Recent progresses in the fabrication of active materials for hybrid water electrolysis: a chemical perspective

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The large-scale utilization of water electrolysis, a sustainable hydrogen production method , is hampered by the sluggish kinetics of the anodic oxygen evolution reaction (OER), hindering the achievement of technologically viable efficiencies. To overcome this challenge, an amenable alternative is disclosed by the replacement of OER with energy saving and more favorable reactions. In this context, the electrolysis of aqueous solutions of biomass-derived alcohols, such as ethanol, endowed with low toxicity and high energy density, enables to conveniently upgrade renewable or low-value feedstocks, increasing the return of energy investment in comparison to conventional water splitting [1,2]. Nevertheless, in order to implement such processes for eventual real-world applications, the fabrication and tailoring of highly active electrocatalysts is a mandatory task [3].

In this context, the present contribution will provide a brief survey on our recent progresses in the design of multi-component (photo)electrocatalysts for ethanol electrochemical valorization, focusing on the following representative case studies:

i) hierarchical MnO_2 nanoarchitectures, grown on high-area Ni foam scaffolds by a plasma-assisted route and functionalized with highly dispersed Au nanoparticles [3];

ii) platinum-graphitic carbon nitride (gCN) nanocomposites with minimal Pt content, obtained by gCN electrophoretic deposition on carbon paper substrates and subsequent Pt sputtering under mild conditions [1];

iii) gCN supported on flexible carbon cloths and functionalized with nano- and ultra-dispersed ZnO and $ZnFe_2O_4$ co-catalysts by cold plasma sputtering [2].

In particular, the attention will be devoted on highlighting the interplay between material chemico-physical properties, investigated *via* a multi-technique theoretical and experimental characterization, and the ultimate functional performances in the target field.

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[3] D. Barreca *et al.*, *J. Mater. Chem. A*, 2020, **8**, 16902.