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POTENTIOMETRIC BIOSENSORS USING SEMI-OPEN ELECTROCHEMICAL CELLS (SOEC): A NOVEL PLATFORM FOR ANALYTICAL CHEMISTRY IN THE POINT-OF-NEED

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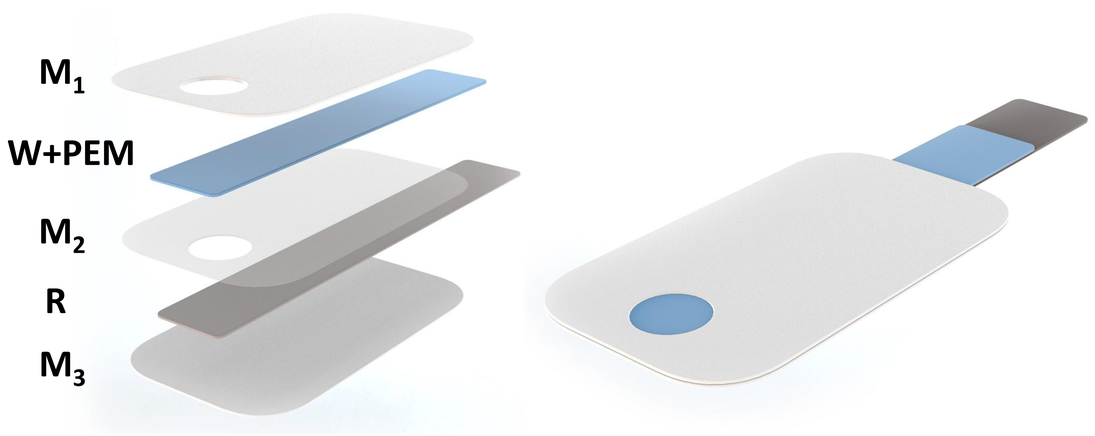
INTRODUCTION

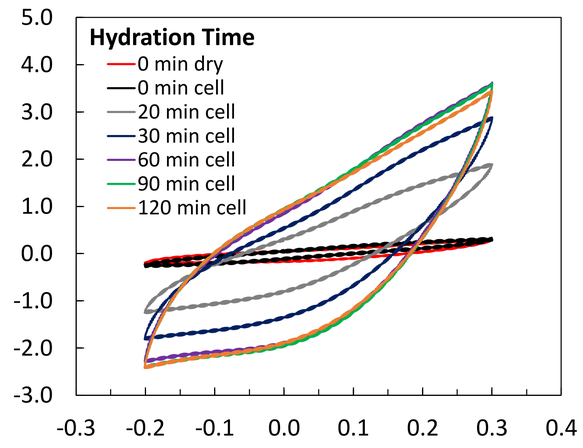
The widespread use of planar cells for electrochemical biosensing presents serious drawbacks when aiming at minimizing sample volume or creating arrays of sensors. We introduce a novel vertically stacked electrochemical cell configuration using a macroporous working electrode, a polyelectrolyte bridge, and a reference electrode. The whole cell is made out of paper so that cost and environmental impact are reduced. The sensor response to hydrogen peroxide was then optimized, including the conditioning and the cell design [1,2]. Besides, full electrochemical characterization provides interesting hints on the pseudocapacitive behaviour of this new electrochemical cell, which allowed working in different operational modes, i.e., potential and current mode. In addition, this new configuration allowed peroxide determination using volumes down to 100 nL with outstanding analytical performance.

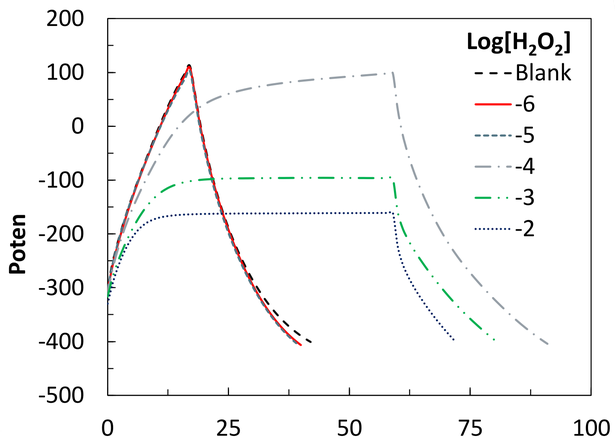
SENSOR FABRICATION



- Working (W)-reference (R) vertical disposition connected via a polyelectrolyte membrane (PEM).
- Porous paper-based Pt electrodes covered with masks (M_{1-3}).
- Nafion coating to enhance the detection of H_2O_2.

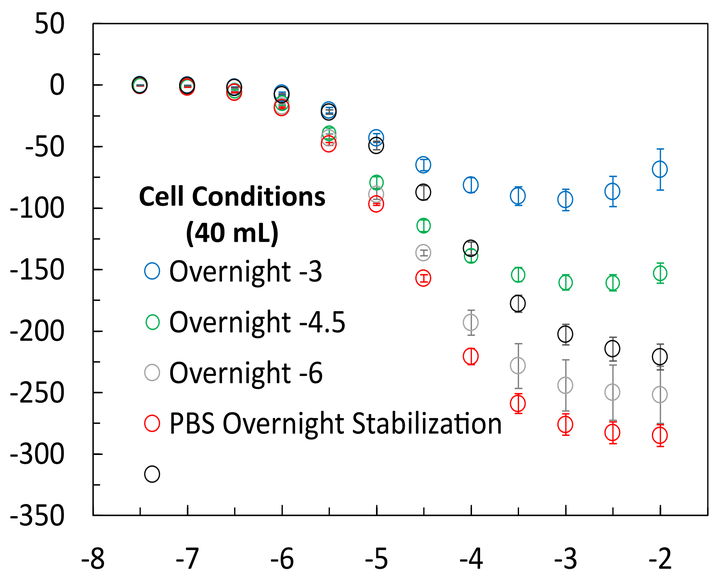
ELECTROCHEMICAL CHARACTERIZATION





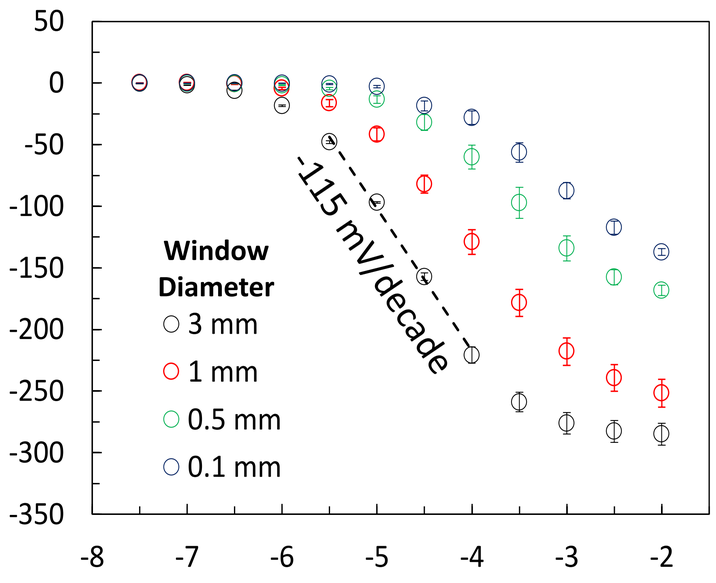
- Pseudocapacitive behaviour in PBS and H_2O_2 cells.
- Nafion complete hydration before sensor usage.
- Hybrid device depending on the electrode polarization.

SENSOR CONDITIONING



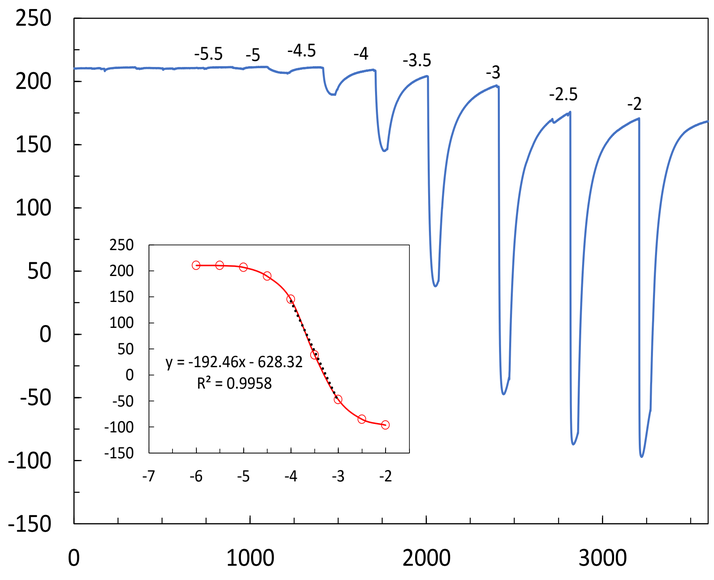
- Response increment with an overnight stabilization in a PBS cell but not in H_2O_2.

DESIGN OPTIMIZATION



- Linear range modulation with sensor geometry.

DROP ANALYSIS



- Cell volume reduced from 40 mL to 100 nL with similar performance.

CONCLUSIONS

- ✓ High versatility and simplicity design.
- ✓ Vertical disposition provides unique pseudocapacitive properties typically observed in energy store electrodes.
- ✓ Complete PEM hydration enhances H_2O_2 total response.
- ✓ Tunable response modifying device architecture.
- ✓ Outstanding analytical performance with low sample volumes.

FUTURE WORK

1. Multiplex analyte detection with oxidase enzymes.
2. Fingertip and wearable sensors for healthcare sensing.
3. Explore other operational modes and sensing techniques.

REFERENCES

[1] M. Parrilla, R. Cánovas, F. J. Andrade, Electroanalysis 2017, 29, 223.

[2] J. F. Baez, M. Compton, S. Chahrati, R. Cánovas, P. Blondeau, F. J. Andrade, Anal Chim Acta 2020, 1097, 204.

ACKNOWLEDGMENTS

The authors would like to acknowledge the financial support from the Spanish ministry of Science and innovation and the state agency of research (AEI) (PID2019-106862RB-I00 / AEI / 10.13039/501100011033) as well as CHEMOSENS (2021 SGR 00705).

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