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Supported Ionic Liquid Phase: A New Frontier in CO_2-Based Cyclic Carbonate Synthesis

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The increasing burning of non-renewable fossil fuels significantly impacts CO_2 emissions, worsening global warming[1]. To mitigate this, research focuses on sustainable CO_2 utilization, such as converting CO_2 into cyclic carbonates, which are valuable for producing polymers, battery electrolytes solvents. Synthesizing cyclic carbonates from CO_2 and epoxides is attractive for converting greenhouse gases into useful products[2]. Ionic Liquids (ILs) are of great interest due to their CO_2 absorption capacity, chemical stability, and tunable properties, making them potential catalysts or co-catalysts in CO2 conversion[3]. This work proposes investigating Supported Ionic Liquid Phase (SILP) catalysts for converting epoxides into cyclic carbonates under mild reaction conditions. The catalysts studied include trichlorozincate of 1-methyl-3-(3-(trimethoxysilyl)propyl)imidazolium, supported on Al_2O_3, and characterized using techniques such as Nuclear Magnetic Resonance (NMR), scanning electron microscopy (SEM), and thermal analysis. The catalytic performance of the SILP-$ZnCl_3^-$ catalyst was thoroughly evaluated, as shown in the image below. It was observed that epoxides containing electron-withdrawing atoms in their structure yielded the best results, with epichlorohydrin achieving 100% conversion. Additionally, bulkier epoxides such as 2-(phenoxy methyl)oxirane and 2-((o-tolyl oxy)methyl)oxirane demonstrated conversion rates close to 90%. Small epoxides, such as propylene oxide and 1,2-epoxybutane, also showed good results. Conversely, epoxides without electron-withdrawing effects exhibited low conversion values, exemplified by tert-butyl glycidyl ether, which reached around 30% conversion. Despite this, both catalysts maintained high selectivity for cyclic carbonate production. However, despite these variations in conversion rates, the catalyst maintained high selectivity for cyclic carbonate production, underscoring their potential for practical applications. The study provides valuable insights into the design and application of SILP catalysts for CO_2 fixation, contributing to the development of sustainable chemical processes that leverage waste CO_2 as a raw material for producing high-value chemicals.

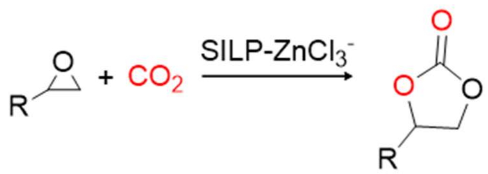

Figure 1. CO_2 fixation reaction in epoxide for epoxide formation.

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