

GAS EVOLUTION IN SODIUM ION BATTERIES

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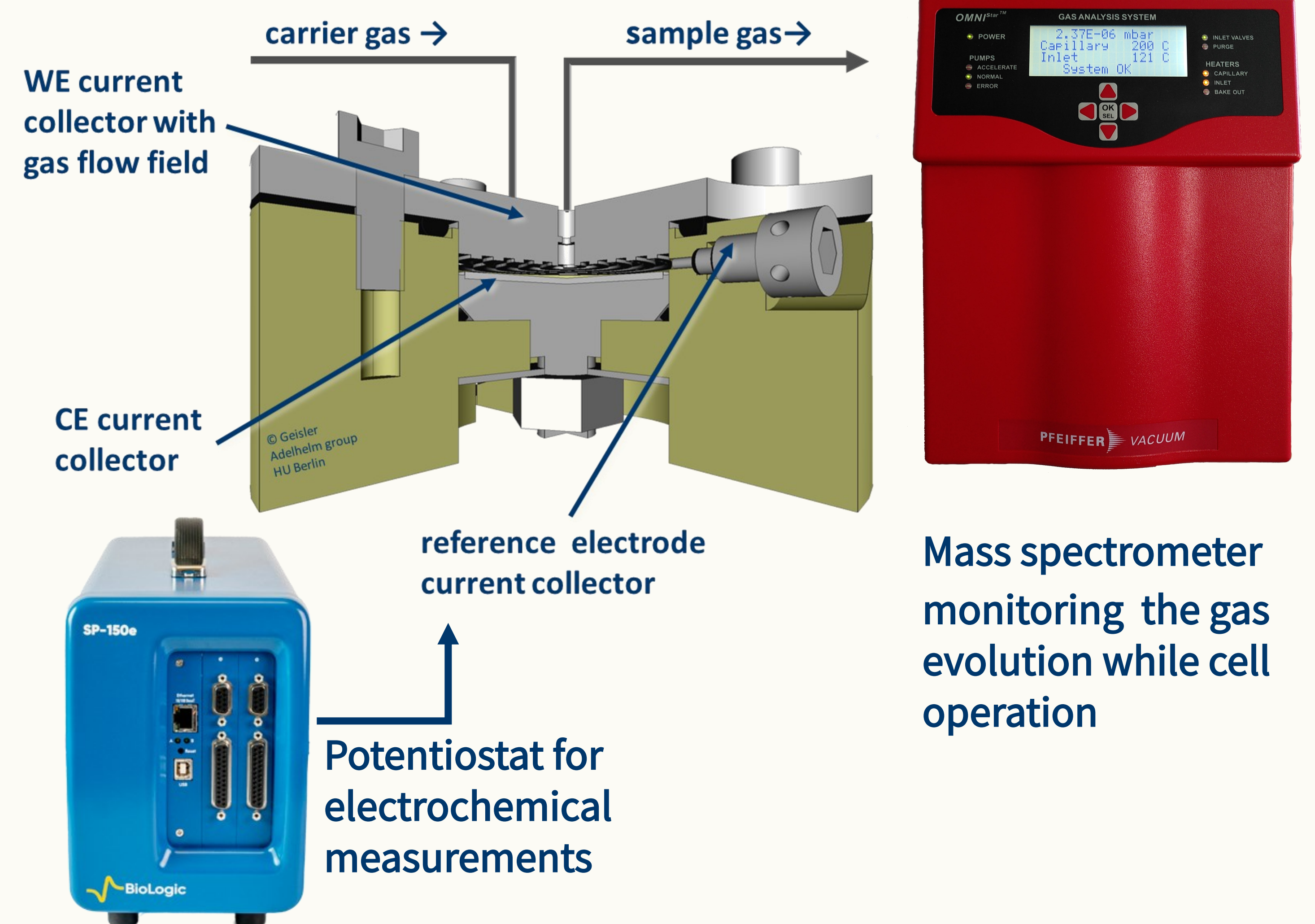
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DEMS FOR BATTERIES

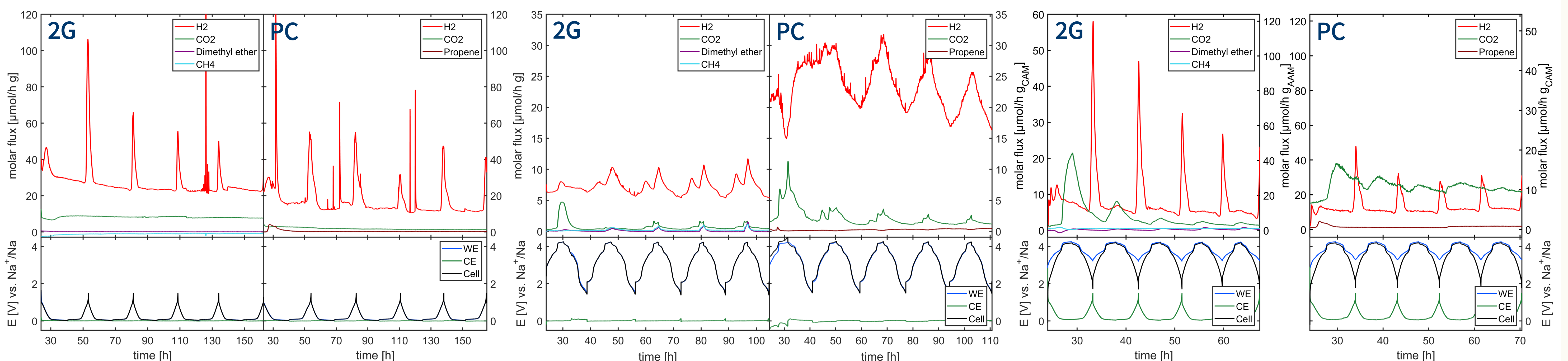
Degradation of battery components as well as certain additives cause gas evolution in batteries.

Differential electrochemical mass spectrometry (DEMS) is a method to detect these gases and correlate their evolution to the electrochemical processes in the cell.

Our 2nd version cell design^[1] is optimized to be simple. With fewer parts and an improved gas flow path, gas transport is improved. Cell sealing is improved with fewer sealing points. It also improves the simplicity of assembly, which is not only more convenient but also more fail-safe.



THE INTERACTION OF ANODES AND CATHODES



DEMS data for a sodium ion battery anode (hard carbon) against sodium metal counter electrode half-cell (left), cathode material (sodium nickel manganese oxide $\text{NaNMO}^{[2]}$) half-cell (middle) and full-cell of both materials (right). Each comparing two electrolytes, 1 M NaPF_6 in diglyme electrolyte (2G) and propylene carbonate (PC). Measured at 20 mA/g_{AM} . Gas flows relative to active material mass.

The gas evolution in the hard carbon anode half-cells for both electrolytes is similar, with a slightly higher evolution for 2G. The main gas formed is H_2 , with distinct spikes at high potentials, in addition to a constant formation originating from the sodium metal.

In the NaNMO half-cells, the main gases for both electrolytes are H_2 and CO_2 . The PC electrolyte leads to a higher evolution of both gases.

Both electrolytes show the strongest gas evolution when the cathode reaches potentials above 3.8 V, causing the decomposition of the electrolyte solvents at the

cathode. The protic decomposition products diffuse to the sodium metal anode, leading to H_2 evolution.

The half-cells' results overlap in the full-cells. The hydrogen signals follow the trend of the anode half-cells. This indicates that the anode is the source of hydrogen. CO_2 evolution is stronger in the case of the full-cell, especially for PC. Which is a result of protic decomposition products, that cannot be scavenged by sodium metal and lead to further decomposition.

(Detailed data analysis in reference [1])

[1] J. Geisler, Dissertation, Humboldt-Universität Berlin, 2023, DOI: 0.18452/26417
 [2] Pfeiffer, L. F. *et al.*, *Front. Energy Res.*, 2022, DOI: 10; 10.3389/fenrg.2022.910842



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 TRANSITION (03XP0186B)
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