Development of Heterogeneous Catalysts for the Synthesis of Cyclic Carbonates from Carbon Dioxide and Epoxides

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Carbon dioxide being the major greenhouse gas formed by human activities, its capture and utilization is highly required. Several technologies are being proposed for the capture and utilization of carbon dioxide. However its high thermodynamic stability makes its conversion very difficult. Hence, catalyst aided conversion of carbon dioxide to value added products are of high relevance. For instance, the synthesis of cyclic carbonate from epoxide and carbon dioxide helps avoid the use of toxic gases like phosgene or CO and at the same time represents an ideal atom-economic process. Cyclic carbonate find uses as solvents, electrolytes in lithium-ion batteries, precursors for polycarbonates and other polymeric materials, as green solvents, as chemical intermediates and pharmaceuticals.

In the past, several homogeneous catalysts such as quaternary ammonium salts, metal halides, and metal complexes were reported to be efficient in the synthesis of cyclic carbonates. However, the difficulty associated with the catalyst recyclability demands highly efficient heterogeneous catalysts. Many heterogeneous catalysts such as metal oxides, zeolites, titanosilicates and ion-exchanged resins are developed with the necessity of harsh reaction conditions. Over the past few years many groups including ours have been focused on the cycloaddition reaction of CO_2 with epoxides using ionic liquid supported materials such as silica, polystyrene and biopolymers [2]. Even though they are catalytically active, leaching of active species is very common. Very recently metal organic frameworks are emerging as new catalysts for this conversion [3-5].

Metal Organic Frameworks (MOFs) are a class of porous crystalline organic-inorganic hybrids that extends in 1-, 2- or 3-D. Characteristic properties of MOFs include accessible pore volumes, ordered pores, high internal surface area, high adsorption capacity, diverse means of functionalization etc. MOFs are excellent materials for gas storage and separation such as methane, hydrogen, CO_2 etc. [6]. Whereas methane and hydrogen are used as fuels, the post-capture treatment of CO_2 (such as sequestration) may require extra burden of desorption. By employing MOFs as catalyst for CO_2 transformation, this could be circumvented.

This lecture discusses the recent advancements in MOF catalysts for cyclic carbonate synthesis.

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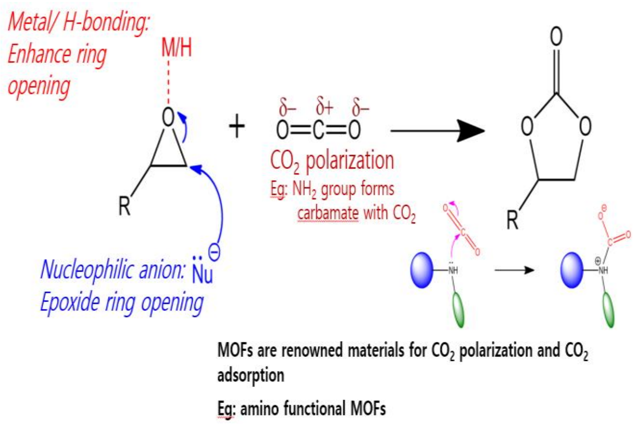

Fig.1. Conversion of CO_2 to cyclic carbonates.