



Chemeca2026
Innovate. Integrate. Impact.

28 – 30 September 2026
Melbourne, Australia



*Chemeca 2026 and Hazards Australasia
28 – 30 September, Melbourne, Australia*

Abstract title

Patterned Anion Exchange Membranes for Delayed Salt Precipitation and Interfacial Ion Transport Control in CO₂ Electrolysis

Author(s) Name

Xiaoyu Jin^{a,b}, Mengran Li^a, Ivo Vankelecom^b, Xing Yang^c, George Chen^a

Affiliation(s)

^aDepartment of Chemical Engineering, Faculty of Engineering and Information Technology
The University of Melbourne

^bDepartment of Microbial and Molecular Systems, Faculty of Bioscience Engineering
KU Leuven

^cDepartment of Chemical Engineering, Faculty of Engineering Science
KU Leuven

E-mail

xiaoyu.jin.2@student.unimelb.edu.au

ABSTRACT

Anion exchange membrane (AEM)-based CO₂ electrolysis (CO₂E) is a promising route for sustainable carbon conversion into valuable chemicals such as carbon monoxide and ethanol, because of its high ionic conductivity and energy efficiency. However, salt precipitation remains a major barrier to long stability and industrial implementation. Existing mitigation strategies, including elevated operating temperature and acidic cathode-side operation, can reduce salt accumulation by increasing salt solubility but often introduce trade-offs such as additional energy demand, increased process complexity, and lower product efficiency. Membrane functionalized as ion transport medium may offer a promising strategy to address this challenge via modulating ion transport to interfacial microenvironment.

This study explores membrane surface patterning as a way to regulate ion transport and interfacial microenvironments in AEM-based CO₂E, aiming to improve performance and stability. While patterned membranes have demonstrated benefits in other electrochemical systems such as water electrolysis and fuel cell, the membrane itself remains an underexplored design variable in CO₂E. We propose that membrane patterning may influence salt precipitation through two pathways, either by modifying intrinsic membrane properties (such

as water uptake and effective conductivity), or by altering local interfacial boundary conditions at the membrane-catalyst interface (such as reactant distribution and local pH). In this work, patterned AEMs were fabricated by hot embossing using silicon wafer molds prepared via photolithography, enabling controlled surface features at micrometer scale.

Preliminary results show that membranes with 5 μm different patterns exhibit noticeable changes in intrinsic membrane properties relative to flat benchmark. Water uptake decreased by 20-30%, while salt permeability increased by approximately twofold, whereas membrane thickness remained almost unchanged. These observations suggest that hot embossing may slightly densify the membrane, thereby affecting water uptake. However, the macroscopically increased salt permeability indicates that this densification effect is likely compensated by the increase in effective membrane surface area introduced by patterning. Importantly, salt precipitation was significantly delayed in the patterned membrane during CO_2E . This suggests that the dominant benefit of patterning may not arise from changes in bulk membrane properties, but rather from altered interfacial boundary conditions, particularly the mitigation of surface polarization through increased active surface area.

These findings provide an initial basis for distinguishing bulk membrane effects from membrane-catalyst interfacial effects in patterned AEMs. Our ongoing work aims to verify this mechanism and elucidate how membrane patterning governs ion transport, local microenvironment evolution, and electrolyzer performance, thereby supporting the design of more stable and industrially viable CO_2E systems.

KEY WORDS

Anion exchange membrane, CO_2 electrolysis, patterning

BIOGRAPHY

Xiaoyu Jin is a joint doctoral student at University of Melbourne and KU Leuven. She completed her Bachelor degree in Chemical Engineering and Technology from Nanjing Tech University, China (2021) and her Master degree in Chemical and Bioengineering from ETH Zurich, Switzerland (2024). She then moved back to China for internship on aerosol and adhesive manufacturing at Saint-Gobain Research Shanghai. She commenced her PhD in May 2025 with the research focuses on investigating ion transport behaviors and interfacial microenvironment around catalyst layer in patterned AEM-based CO_2 electrolysis.

CONFERENCE PROGRAM

Please indicate which conference program your abstract relates to:

Hazards Australasia

Chemeca