3ème Conférence Internationale sur les Sciences Appliquées et l'Innovation (CISAI-2025)
Proceedings Book Series –PBS- Vol 25, 169-171

Engineering High-Performance and Stable Electrocatalysts for Seawater Electrolysis: Design of $MnFe_2O_4$@Co Core@Shell Nanostructures

Hatem Guermazi [a], Mourad Smari [b], Taoufik Mnasri [a]

[a] Laboratory of Technology, Energy and Innovative Materials, TEMI, Department of Physics, Faculty of Sciences of Gafsa, University of Gafsa, 2112, Tunisia.

[b] Center for Advanced Materials Research, Research Institute of Sciences and Engineering, University of Sharjah, P. O. Box 27272, Sharjah, United Arab Emirates

Corresponding Email: guermazihatem4@gmail.com

Introduction :

- Seawater electrolysis enables large-scale hydrogen production, utilizing abundant seawater resources and offshore renewable energy **[1]**.

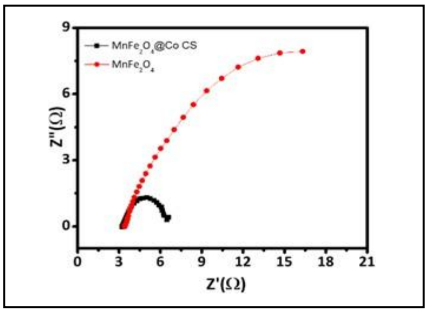
- High chloride ion concentrations (~0.5 M Cl^-) lead to parasitic chlorine evolution reactions, causing electrode corrosion and performance degradation **[2]**.

- Alkaline precipitation ($Ca(OH)_2$, $Mg(OH)_2$) obstructs active catalytic sites, further reducing long term efficiency **[3].**

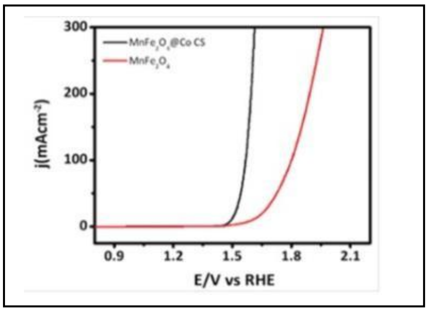
- Traditional metal oxides (Fe-, Ni-, Co-based) suffer from oxidative dissolution, limiting their scalability for seawater electrolysis **[4]**.

- This study presents a $MnFe_2O_4$@Co core@shell electrocatalyst, where the cobalt shell enhances charge transfer and serves as a protective barrier, stabilizing the material for prolonged seawater electrolysis .

Resultats :



Electrochemical impedance spectroscopy **(EIS)**



Cyclic Voltammetry **(CV)** Curves

ISSN: 2961-6611

*** Comments**

- **Enhanced Electrochemical Performance**: The $MnFe_2O_4$@Co electrocatalyst exhibits a remarkably low onset potential **(~1.41 V vs. RHE)**, a reduced Tafel slope, and a high exchange current density, demonstrating superior OER kinetics compared to $MnFe_2O_4$ and Co-based benchmarks.

- **Optimized Charge Transfer**: Electrochemical impedance spectroscopy **(EIS)** reveals a significant reduction in charge transfer resistance, indicating enhanced electronic conductivity and faster interfacial kinetics.

- **Interfacial Electronic Coupling**: The core@shell architecture facilitates strong electronic interactions between $MnFe_2O_4$ and Co, lowering the energy barrier for OER intermediates and optimizing charge transfer efficiency.

- **Improved Corrosion Resistance**: The Co shell serves as a protective barrier, suppressing metal ion leaching and mitigating chloride-induced degradation, ensuring long-term stability in seawater electrolysis.

Conclusion :

- $MnFe_2O_4$@Co nanostructure demonstrates high catalytic activity and corrosion resistance.

- The cobalt shell plays a crucial role in stabilizing anode materials in seawater electrolysis.

- These findings pave the way for advanced electrocatalyst designs in sustainable hydrogen production.

References :

[1] K. Mao, Y. Zhang, S. C. Tan,Nat. Water. 3 (2025) 144-156. https://doi.org/10.1038/s44221-024-00363-x.

[2] Z. Feng, M. Zhang, C. Gu, A. Zhang, L. Wang, Adv. Sustain. Sys. 9 (2025) 2400689. https://doi.org/https://doi.org/10.1002/adsu.202400689.

[3] X. Chen, Y. Tan, Z. Li, T. Liu, Y. Song, S. Zhai, N. Yu, Z. Shao, M. Ni, Adv. Mater. n/a (2025) 2418620. https://doi.org/https://doi.org/10.1002/adma.202418620.

[4] R. Ge, S. Yu, Y. Li, J. Huo, Y. Guo, Y. Kang, W. Li, Z. Bai, H. Liu, Y. Yamauchi, , Adv. Mater. (2025) 2503223.

ISSN: 2961-6611