Novel electrosynthetic pathways to ethylene glycol, acrylic, adipic and glycolic acids: CO_2 based C_2-C_6 building blocks for sustainable polymers

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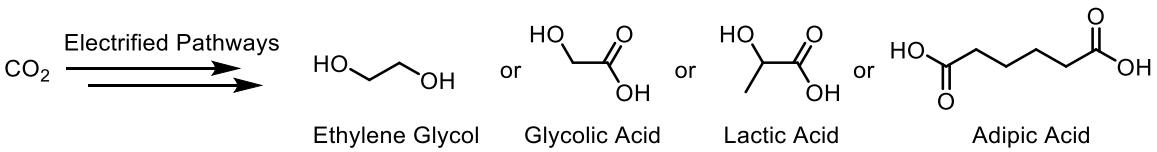
Plastic production plays a crucial role in the modern society, with a staggering amount of 400 Mt of plastics produced annually. [1] The vast majority of industrially relevant monomers are derived from fossil feedstocks, and the production of monomers is associated with substantial greenhouse gas emissions (e.g., adipic acid 4.5 kg CO_2-e/kg; ethylene glycol up to 4.7 kg CO_2-e/kg).[2, 3] Production of bulk monomers from captured CO_2 using electrified conversion paths would thus open a possibility to reduce carbon footprint of plastics production.

At VTT, we have recently considered electrosynthetic coupling of CO_2 and/or CO_2-derived C_1-C_2 building blocks (Scheme 1). Under industrially relevant current densities, we have achieved electrosynthesis of MEG in a multigram scale with batch and continuous flow electrolysis processes.[4–5] The impact of electrodes, supporting electrolyte, additives, and reaction conditions on current efficiency and conversions have been systemically studied using DoE approach. Our recent studies with electrified pathways towards glycolic acid, adipic acid, and *rac*-lactic will be also discussed.[6] The latter is a known progenitor to acrylic acid monomer.



Scheme 1. Electrified pathways from CO_2 to various monomers.

This work highlights the broad spectrum of possibilities of electrosynthetic coupling of CO_2 with C_1-C_2 building blocks to produce value added monomers. Technoeconomic analysis of the selected transformations, as well as further research questions pertaining to technology maturation, integration with point source or DAC capture processes will be discussed in the presentation.

REFERENCES

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