

Preparation and characterization of phosphorus-containing electrocatalyst for OER, HER and ORR

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Phosphorus-based materials, such as transition metal phosphides and phosphates/pyrophosphates, have drawn considerable attention as promising alternatives to noble metal-based catalysts (Pt, Ru, Ir) owing to their widely tunable electrocatalytic properties.[1]

In this work, we propose the preparation of electrocatalysts using metal phosphonates of composition $M(O_3PCH(OH)COOH) \cdot 2H_2O$ ($M^{2+} = Mn, Fe, Co, \text{ and } Ni$) as precursors.[2] The electrocatalysts were obtained by pyrolytic treatments (N_2 or 5% H_2 -Ar atmospheres) giving rise to a wide family of crystalline and amorphous metal pyrophosphates and phosphides. The full-characterised solids by XRD (laboratory and synchrotron), TEM and XPS were then assayed as catalysts for Oxygen Evolution Reaction (OER), Oxygen Reduction Reaction (ORR) and Hydrogen Evolution Reaction (HER). The amorphous iron(II)-doped cobalt pyrophosphate and crystalline phosphides (MP and/or M_2P ; and $M^{2+} = Co, Ni$) exhibited the best performances and long-times stabilities. On the other hand, pair distribution function (PDF) studies, using synchrotron radiation, and XPS analysis reveal that the amorphous/crystalline phases are stable for the HER and ORR processes, while solids evolve to other active phases, such as (oxy)hydroxides, upon conducting the OER. The performance of selected electrocatalysts has been tested for H_2 production and monitored by laboratory X-ray computed nanotomography (nanoCT).

References

- [1] X. Lin, J. Wang. *Adv. Mater. Interfaces*, **2020**, 7, 2000676.
[2] I. R. Salcedo, M. Bazaga-García, A. Cuesta, E. R. Losilla, K. D. Demadis, P. Olivera-Pastor, R. M. P. Colodrero, A. Cabeza. *Dalton Trans*, **2020**, 49, 3981-3988.