

Capture and Separation, the First Step toward Circular Economy; a Regenerable, Bio-Based, Polymerized, Ionic Liquid Membranes

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B.15 CO₂ Capture and Separation, the First Step toward Circular Economy; a Regenerable, Bio-Based, Polymerized, Ionic Liquid Membranes

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Air can be considered as a source of CO₂, with concentrations of approximately 408 ppm reported in 2018 and predicted levels expected to reach 600–1550 ppm in 2030. Direct air capture (DAC) from the atmosphere is considered as a CO₂ separation technology that can be realized and a source of CO₂ exploitable as building block for utilization. The use of solid amines for CO₂ adsorption following a two-steps process: the adsorption of CO₂ from the direct air and the separation of CO₂ from the sorbent. The separation of CO₂ from amines is relatively easier than from strong liquid bases as it requires less energy due to the weaker bonds between CO₂ and the solid sorbent. The benefit of the DAC technology is that it can be implemented anywhere because of the fast mixing of CO₂ in the air. However this technique rely on the preparation of amine sorbed on solid inorganic substrate such as silica substrate and even if durable are quite difficult to regenerate once spent. Our substrate is based on polymerized ionic liquid that use as functional amino acid anions as active sorbent.

Ionic liquids (ILs) are organic salts that melts below 100°C been studied as innovative material for CO₂ capture. Polymerized ionic liquids (PILs) merge ILs and macromolecules peculiarities resulting in a novel class of material that features high tunability and ionic exchange ability as well as easier handling, processability typical of polymer. PILs have been studied for gas separation and demonstrated, higher CO₂ loading than common ILs, as well as faster absorption/desorption rate. However, despite the chemical absorption of CO₂ in ILs is a well-established concept divided as capture by chemisorption or by physisorption in PILs the majority of the studies focus on material without CO₂ reactive species and no explicit reference to chemical nor physical sorption materials.

Different PILs with amino acid anions were developed and tested for CO₂ absorption in solid phase. The research on PILs aimed to explore different AA anions as well as different polymeric structures. Ionic exchange procedures were tuned depending on the solubility property of the starting PIL with several AA. All synthetic procedures aimed to avoid toxic and hazardous chemicals. Obtained PILs were identified and were tested for CO₂ and water absorption and desorption.