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Review article

Ionic liquid as a catalyst for utilization of carbon dioxide to production of linear and cyclic carbonate

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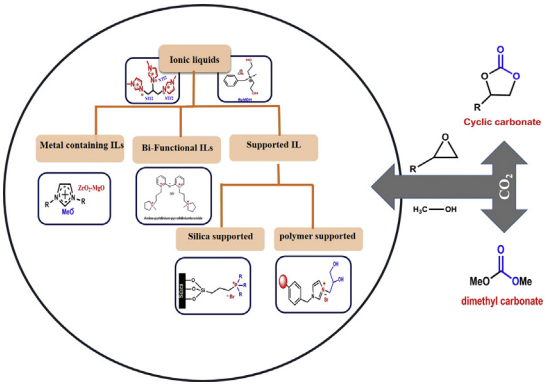
GRAPHICAL ABSTRACT



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ABSTRACT

In this review, primary focus on the ionic liquid (IL) catalysts and related catalytic systems for utilization of carbon dioxide to a production of linear as well as cyclic carbonate, and describes the innovative progress observed during last ten years. This review covers trend of various catalysts starting from first conventional ILs (tetrabutylammonium bromide and imidazolium IL) to the latest metal containing IL systems employed for the efficient production of dimethyl carbonate. Moreover, recent advances in DMC production also summarizes using the catalysts which contain novel super base facilitated tricationic IL systems. Similarly, cyclic carbonate synthesis reveals the benefits of using IL based catalyst on the verity of different supporting materials such as alumina, silica, carbon nanotubes, magnetic nanoparticles, poly(ethylene glycol), polystyrene, cellulose, and chitosan. The summary of ammonium, phosphonium and both functionalized and unfunctionalized imidazolium salts indicates that the turnover frequency for epoxide and propylene oxide enhances under mild reaction condition. Overall, it is clear that metal ions or super base in the combination of ILs can improve the conversions and the presence of hydroxyl, carboxyl, and other functional groups will enhance the yield multiple folds through hydrogen bonding interaction.

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1. Introduction

In recent years, ionic liquids have been widely used in catalysis [1], electrochemistry [2] and fuel cell [3] applications. As well as its valuable chemical and physical properties of solvents, reagents and catalysts have been establishing massive growth to these fields. Therefore, IL research area is being interesting and has challenging growth in developing greenery catalysts, wherein it exposes their promising advantage by presenting specific properties such as high-temperature stability, viscosity, density, solubility, coordination and acidic properties [4,5]. Moreover, it catalytic properties can tune according to the reaction by easily carrying metathesis with various types of cationic and anionic salts [5,6]. The combination of wide variety of cations and anions leads to a theoretically possible number of 1018 ILs, which can extend more opportunities in designing and optimizing most suitable catalyst and catalytic process [7]. Consequently, IL research has been existing a bridge for development and implantation in many fields of industrials such as application in lubricant, electrolyte, solar cells, electroplating and biomass processing.

Recent development in IL is trend to use as a superior dehydrating agent and catalyst in CO_2 utilization process because CO_2 reduction is essential to consider the global climate are changing concern to the temperature and continuously increasing atmospheric carbon dioxide [8,9]. Thus, efficient capture and utilization of atmospheric carbon dioxide (CO_2) to the value-added chemicals is the best way to take the initiative in diminishing global warming. Interestingly, literature finding related to CO_2 absorption and utilization indicates that the ionic liquids (IL) are favorable liquid phase media for significant CO_2 solubility thereby it has a potential to become a suitable medium for discovering new chemistry of CO_2 [10,11] (Fig. 1). Predominantly the mono-cationic, di-cationic and tri-cationic IL can effectually establish the CO_2 concentration in liquid media and its variation to bi-functional and multi-function

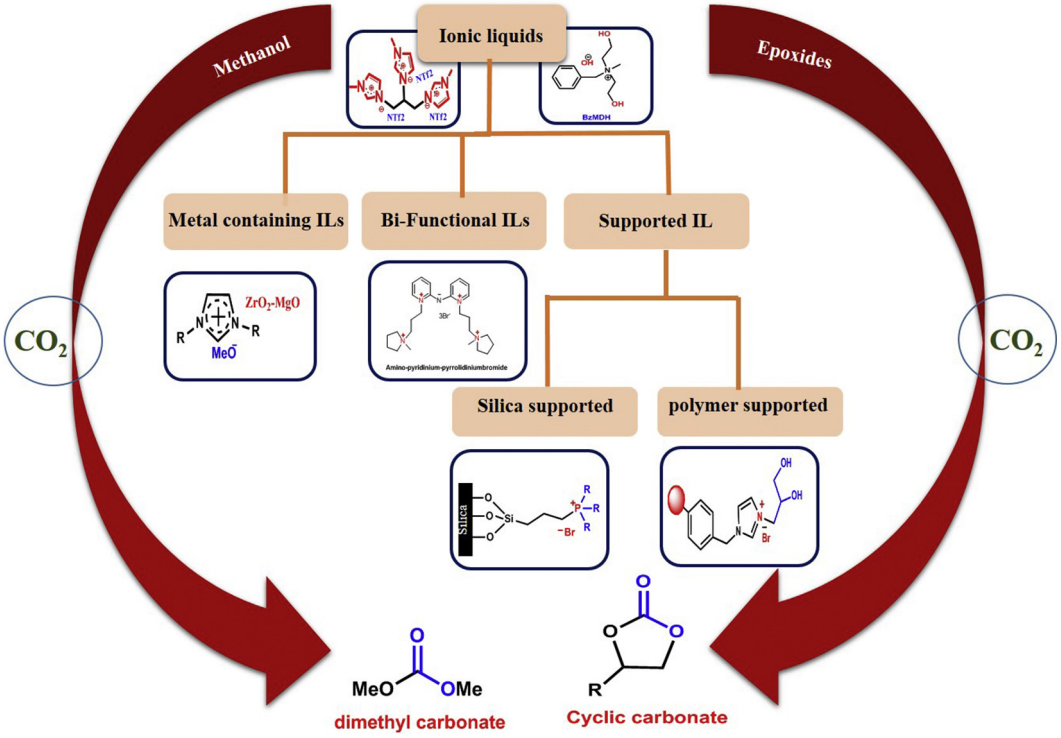

Fig. 1. General Ionic liquids classification for synthesis of linear and cyclic carbonate.