unique catalytic ability, have been testified efficient on cyclic carbonate synthesis by facilitating both the capture and activation of epoxides, and synergistical ring-opening process.

In this study, we utilized a series of PSIL catalysts in a continuous-flow cyclization of epoxides with CO_2. We synthesized variously substituted imidazolium polymers using polystyrene with a 4-bromobutyl linker. Among them, resins bearing hydroxyethyl group proved to be beneficial for the reaction to attain high yields. Based on those findings, we further modified the structure to obtain the optimal catalysts, guaranteeing continuous 90% and 91% yields under gaseous and supercritical CO_2 conditions. In the presentation, we will discuss the latest progress of this research project.



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