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Cationic Covalent Organic Frameworks as Anion Exchange Membranes for Electrochemical Energy Applications (COFFEE)

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Introduction and objectives

- Covalent organic framelowrks (COFs) are highly ordered, porous networks of organic building blocks
- Synthesis and functionalization of a library of molecular building blocks for development of the anion exchange



- membranes (AEMs) with tuneable properties
- Demonstrated as components for energy device application, i.e. zinc-air battery (ZAB)

Synthesis of cationic COFs and COF-based membranes

COF are crystalline \rightarrow polymeric component added for mechanical flexibility



Three routes for cationic functionalization of the COFs: 1. Commercially available ethidium bromide as quaternary ammonium group

Ex-situ characterization

Ion Exchange capacity (IEC) by titration of OH⁻ released by exchange \rightarrow no OH⁻ uptake observed in DD3 and CNEtBt



Zincate diffusivity experiments: low diffusion of Zn delays cathode degradation and extend the lifetime of the ZAB



2. Direct reduction and quaternization of the COF backbone



3. Diaminoguanidinium





Separator	D _{zn} (cm²/min)
Sustainion	2.3 x 10 ⁻⁶
PVA	6.2 x 10 ⁻⁷
SD1-DAG50%	2.1 x 10 ⁻⁷
Zincate diffusion coefficient for a commercial separator, PVA hydrogel film and a COF sample	

Cell testing

• Comparable performance and stability to commercial AEM and solid polymer electrolyte



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Gas diffusion Zinc electrode electrode Separator



ZAB cell tests carried out with Zn foil and commercial MOC GDE (Gaskatel). Electrolytes: 0.5 M ZnO in 6 M KOH and 6 M KOH on anode and cathode chambers, respectively. Cycling protocol: 10 mA/cm², 30 minutes/cycle. R_{cell} estimated by HFR intercepts through EIS measurements carried out at OCV at the beginning of test.







