

ABSTRACT:

Innovative Electrocatalysts for Clean Energy Production: Challenges and Advances Towards a Sustainable Future

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Over the last decade, the emerging energy crisis and global warming have significantly intensified the focus on clean energy production. In this regard, promising solutions to achieve net-zero emissions by 2050 include the exploitation of natural resources, such as water splitting to green hydrogen and biomass-derived ethanol valorization. However, these technologies are not yet competitive with fossil fuel use, compelling further research on efficient and cost-effective systems. In this scenario, further advancements mainly depend on two key factors: developing eco-friendly, active and stable electrocatalysts, and harnessing inexhaustible solar energy in a carbon-neutral behavior. This presentation will overview our recent research group's achievements toward the development of non-precious electrocatalysts for environmental-friendly energy production, with particular regard to oxygen evolution reaction (OER), a crucial step in H₂O electrolysis for H₂ production, and ethanol oxidation reaction (EOR), as a potential route for waste-to-resource conversion. This lecture will focus on selected case studies involving metal oxide based electrocatalysts: a) MnO₂ nanostructures coupled with exfoliated carbon nitride (gCN) nanoaggregates, to yield an enhancement of the OER activity [1]; b) 3D hierarchical Au-functionalized MnO₂ by plasma-assisted techniques, providing excellent performances as EOR electrocatalysts [2]; c) eco-friendly Cu_xO/CN (x = 1,2), designed by a novel plasma-assisted method, showing promising efficiency for green H₂ production [3]; d) Pt-gCN nanocomposite architectures, prepared by electrophoretic deposition and RF-sputtering, featuring attractive EOR performances with minimal platinum content [4].

[1] C. Maccato et al., ACS Appl. Mater. Interfaces, 15, 47368 (2023).

[2] C. Maccato et al., J. Mater. Chem. A, 8, 16902 (2020).

[3] C. Maccato et al., Dalton Trans., 53, 17452 (2024).

[4] C. Maccato et al., ChemSusChem 2024, 17, e202401041 (2024).