Conversion of propylene oxide to cyclic propylene carbonate in CO_2 over heterogeneous catalysts

Daeho Kim, and Kyungsu Na*
Department of Chemistry, Chonnam National University, Gwangju, Republic of Korea

*E-mail: kyungsu_na@chonnam.ac.kr

CO_2 is the one of the most representative greenhouse gases that can cause increase of average temperature of earth [1]. In order to remove CO_2 from the atmosphere, ultimate solution is utilization of CO_2 to other value added chemicals with input of less energy [2]. Many catalytic pathways that can convert CO_2 to other chemicals were reported, but such routes were inhibited due to low reactivity of CO_2 and high input of energy to the reaction system that can increase the capital cost for CO_2 conversion. Instead of sole conversion of CO_2 without any other reagents in the reaction system, reaction with other reactive chemicals can be a possible candidate for effective CO_2 conversion. One representative example is production of cyclic carbonates from the reaction between epoxide and CO_2 [1-2]. More specifically, propylene oxide (PO) can react with CO_2 to produce cyclic propylene carbonate (CPC) over the catalysts [3]. The resultant CPC can be used as aprotic polar solvents, electrolytes, polymer precursors and intermediates for producing pharmaceuticals [4-6], which are much more valuable than the worth of PO and CO_2.

It was reported that the mixture of quaternary ammonium halide with metal salt having Lewis acidity can effectively convert PO to CPC in the presence of CO_2. However, this catalyst structure is a form of homogeneous catalyst that is difficult to handle and recycle. Nanostructured materials having similar catalytic functions are also reported, and they can be used as heterogeneous catalyst [7]. However, as compared with the reports on homogeneous catalysts, less studies on the heterogeneous catalysts were reported so far. In this presentation, heterogenization of homogeneous catalyst containing same catalytic functions in quaternary ammonium halide with metal salts has been investigated. For this purpose, the hexagonally ordered mesoporous silica, SBA-15, was used for the platform that can accommodate two catalytic functions addressed above. In order to investigate the catalytic behavior in detail, type of halide in ammonium and aluminum content on the mesopores wall were varied in the resultant catalyst structure. The materials obtained were characterized with X-ray diffraction, elemental analysis, thermogravimetric analysis and infrared spectroscopy. The catalytic performance of the series of resultant catalytic materials were investigated in the liquid phase batch reaction between PO and CO_2 for the production of CPC, with variation of temperature, pressure and solvent [Fig. 1]. The details of synthesis and catalytic reaction studies will be discussed in this presentation.

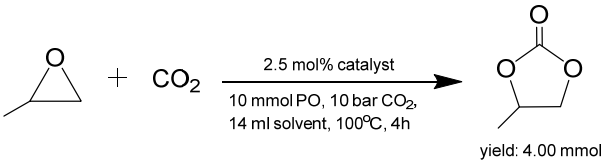

Fig. 1 Reaction scheme and the yield of cyclic propylene carbonate over the catalyst.

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