

CO₂ Electrolysis by Iron-Porphyrin Complexes Incorporated in Coordination Polymer Glasses

(¹Graduate School of Engineering, Kyoto University, ²Institute for Advanced Study, Kyoto University) ○Sara AlShukaili,¹ Hiroyasu Tabe², Satoshi Horike^{1,2}

Keywords: Coordination polymer, melt-quenching, CO₂ reduction, electrocatalysis

Reducing CO₂ into hydrocarbons and carbon monoxide (CO) is scientifically important in the current society. Catalysts with high activity and selectivity are required for CO₂ reduction because of the low reactivity of CO₂ molecules. Homogeneous catalysts composed of metal complexes exhibit high selectivity for CO₂ to CO. Several issues associated with homogeneous catalysts such as low reusability can be solved by immobilizing the catalysts on a solid substrate.¹ Conventional catalyst substrates have drawbacks such as low ion conductivity and low processability on the electrode. Herein we used glassy coordination polymers composed of metal ions, phosphate ions, and azoles (phosphate-azole CPs) as a solid substrate.² Meso-tetraphenylporphyrin iron (III) chloride (Fe (TPP)Cl) was immobilized in melt-quench process. Fe (TPP)Cl was mixed with a liquid of several phosphate-azole CPs such as [Zn^{II}(HPO₄)(H₂PO₄)₂](ImH₂)₂ (**ZnPIIm**, Im = imidazolate).³ Then glass membranes (20, 40, 75 μm) were fabricated by cooling the liquid on an FTO electrode (Fig. 1). Electrocatalytic CO₂ reduction was examined by applying potentials to the glass membrane in acetonitrile saturated with CO₂. **ZnPIIm**-Fe(TPP)Cl membranes with 40 μm thickness showed the highest catalytic performance, indicating CO₂ molecules have been able to access Fe (TPP)Cl catalysts in the **ZnPIIm** substrate at this thickness.

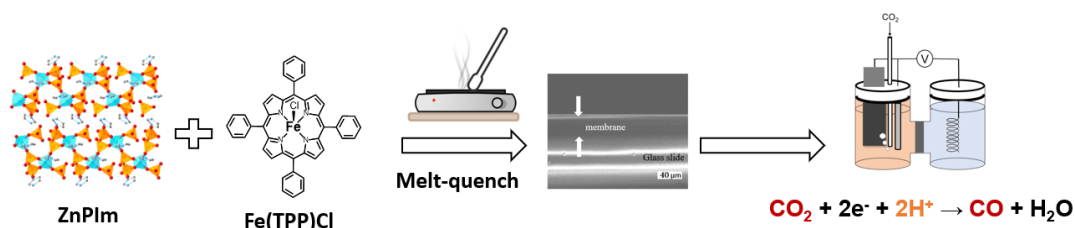


Figure 1: Scheme of the **ZnPIIm**-Fe(TPP)Cl membrane fabrication via melt quenching, and CO₂ electrolysis.

- 1) Sun, L., et al., *Energy Environ. Sci.*, 2020, **13**(2): p. 374-403.
- 2) Ma, N. and S. Horike, *Chem Rev*, 2022, **122**(3): p. 4163-4203.
- 3) Horike, S. et al. *J. Am. Chem. Soc.*, 2015, **137**(2), p. 864-870.