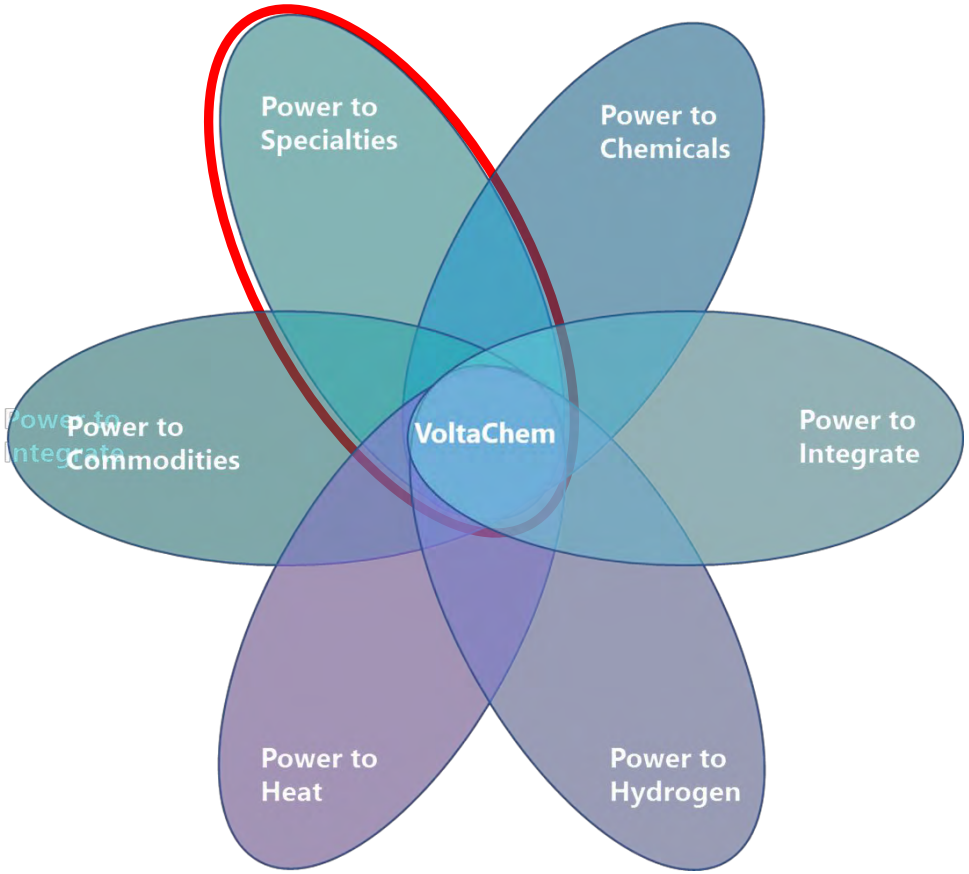
VOLTA CHEM

Sustainable Electrification of the Chemical Industry

Challenges and advances in organic electrosynthesis: combining building blocks in electrochemical reactions.

Dr. Amanda Garcia

Powered by: TNO innovation for life ECN

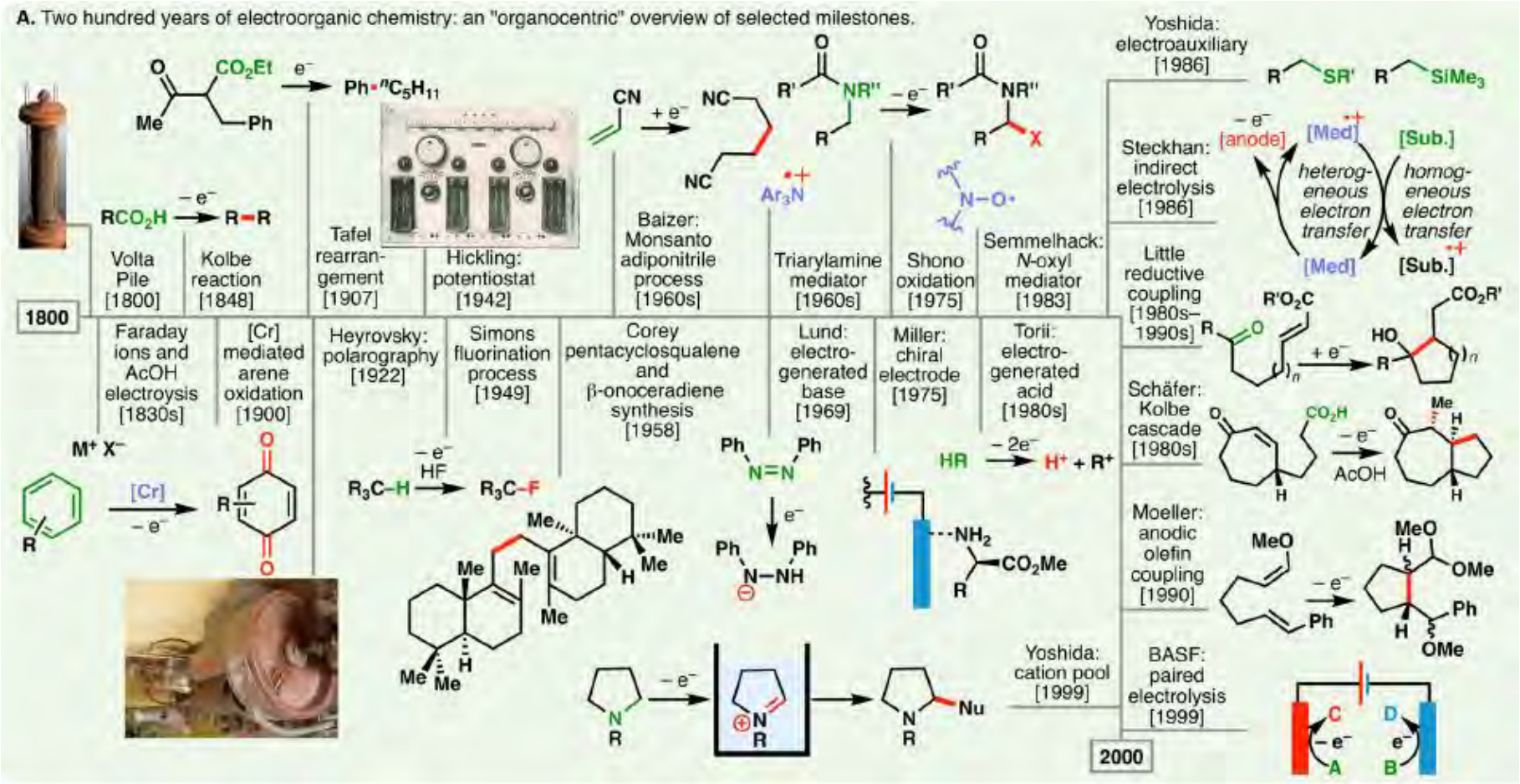


- Power to Specialties:

Focus on bio-based feedstocks

Expanding toolbox with C-C coupling, electro-amination, electro-hydroformylation, electro-conversion of sugars.

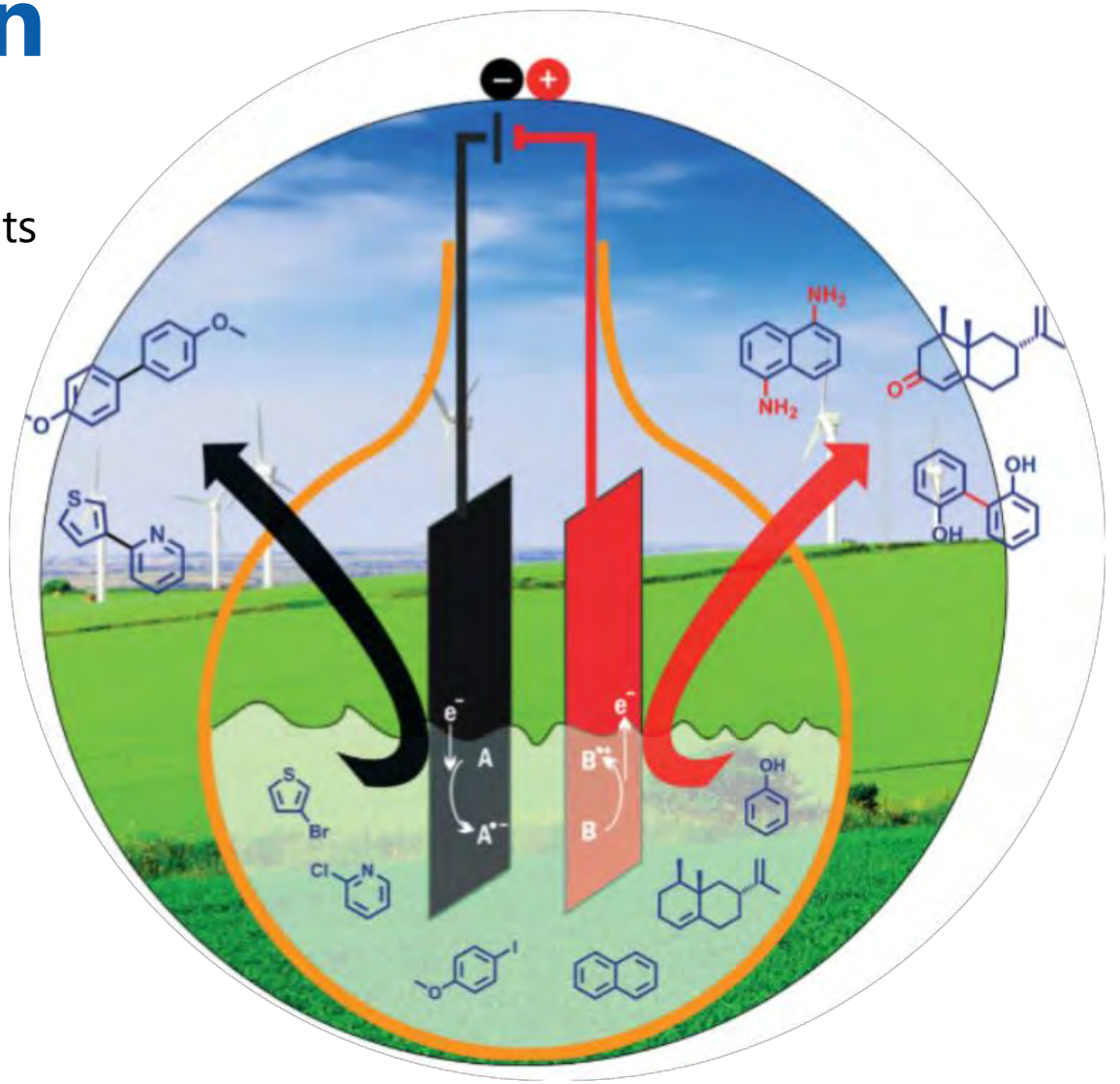
Electro-organic synthesis – State of the art



Electrochemical production

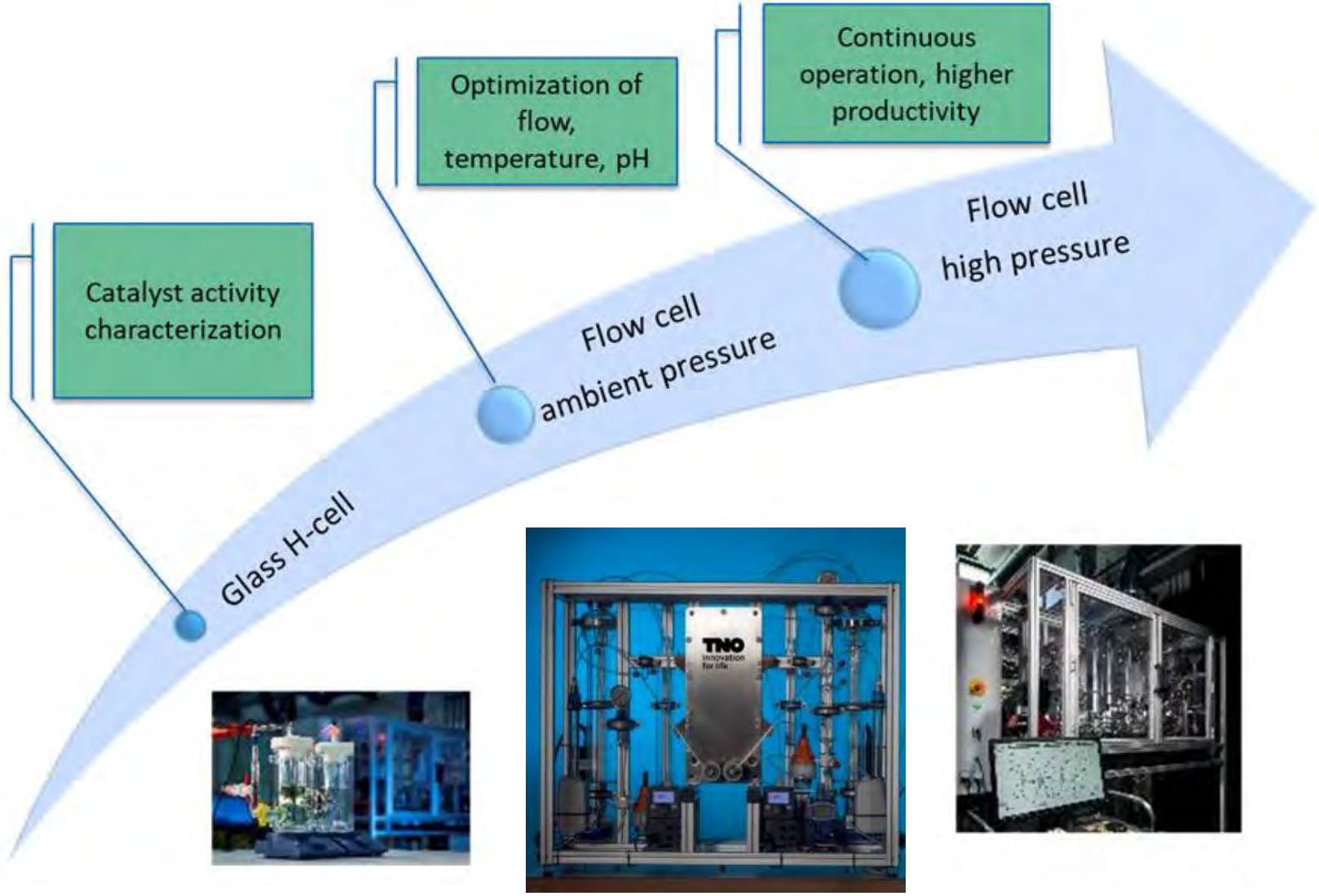
- Replace of conventional chemical oxidizing or reducing agents by electric current
- Renewable and safe technology
- No reagent waste
- Reactivity can be tuned by changing the applied potential
- Easily scalable to the industrial level
- Provides high selectivity in mild conditions

- Still considered a specialist topic
- Reaction mechanisms are often complex
- Requires equipment that often is not available in organic lab
- Requires more fundamental understanding



Angew.Chem. Int. Ed. 2018, 57,5594 –5619

Focus on development and scale-up



Our tool box

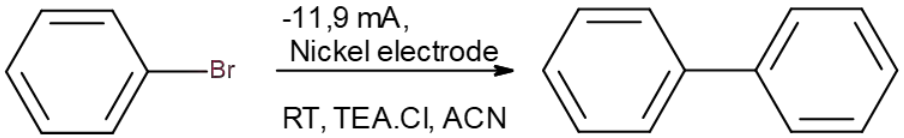
Arylation Reaction

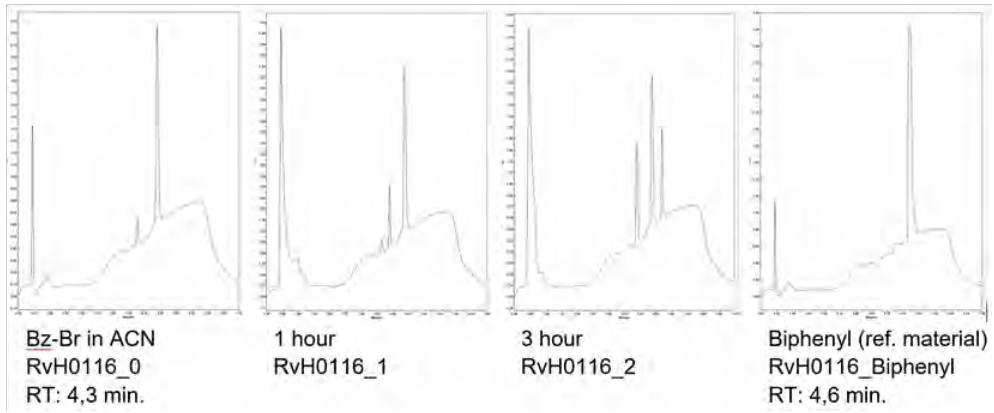
1

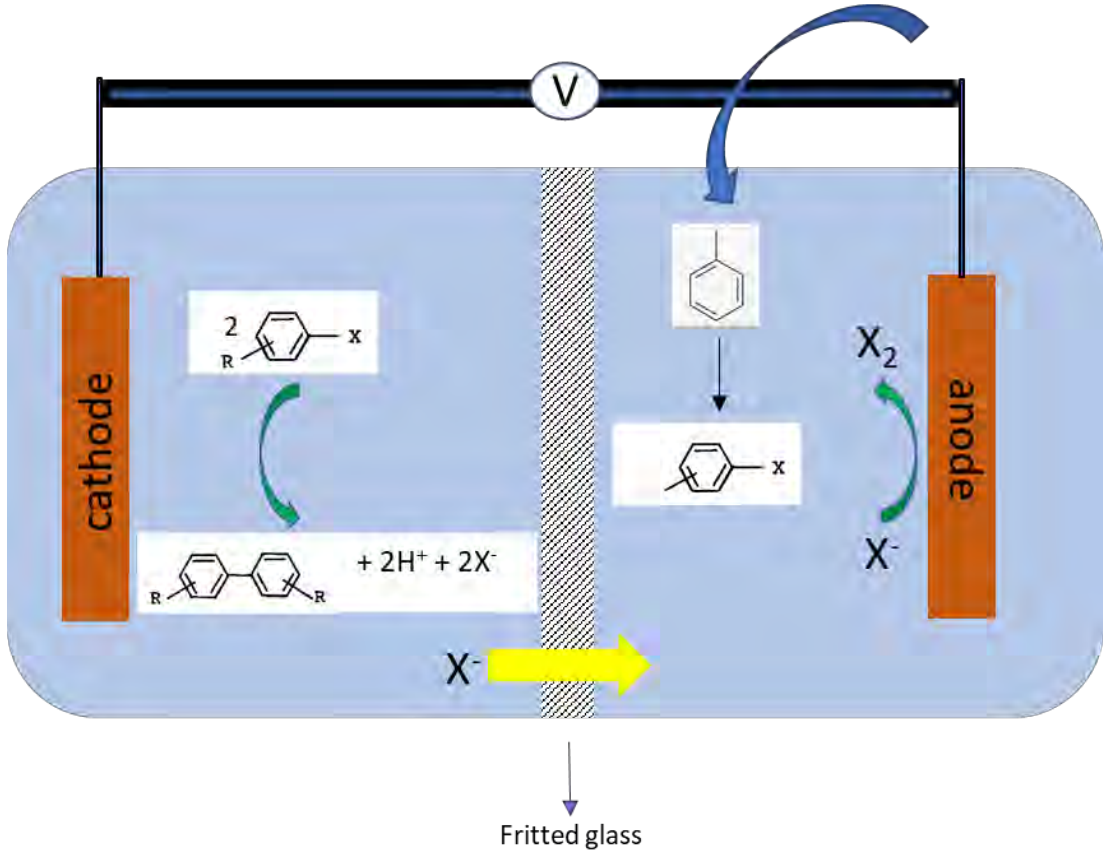
2

X = leaving functionality or H

extended π system facilitated conversion

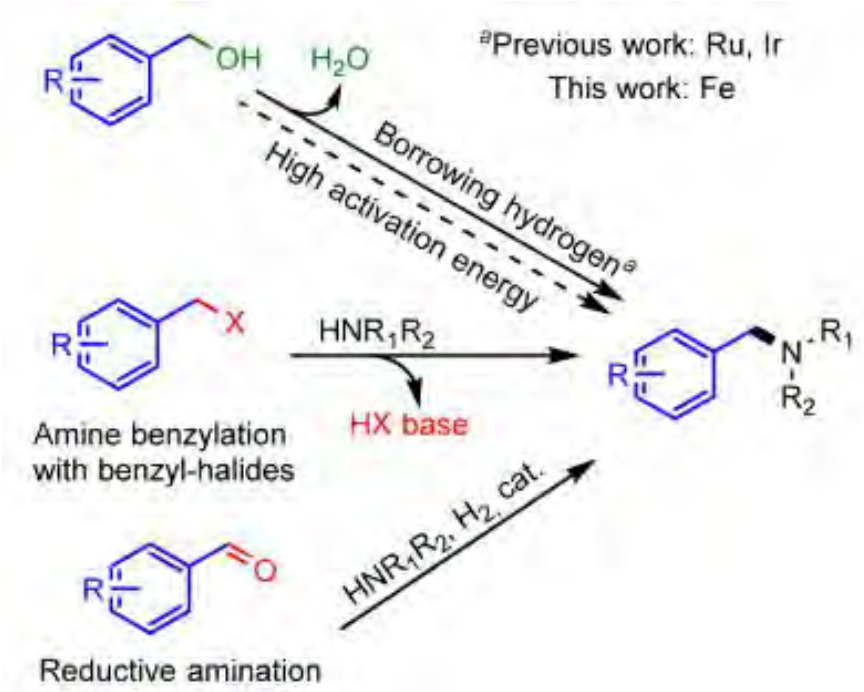


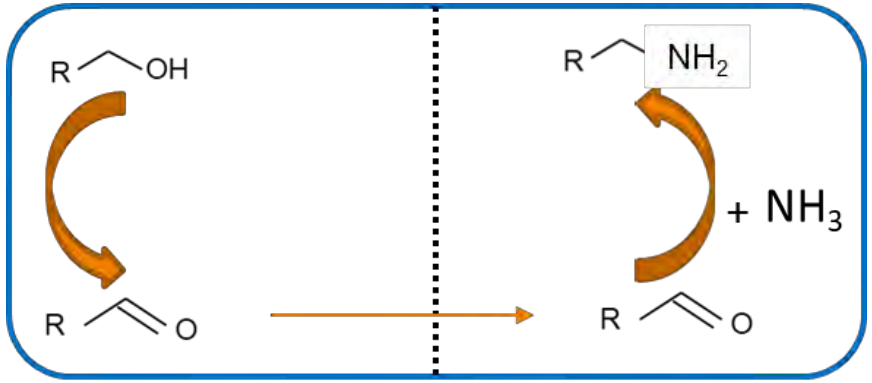


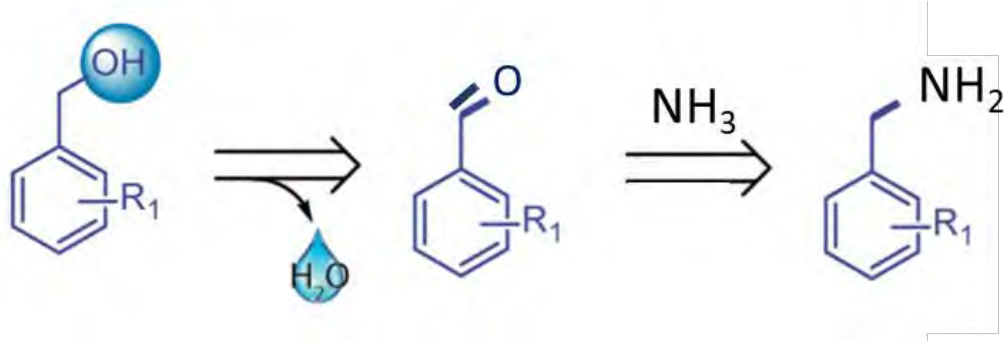


Chem. Rev. 2018, 118, 6706−6765

Electroamination of benzyl alcohols



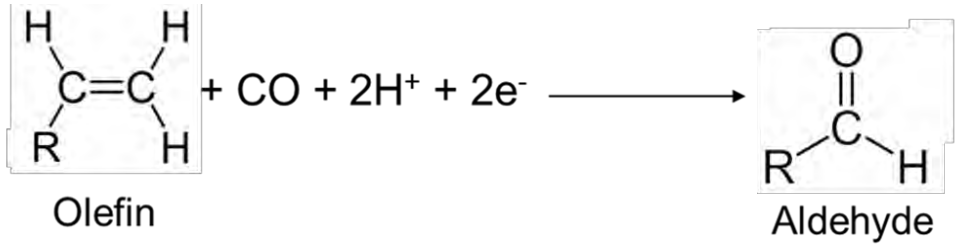




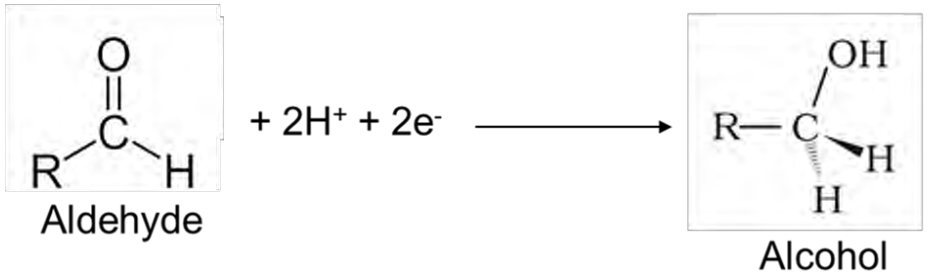
Applications

- Pharmaceutical active compounds
- Rivastigmine for treating dementia due Parkinson
- Drugs to reduce cholesterol

Electrohydroformylation Reaction



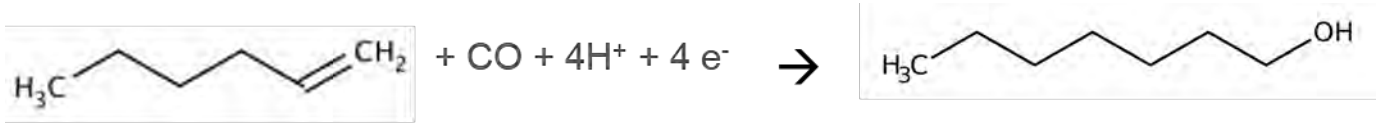
Olefin Aldehyde



Aldehyde Alcohol

- High demand in industry for linear alcohols as well as linear aldehydes
- large availability of 1-alkene from the petrochemical industry
- the large increase in production of plastics
- industrially useful compounds produced by hydroformylation (long carbon chain alcohols (detergents))

Hexene to Heptanol in organic solvent using Cu electrode



Electrochemical C-C coupling

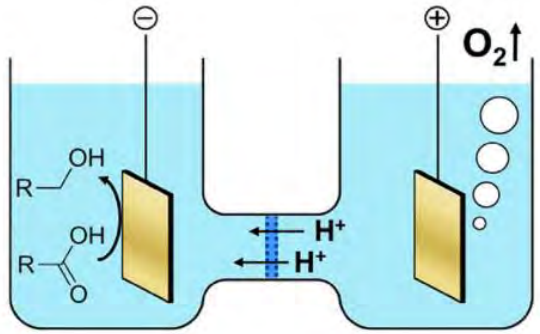
Dimerization reaction for production of tartaric acid

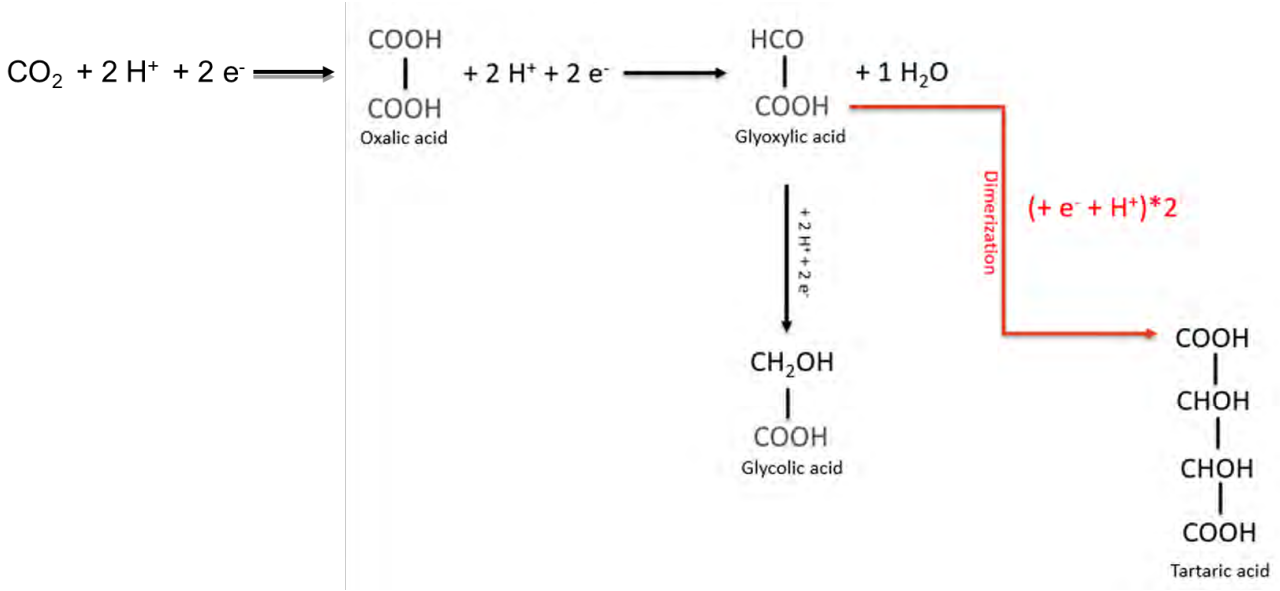
Conventional production

- TTA is industrially produced by bacterial fermentation of glucose or oxidation of carbohydrates.
- Low yield

Electrochemical production

- Selective reduction on Ag and Pb electrode at ambient conditions
- High yield

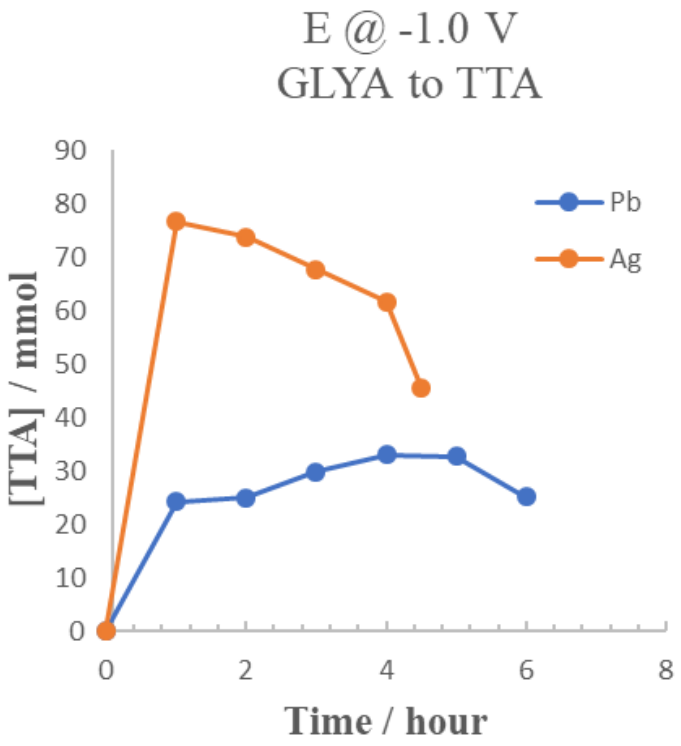


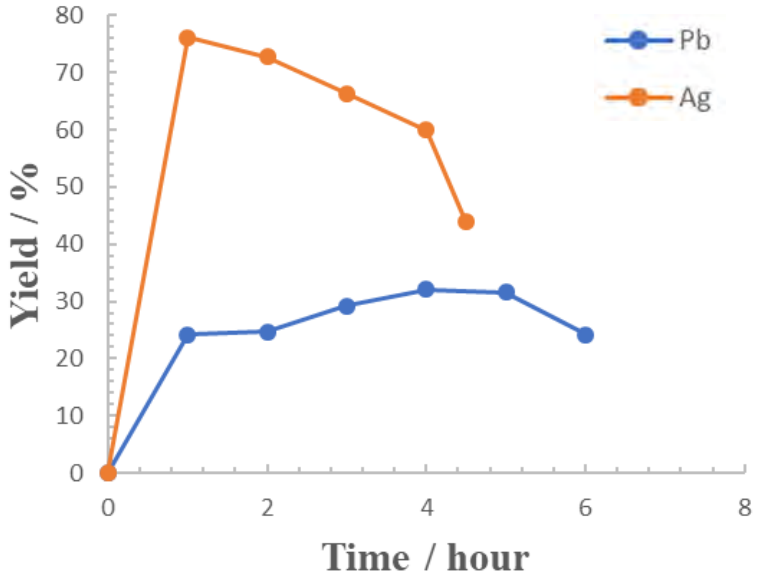


Electrochemical reduction of CO_2 to C_n products

Electrodimerization reaction

Electrochemical Reduction of GLYA to TTA in aqueous solvent on Pb and Ag

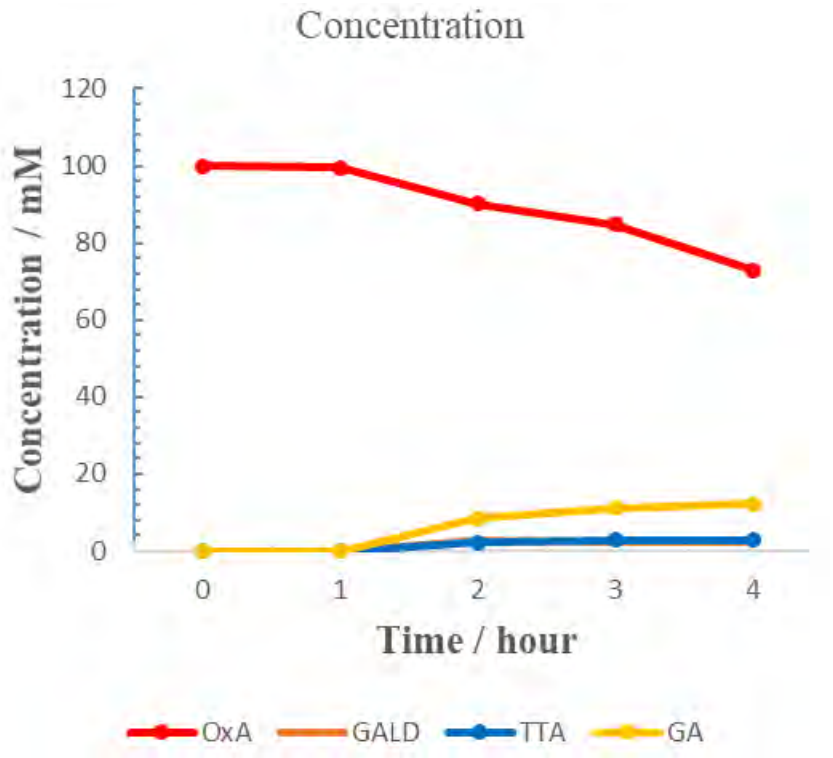




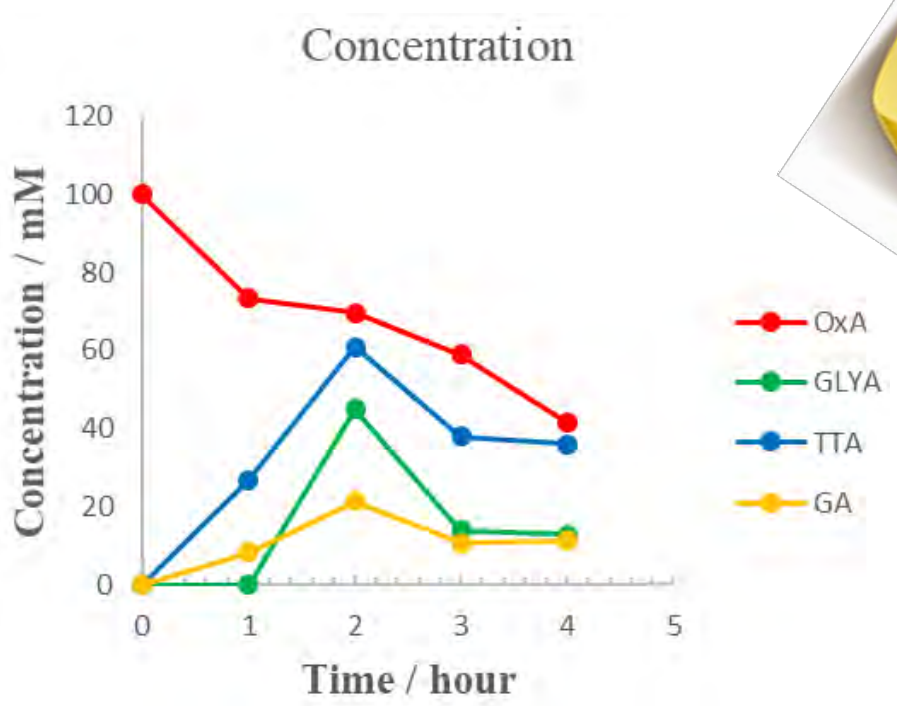
Electrodimerization reaction

Electrochemical Reduction of OxA to TTA in acetonitrile on Pb and Ag (E= -1.0 V)

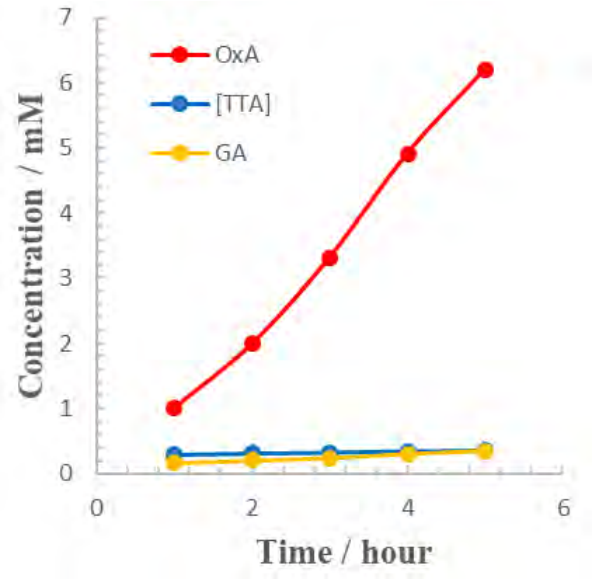
Pb



Ag

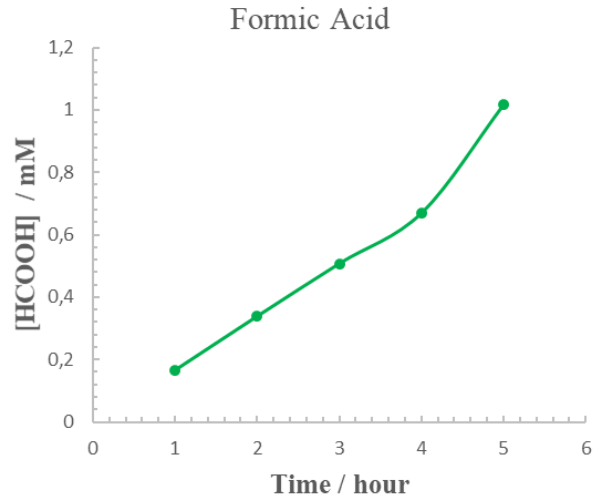


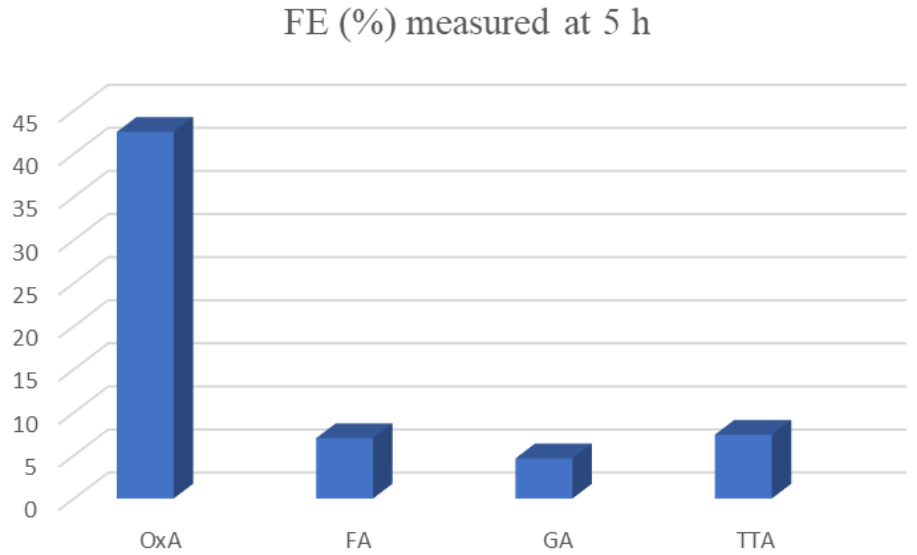
Electrochemical Reduction of CO_2 to TTA in acetonitrile on Pb



E=-2.5 V

OxA = oxalic acid
GLYA= glyoxylic acid
TTA = tartaric acid
GA = glycolic acid





Paired Electrolysis

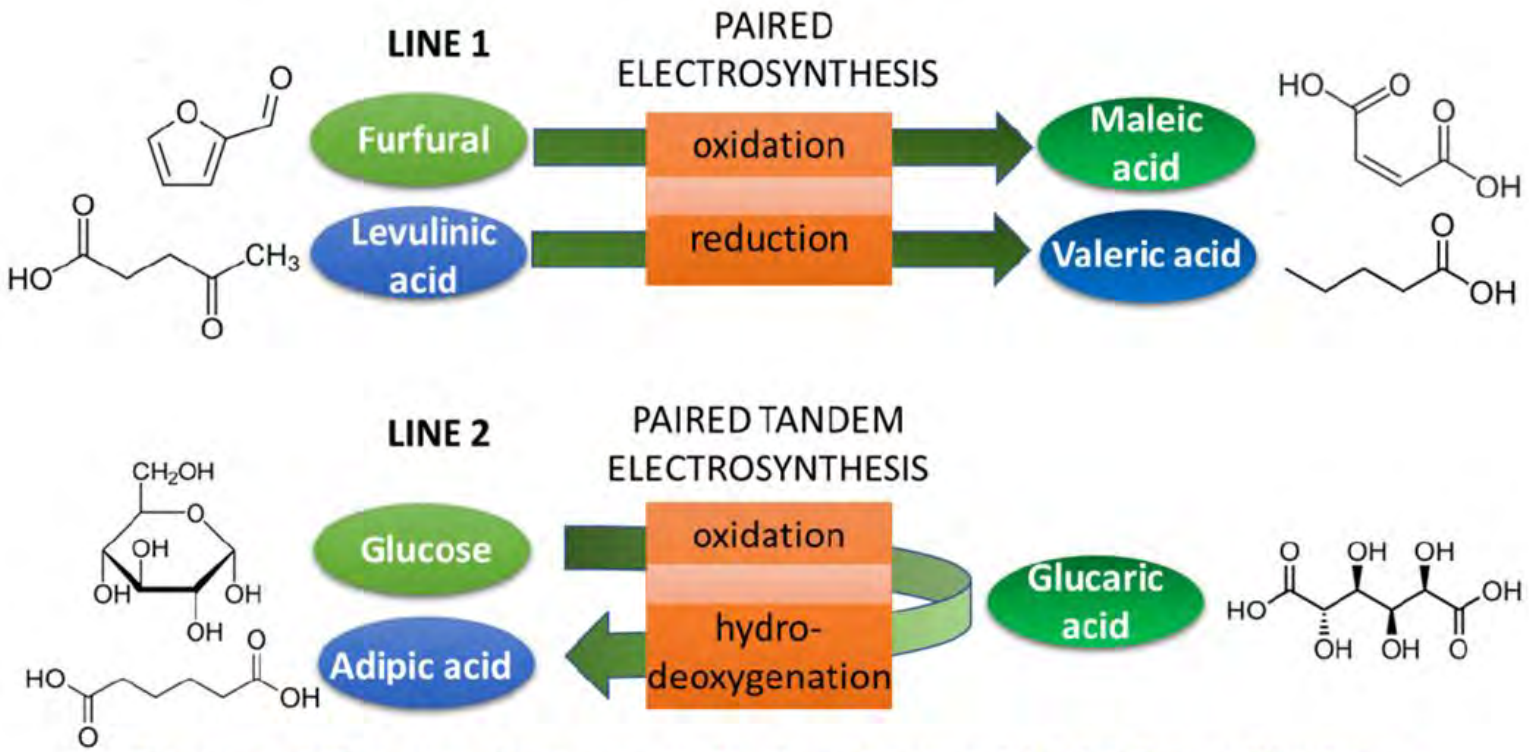


Figure 1.2 The two showcases to be demonstrated in the PowerPlatform

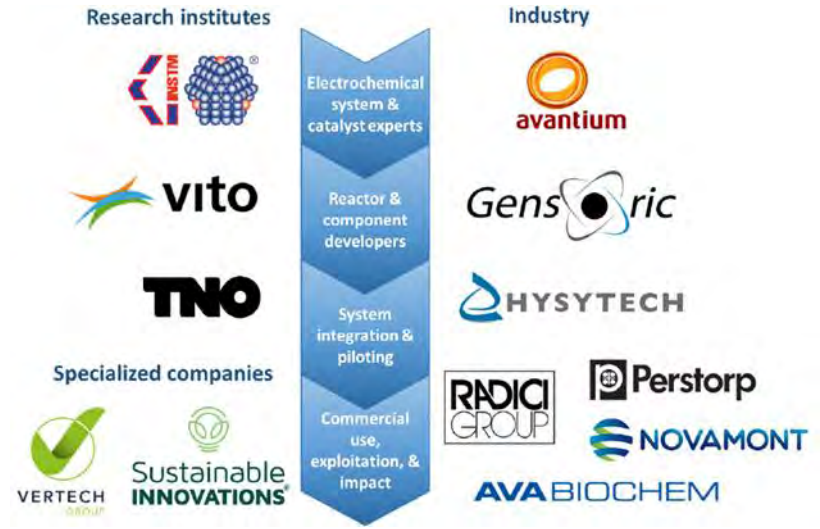
PERFORM

PowerPlatform: Establishment of platform infrastructure for highly selective electrochemical conversions

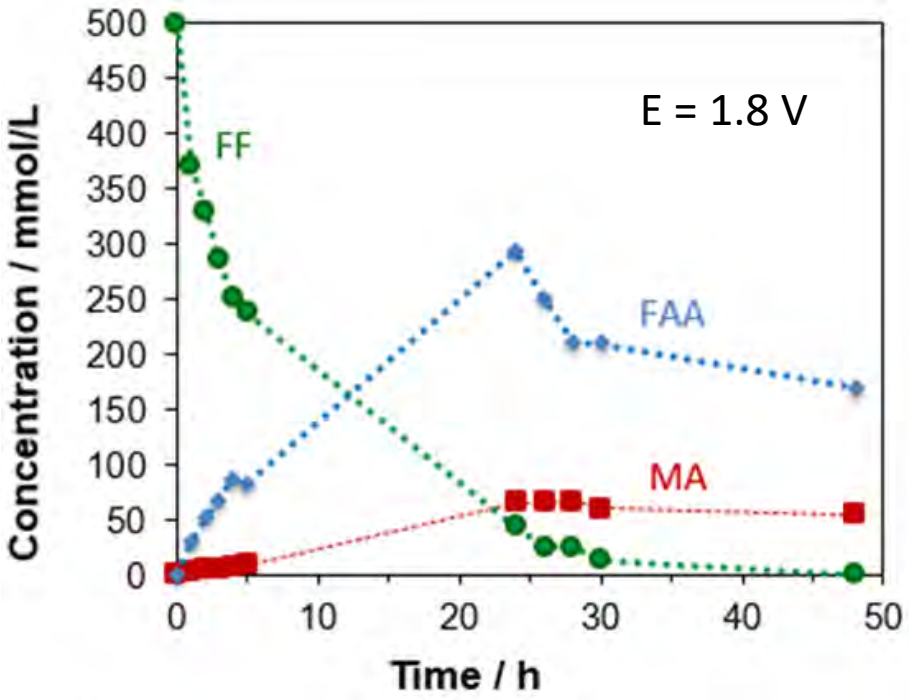
PowER platFORM

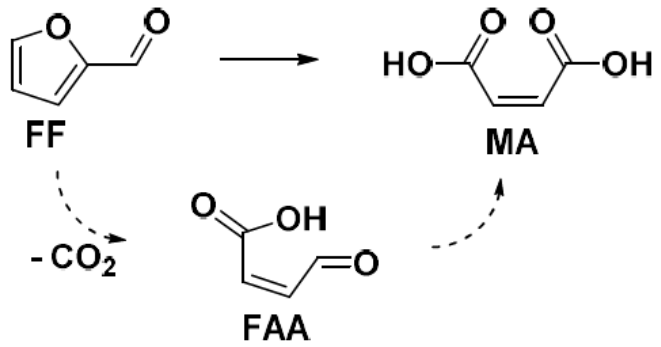
Work programme topics addressed

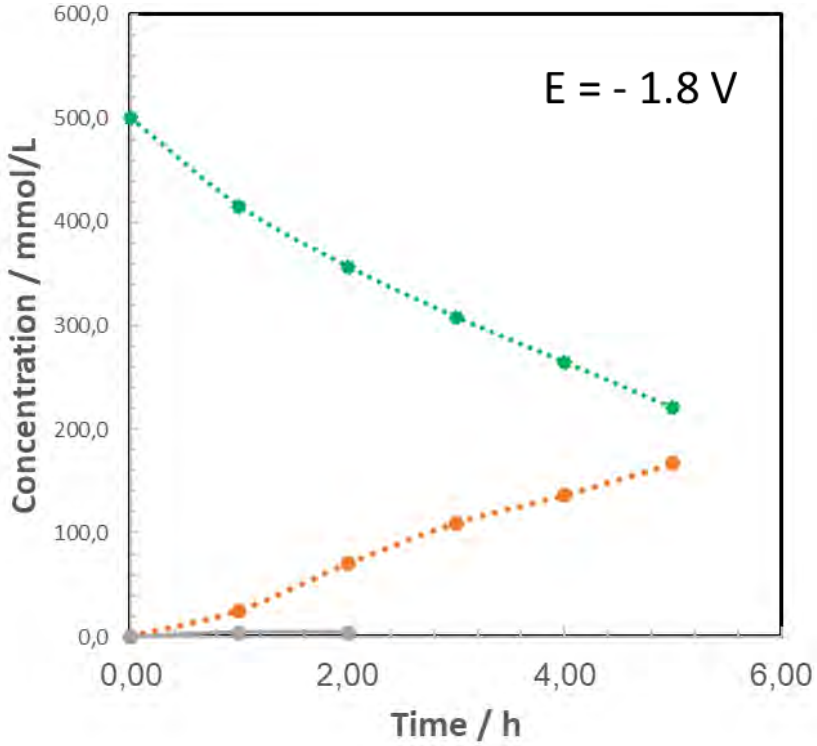
H2020- CE-SPIRE-02-2018: Processing of material feedstock using non-conventional energy sources

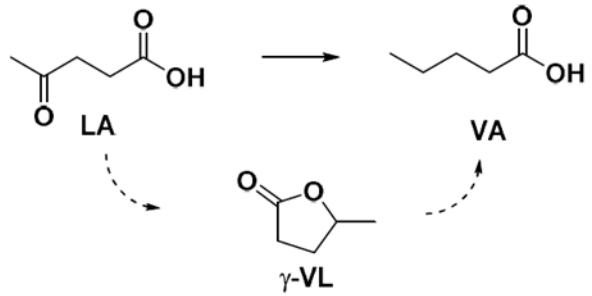


Conversion of Furfural to Maleic Acid on PbO_2



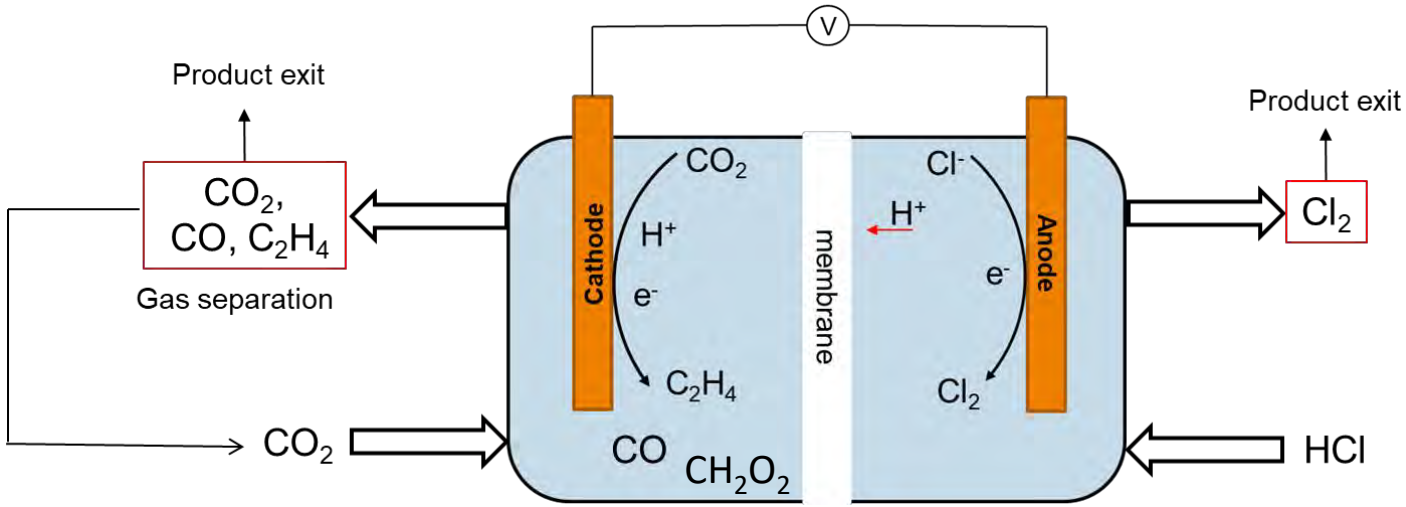






Paired Electrolysis

CO_2 Reduction / Chloride oxidation



E-COUCH

Production of valuable chemicals in a highly efficient manner from essentially waste materials.

TNO innovation for life avantium University of Amsterdam

VOLTA CHEM

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Glycerol as feedstock

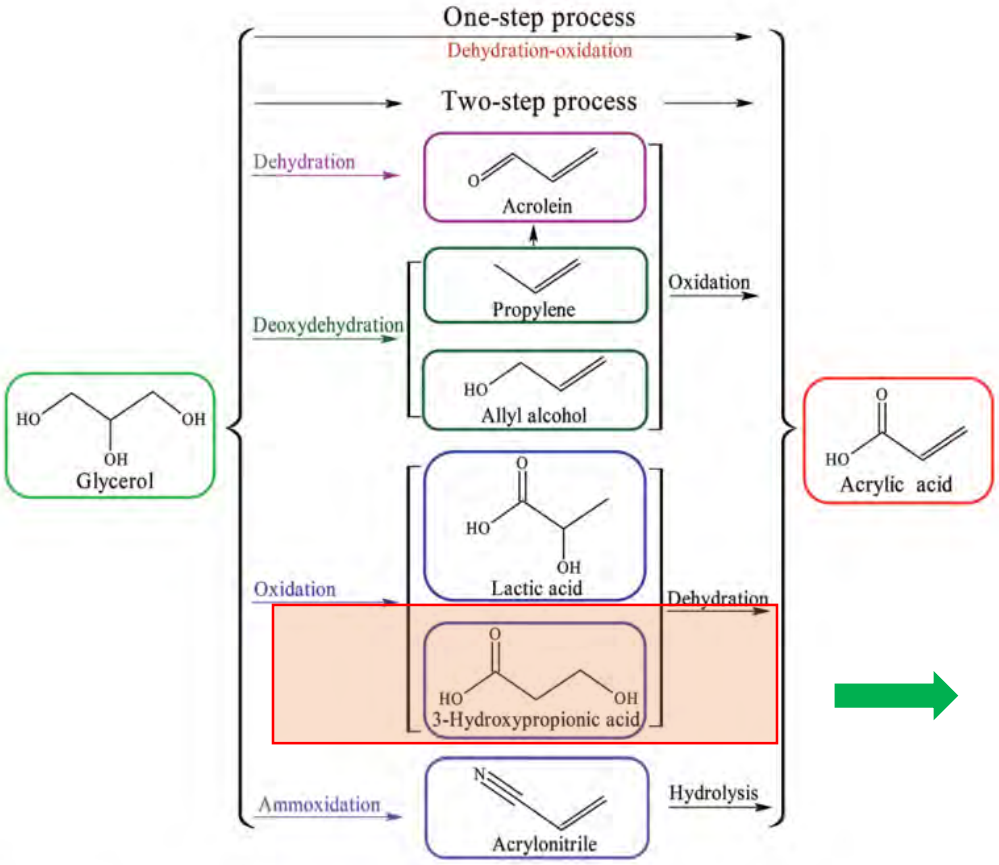


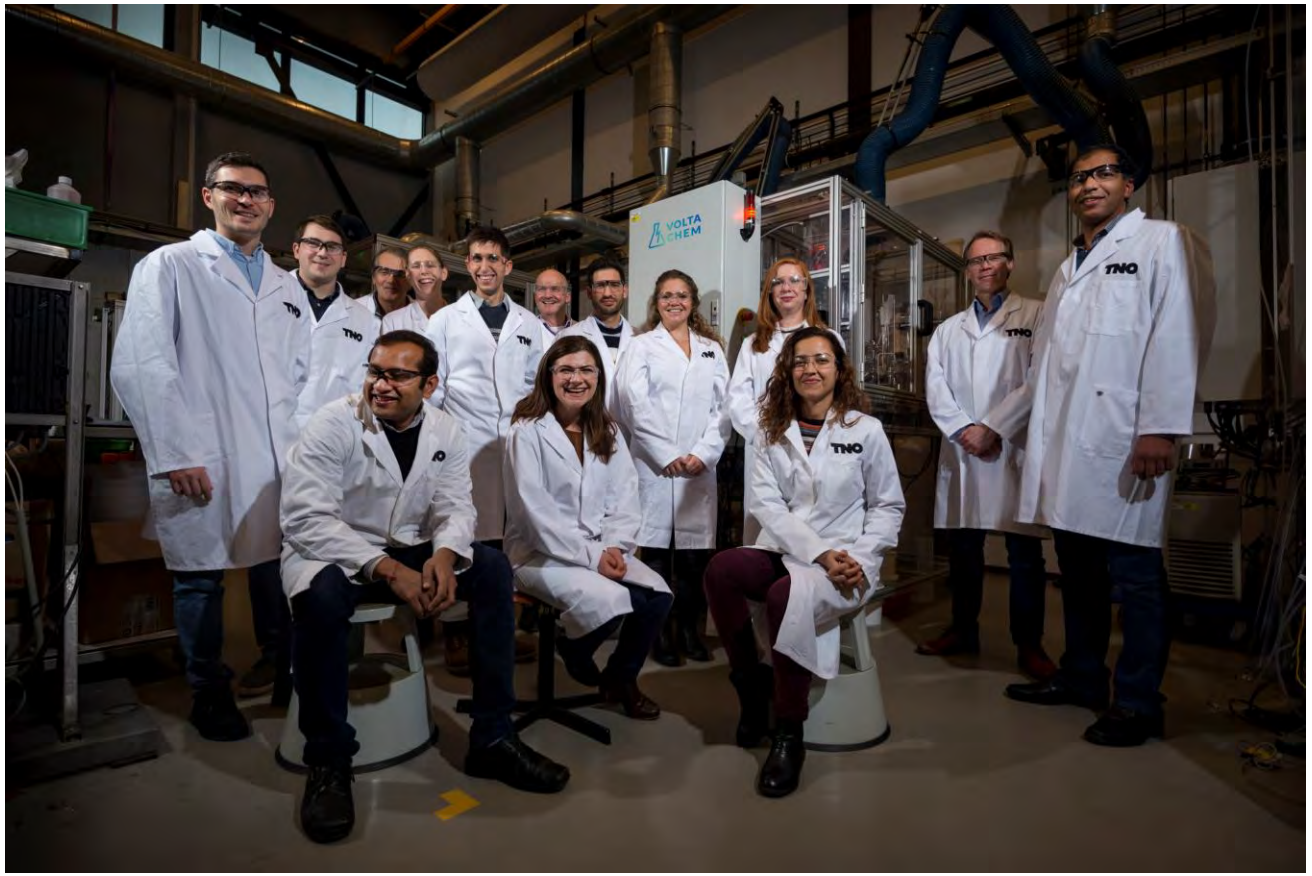
Fig. 1 Conversion of glycerol to acrylic acid *via* different routes.

Acrylic acid is an important bulk chemical widely used in the manufacture of polymeric products.

This route would be the most interesting because of the price of feedstock doesn't change (glycerol and 3-HPA have both three oxygen atoms)

LA is the most stable
Dehydration to acrolein is more difficult.

Acknowledgment



Thank you for your attention!!!

Contact: amanda.garcia@tno.nl