

GASSING OF SODIUM ION BATTERY ANODES IN FULL-CELL MEASUREMENTS



J. Geisler*, P. Appel^o, J. Krug von Nidda^o, T.-P. Fellingner^o and P. Adelhelm*

*Department of Chemistry, Humboldt-Universität zu Berlin

^oBundesanstalt für Materialforschung und -prüfung

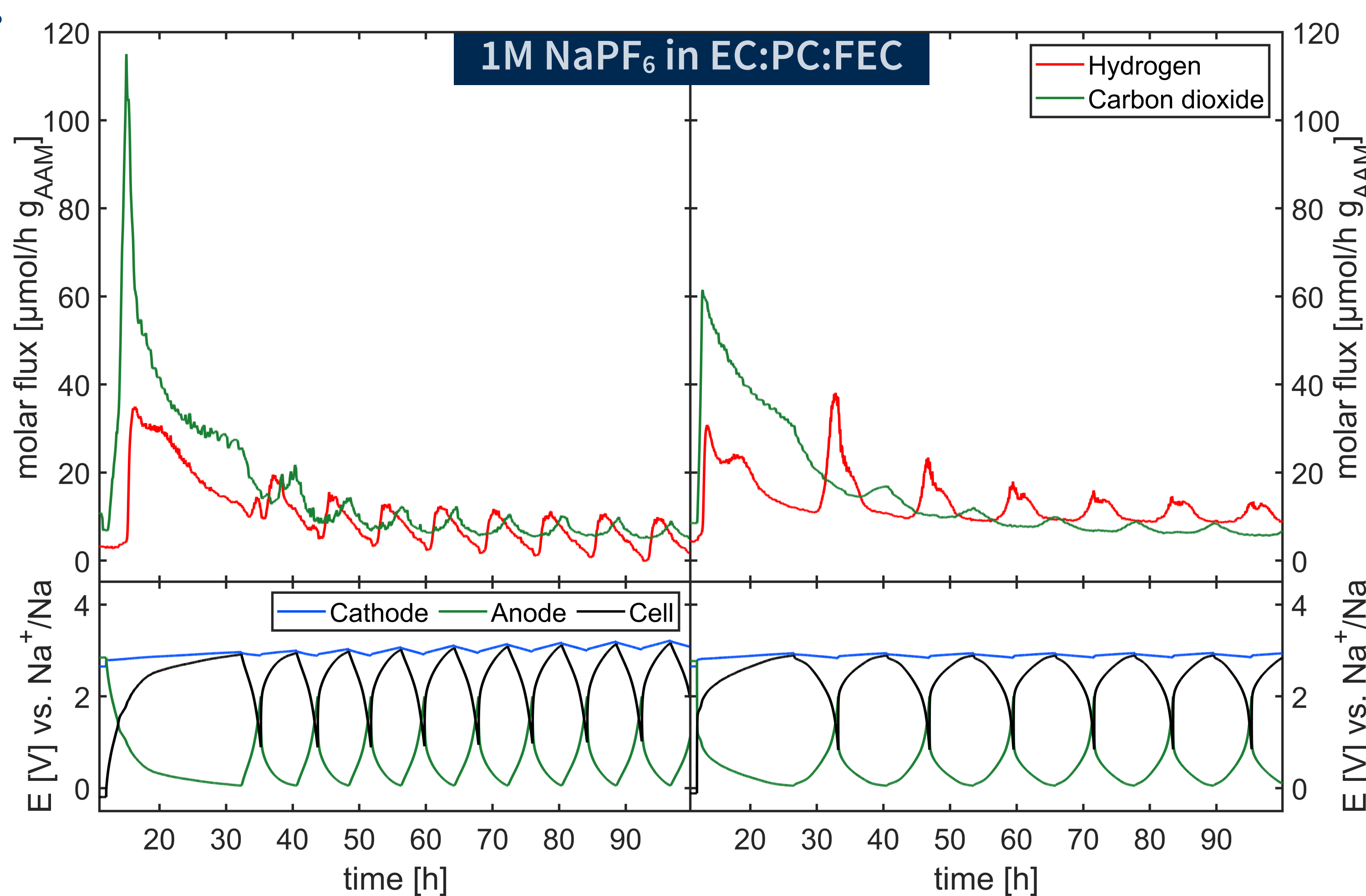
Contact: jonas.geisler@hu-berlin.de

ARTIFICIAL SEI THROUGH CVD COATING OF ACTIVATED CARBON

The capacity of hard-carbon anodes strongly depends on porosity: higher porosity provides more sodium storage sites but increased surface area leads to more side reactions with the electrolyte. Pores, which are inaccessible to electrolyte (closed or bottle-neck pores), are therefore preferred. Here the recent core-shell concept (a porous core with an electrolyte-sieving shell) is tested, using commercially available activated carbon coated using chemical vapor deposition (CVD) [1]. Differential Electrochemical Mass Spectrometry (DEMS) [2,3] is used to compare core and core-shell materials in two electrolytes.

Untreated + carbonates:

- High irreversible capacity in 1st cycle
- Strong evolution of CO₂ in 1st cycle
- Lower gassing in the next cycles, but also significantly lower capacity.
- H₂ formation strongest during sodiation. H₂ can freely leave the pores.

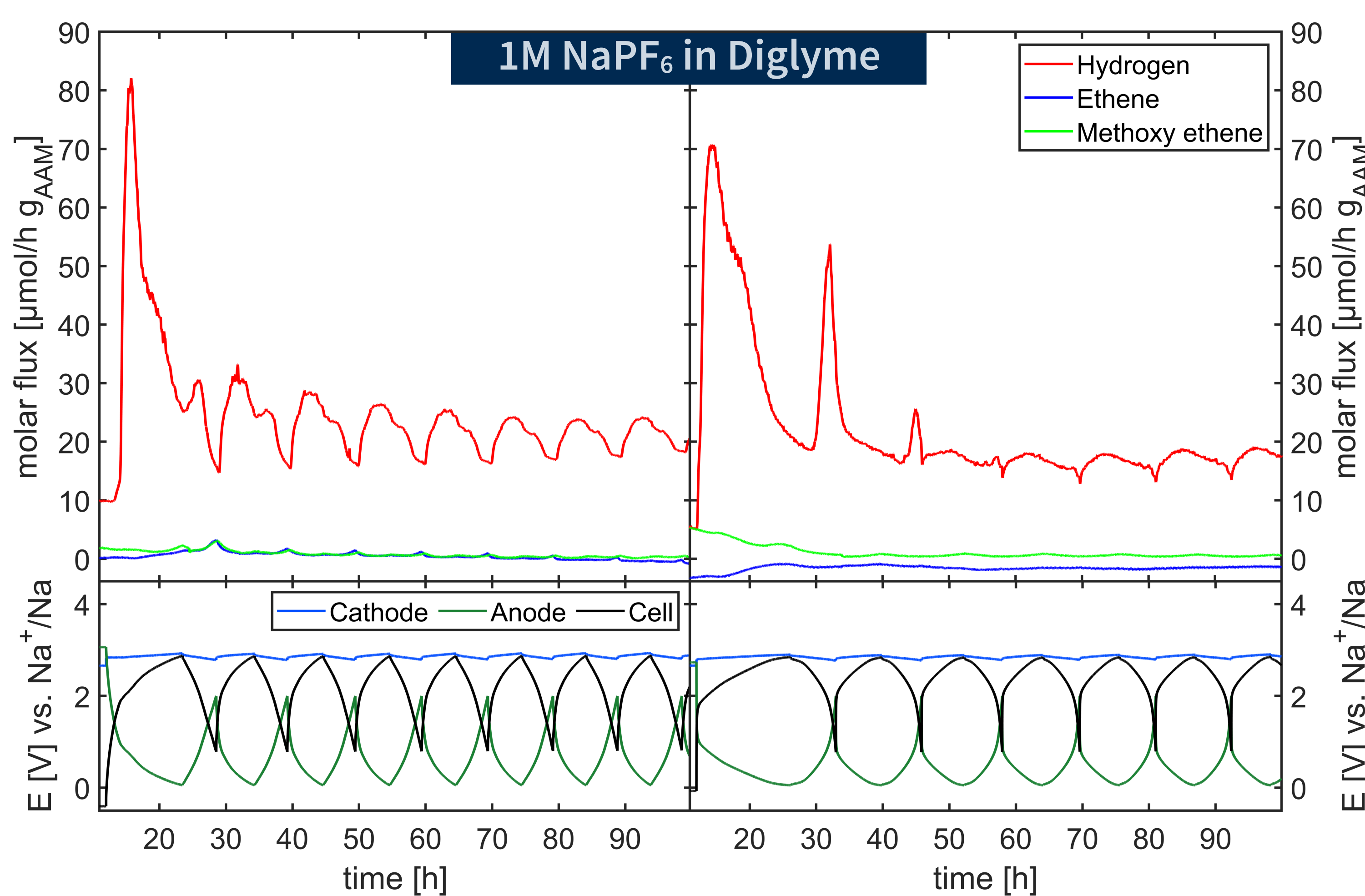


CVD-coated + carbonates:

- Capacity retention strongly increased
- Less CO₂ in 1st cycle
- Similar amounts of H₂, probably mainly product of sodium reacting with protic surface groups of the carbon.
- H₂ formation strongest at the upper voltage cut-off of the anode. H₂ is trapped in the particle until it contracts in desodiated state.

Untreated + diglyme:

- Less irreversible capacity in 1st cycle compared to carbonates, but still significant.
- Strong H₂ formation in the 1st cycle
- H₂ formation strongest during sodiation. H₂ can freely leave the pores.
- Evolution of small amounts of ethene and methoxy ethene as decomposition products of diglyme



CVD-coated + diglyme:

- Capacity retention further increased
- Less but similar H₂ release
- Similar amounts of H₂, probably mainly product of sodium reacting with protic surface groups of the carbon.
- H₂ formation strongest at the upper voltage cut-off of the anode.
- Less or no evolution of ethylene and methoxy ethene (bend baselines are an artifact of the data evaluation)

DEMS Cells were measured against a commercially available NaNFM (nickel iron manganese oxide) cathodes and sodium metal reference electrodes. The measurements were conducted with 20 mA/g_{AM} (CC). Details of the DEMS method are described in [2,3], synthesis and further material characterization in [1].

[1] Appel, P. A. et al., Angew. Chem. Int. Ed, accepted, DOI: 10.1002/anie.202519457

[2] Geisler, J., Dissertation, Humboldt-Universität Berlin, 2023, DOI: 0.18452/26417

[3] Geisler, J. et al., Batter. Supercaps, 2024, 7, e202400006 DOI: 10.1002/batt.202400006



Funded by the German Federal Ministry of Research, Technology and Space (BMFT)

Projects:
DIALYSORB (03XP0410C)
TRANSITION (03XP0186B)
TRANSITION TRANSFER (03XP0533C)



Bundesministerium für Forschung, Technologie und Raumfahrt