



## scientific breakthroughs

- $H^+$  supply correspond to activities of extremely high pressures
- control  $H_2$  flooding for  $CH_4$  byproduct minimization
- $O^{2-}$  removal to suppress  $H_2O/CO$  byproducts and shift conversion
- increase  $C_{2-4}^{\equiv}$  selectivity

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HORIZON-EIC-2022-PATHFINDER-01  
101099717 ECOLEFINS  
EISMEA funding: 2.5 M€  
Duration: 10/23 – 9/26

# ECOLEFINS

co-ionics for carbon negative petrochemicals

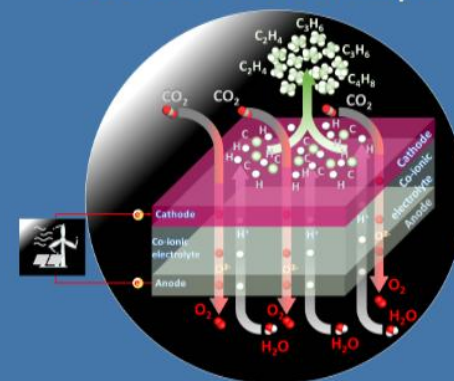
$CO_2/H_2O$  co-electrolysis and  $CO_2$  hydrogenation to  $C_{2-4}^{\equiv}$  in **co-ionic Electrochemical Membrane Reactors (ci-EMRs)**

$CO_2$  to  $C_{2-4}^{\equiv}$  benchmark (@ 30 bar):  
 $nCO_2 + nH_2 \leftrightarrow C_nH_{2n} + 2nH_2O$

ECOLEFINS' ci-EMR (1 bar):  
 $nCO_2 + 2nH^+ + 6ne^- \leftrightarrow C_nH_{2n} + 2nO^{2-}$

disconnect light olefins ( $C_{2-4}^{\equiv}$ ) from petroleum

ECOLEFINS concept



electrochemically supply protons ( $H^+$ ) and remove  $O^{2-}$  to/from  $CO_2$

**ECOLEFINS**  
CO-IONICS FOR CARBON NEGATIVE PETROCHEMICALS



integrate electrolysis endothermicity with  $CO_2$  hydrogenation exothermicity

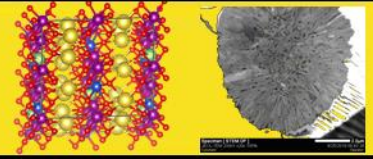
- bypass  $H_2$  compression
- electrolysis at  $>400^\circ C$
- increase  $C_{2-4}^{\equiv}$  yield
- reduce energy demand

reverse 5 – 11 tn  $CO_2$ /tn  $C_{2-4}^{\equiv}$  emissions to -3 tns  $CO_2$ /tn  $C_{2-4}^{\equiv}$  capture

**innovations**

**integrated approach**

DFT designed  
co-ionic membranes and  
electrified interfaces

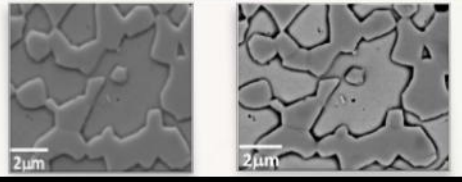


Co-ionic Electrochemical  
Membrane Reactors (ci-EMRs)  
up-scaling

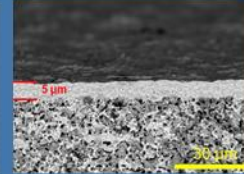
ci-EMR  
tubular  
modules



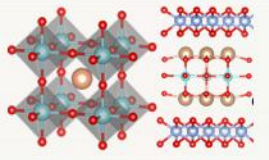
dual phase (cer-cer)  
membranes of  
co-ionic conductivity



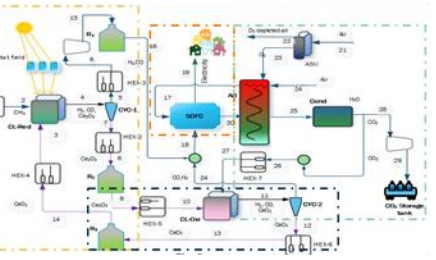
ci-EMR  
planar  
stacks



electrodes of triple  
phase ( $H^+$ ,  $O^{2-}$ ,  $e^-$ )  
conductivity



planar stacks and  
tubular modules testing

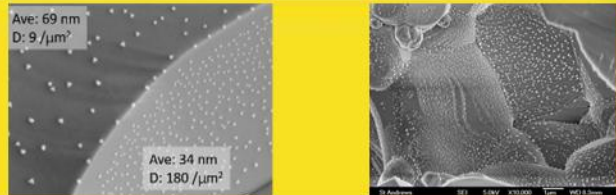


Integrated ECOLEFINS  
process modelling

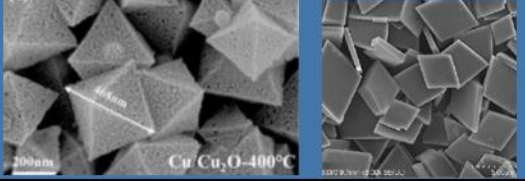
CFD  
modelling



exsolutions, for confided and  
dispersed  
catalytic nanoparticles



MOF-derived  
(bi)metallic,  
catalytic nanoparticles

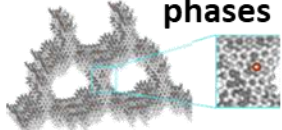


economic feasibility and  
sustainability assessment

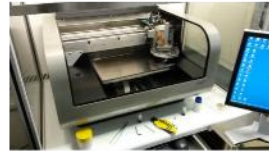


LCSA and  
social-LCA

COF-derived  
conductive graphitic  
phases



inkjet printing for  
planar stacks



public awareness  
and social acceptance

market opportunities  
of ECOLEFINS processes,  
ceramics and  
electrochemical  
components