

Production of Succinic and Adipic Acids from CO₂ and Ethylene via Electrochemical Carboxylation

Valtteri Oksanen, Tom Wirtanen, Alexander Reznichenko,

valtteri.oksanen@vtt.fi

VTT Technical Research Centre of Finland Ltd.

Box 1000, FI-02044, Espoo, Finland

Adipic acid (AA) and succinic acid (SA) are key building blocks for various polymers. However, their conventional synthesis routes rely heavily on fossil resources, and it has been estimated that greenhouse gases are emitted up to 8 tons of CO₂ equiv. per ton of AA, and 1.9 tons of CO₂ per ton of SA. [1] Recent advances in electrosynthesis have demonstrated sustainable pathways for synthesis of several carboxylic acids, allowing utilization of captured CO₂ for reduced carbon footprint monomers. [2,3]

Herein, we present our recent developments for electrosynthetic pathway for conversion of CO₂ and ethylene towards succinic and adipic acids. [4,5] Employing machine learning for reaction condition optimization substantially enhanced SA and AA current efficiencies vs. previous examples. Sustainability of processes was further improved by replacing sacrificial anodes with stable anode materials. Furthermore, the preliminary techno-economic analysis highlights the potential of the reaction, and future research directions, for cost competitive industrial production.

References

- [1] M. Smidt, J. Den Hollander, H. Bosch, Y. Xiang, M. Van Der Graaf, A. Lambin, J. P. Duda, *Sustainability Assessment of Renewables-Based Products: Methods and Case Studies* **2015**, 307–321.
- [2] H. Senboku, A. Katayama, *Curr. Opin. Green Sustain. Chem.* **2017**, 3, 50–54.
- [3] V. Oksanen, K. Malinen, T. Wirtanen, *RSC Adv.* **2025**, 15, 45724–45728.
- [4] V. Oksanen, T. Wirtanen, Priority filing, Finnish patent application No. 20253886
- [5] V. Oksanen, M. Luukkonen, K. Malinen, N. Heikkinen, A. Reznichenko, T. Wirtanen, Manuscript in Preparation