Bipolar membrane electrochemical performance using different concentrations salt electrolytes

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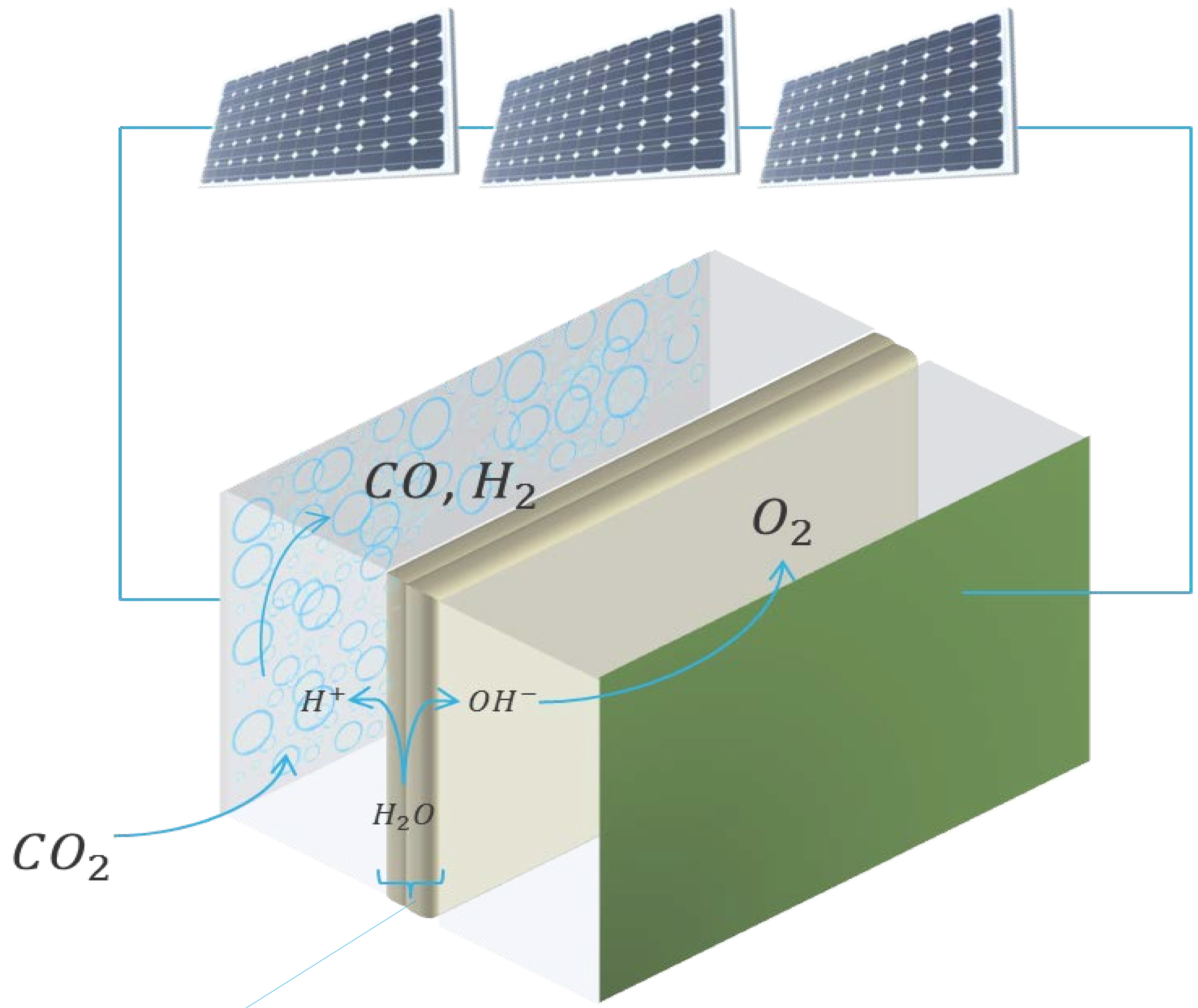
Introduction

- A bipolar membrane (BPM) can dissociate water ($H_2O \rightarrow H^+ + OH^-,\ E^0 = 0{,}826V$) at the interface of two laminated ion exchange layers[1]
- Allows to operate in different conditions in each compartment with a varying BPM performance[2]
- To understand ion transport mechanisms in BPM salt electrolytes (NaCl) are varied



Methods

- Equal concentrations NaCl in both compartments
- Measuring potential across BPM via Ag/AgCl REs
- Monitoring ΔpH to observe water splitting rate

Results

- Higher concentration in bulk (c_{bulk}) electrolyte has higher ion concentration in BPM
- Migrational component from Nernst-Planck equation ($J_j(x) = -D_j \frac{\delta c_j(x)}{\delta x} - \frac{z_j F}{RT} D_j c_j \frac{\delta \varphi(x)}{\delta x}$) has linear relationship with salt concentration as confirmed in Fig 3
- Fig 4 & 5 show ion transport in co-ion region and water dissociation region, respectively
- At higher salt concentrations, higher current is needed to deplete transition region

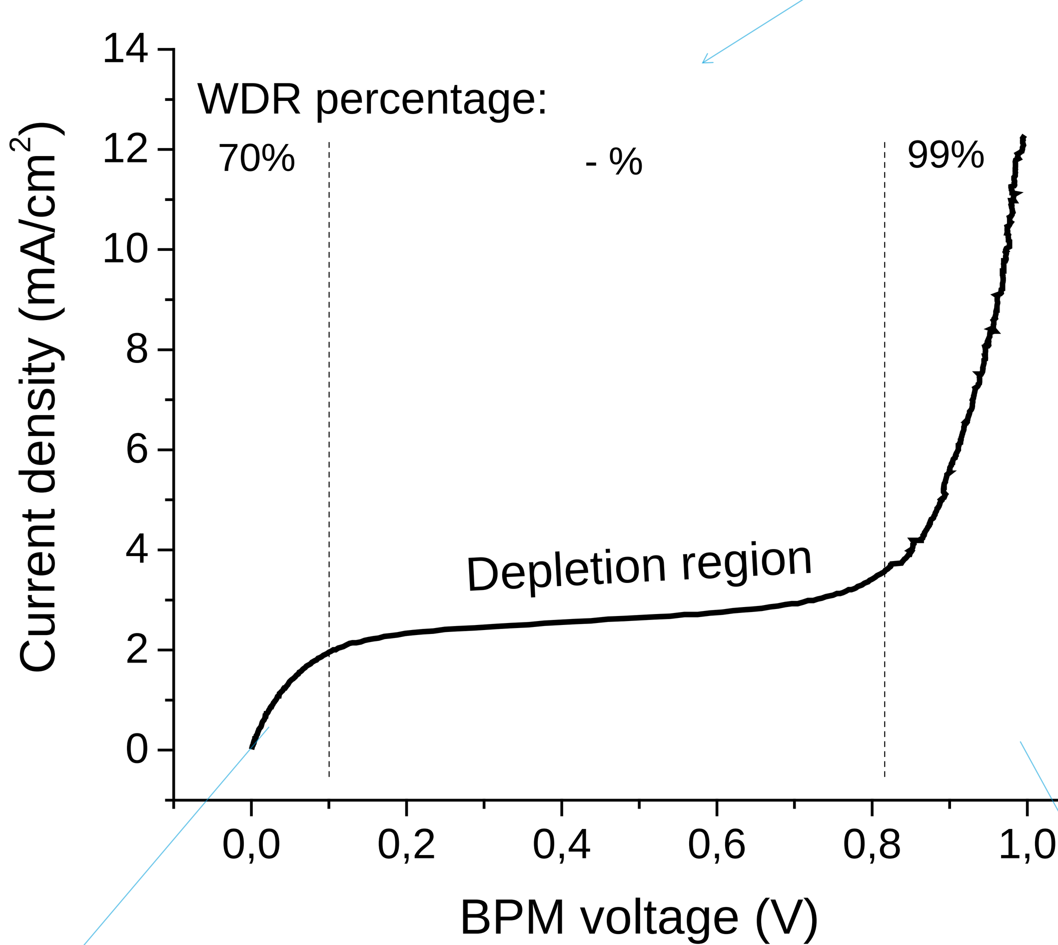


Fig 2: Typical current voltage curve of a BPM illustrating three different regions with indicative WDR percentages

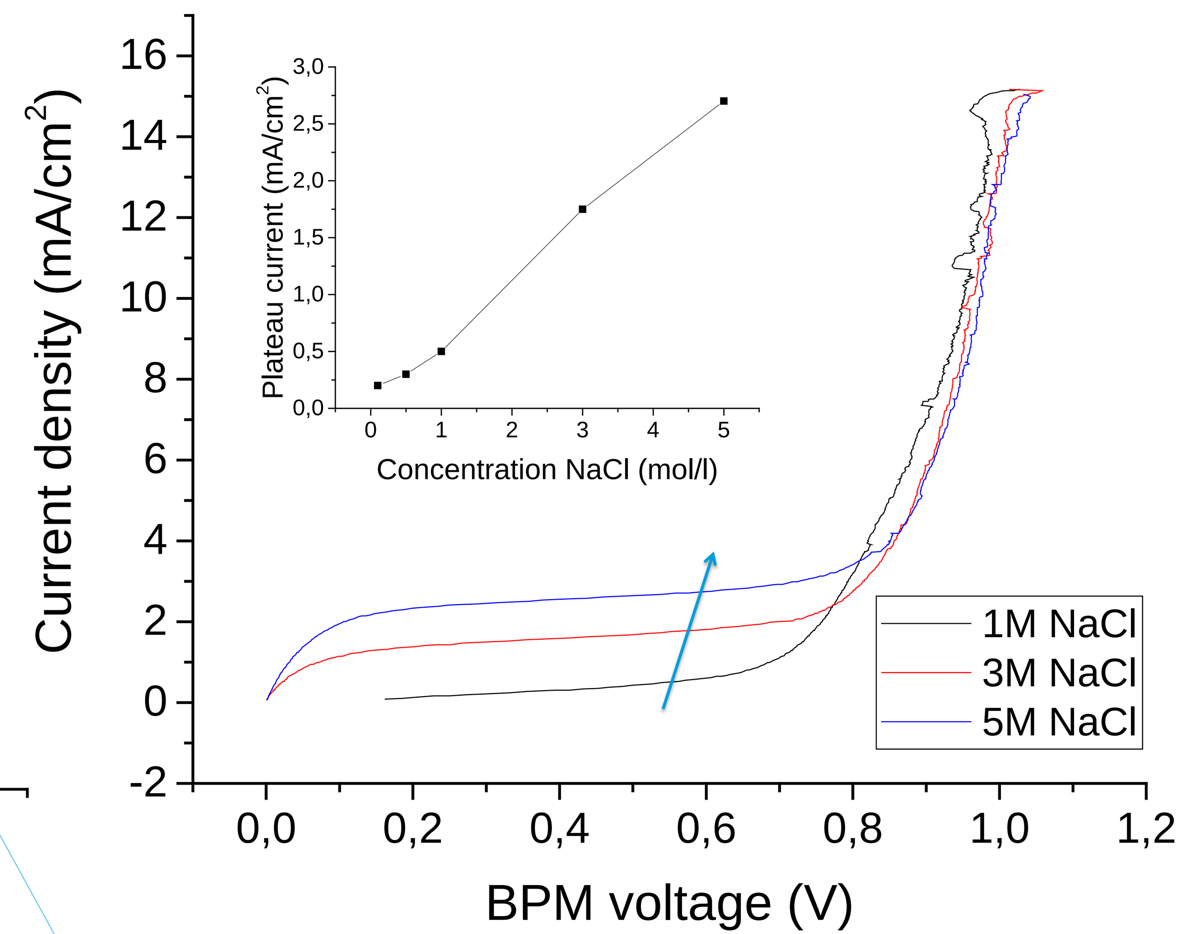


Fig 3: Current voltage curves of a BPM at three NaCl concentrations (1, 3 & 5 M). Inside: plateau current vs NaCl concentration.

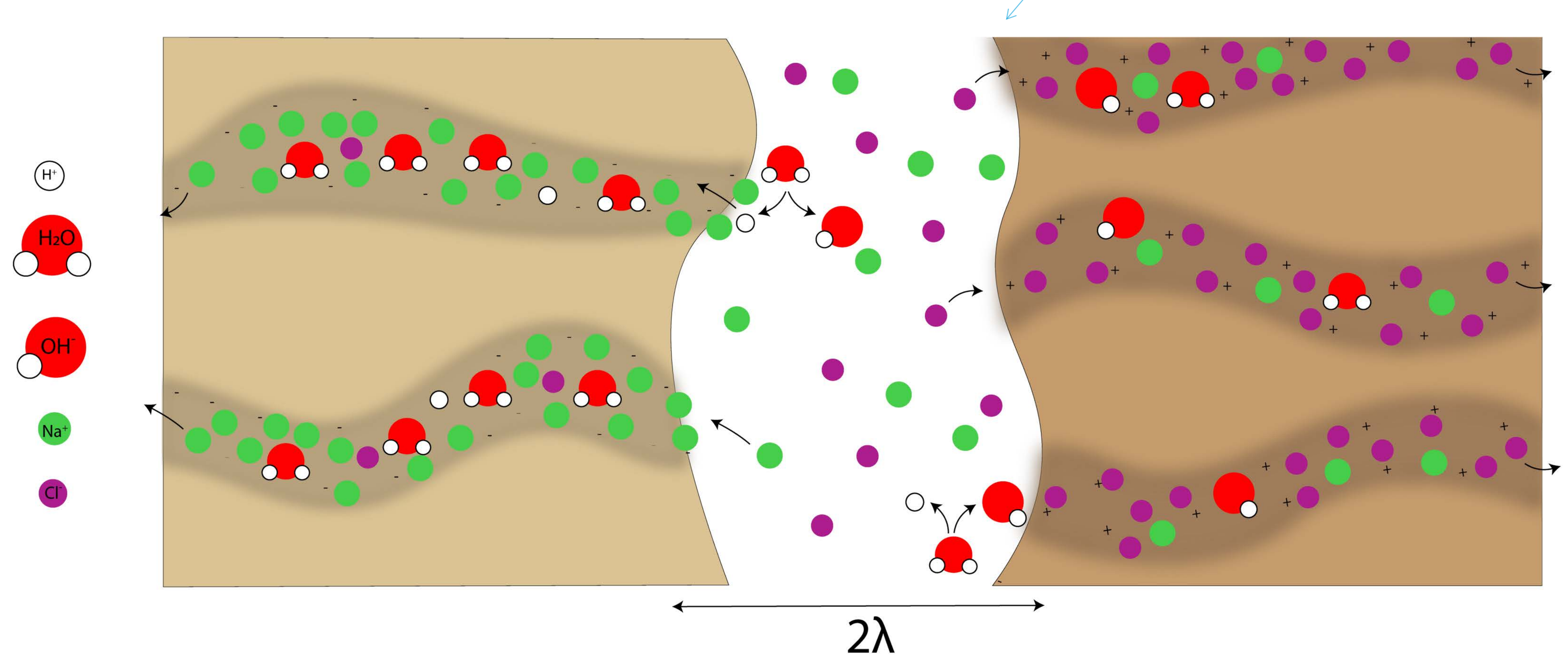


Fig 4: Transition region of BPM in co-ion region, transport is partly done by co-ions and water dissociation

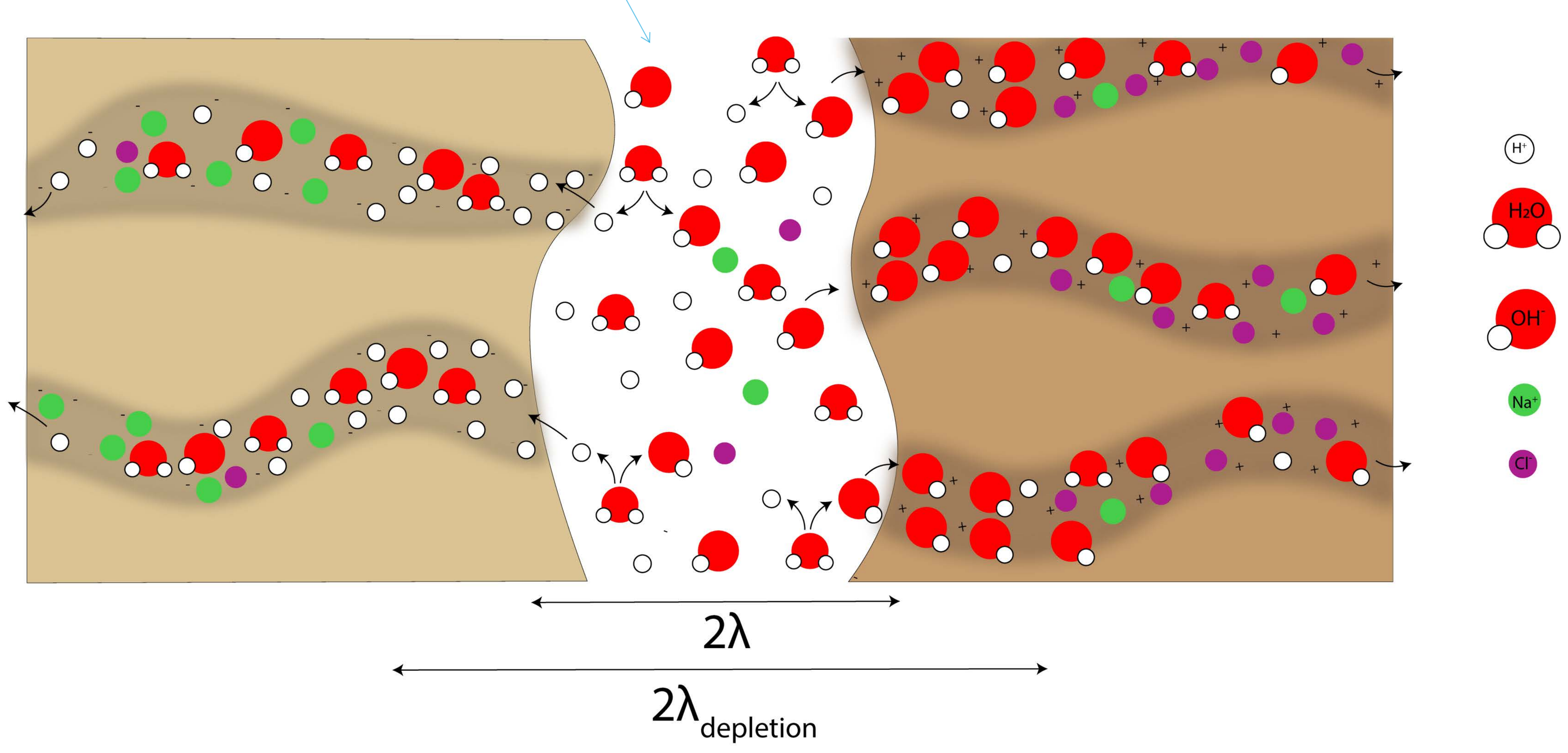


Fig 5: Transition region of BPM in water dissociation region, transport is almost completely done by H^+ and OH^- from water dissociation

Conclusions

- Higher salt concentration leads to a delayed depletion of transition region in BPM
- An increased co-ion region allows flexibility in system approach: a higher current and almost complete WDR or low current and minimal overpotential

References

- [1]Sun, K. *et al.* Adv. Energy. Mater. **6,** 1–7 (2016)
- [2]Vermaas, D. A., *et al.* Sustain. Energy Fuels (2018)

More information?

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