Mimicking Nature using immobilized Rubisco on polyethyleneimine/dopamine codeposited membranes for CO2 capture and conversion

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CO2 capture and valorization is an emerging need to achieve reduction of global CO2 emissions. Using amine-based solvents to capture post-combustion CO2 gas leads to energy intensive processes and use of toxic solvents. Benign water-based solvents are an attractive alternative to avoid additional environmental concerns [1]. Despite the poorer performance of water-based solvents compared to amine-based solvents, the incorporation of enzymes have shown improvements in its CO2 capture performance [2]. In this work, the enzyme ribulose-1,5-biphosphate carboxylase/oxygenase or Rubisco is proposed as the biocatalyst to facilitate the conversion of CO2 into high-value products. This enzyme is responsible for converting inorganic CO2 into organic acid during photosynthesis. However, in spite of being the most abundant enzyme in Nature, it has a slow turnover rate and poor CO2/O2 specificity [3]. In addition, its application can be limited by its short service life. In this study, Rubisco is covalently immobilized on porous membranes to improve its stability. Dopamine (DA) and polyethyleneimine (PEI) were used for surface modification to improve enzyme compatibility, while glutaraldehyde was used for covalent immobilization on the coated membrane. The effect of coated membrane on retained enzyme activity, reusability, storage stability and CO2 conversion performance were investigated. Initial SEM results confirmed successful coating on the porous membranes using DA and PEI. On the other hand, the presence of new peaks at 1500-1800 cm-1 and 2800-3750 cm-1 in ATR-FTIR spectra confirm the presence of the DA/PEI coating and Rubisco immobilization, respectively. With this study, preliminary steps are taken in exploring the potential of biocatalytic membrane contactors for CO2 valorization into organic compounds.

References

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