Ternary cobalt-nickel phosphide nanowire catalysts for electrochemical oxygen and hydrogen evolution in alkaline media

Isilda Amorim, Junyuan Xu, Lifeng Liu*

International Iberian Nanotechnology Laboratory (INL), Avda. Mestre José Veiga, 4715-330 Braga, Portugal

lifeng.liu@inl.int

Electrochemical water splitting enabled by renewable energy sources represents a promising approach to the generation of clean and high-purity hydrogen (H_2) fuels because unlike steam reforming of hydrocarbons this process does not emit any pollutants. Despite the advantages, the cost of water electrolyzers prohibits their market penetration and makes electrolysis not an economically viable approach for the production of H_2. In order to reduce the production costs and improve the overall water splitting performance it's important to develop highly efficient, low-cost and durable electrocatalysts in order to drive the hydrogen evolution (HER) and oxygen evolution reactions (OER). In this context, several new nanostructured catalysts have been recently synthetized based on the transition metal phosphides (TMPs) to expedite the OER and HER.[1,2]

In this talk, ternary Co_xNi_yP nanowires (NWs) and their catalytic performance for both OER and HER will be presented. These NWs were fabricated by a facile hydrothermal method with different Co:Ni ratios, followed by a phosphorization treatment with NaH_2PO_2 at a low temperature. The Co_xNi_yP nanowires with a Co:Ni ratio of 1:1, relative to those with Co:Ni ratios of 2:1 and 10:1 as well as binary CoP and NiP, show the best electrocatalytic performance for OER in 1.0M KOH: a benchmark anodic current density of 10 mA cm^{-2} can be achieved at a small overpotential of 301 mV, with a moderate Tafel slope of 54 mV dec^{-1}. Furthermore, all the catalysts show long-term durability. When tested under HER conditions in the same alkaline electrolyte, the catalysts also exhibit reasonably good activity with best performance achieved by CoNiP NWs with the Co:Ni ratio of 1:1.

References

[1] X. Wang, W. Li, D. Xiong, L. Liu, *J. Mater. Chem. A.*, *4* (2016) 5639.

[2] X. Wang, W. Li, D. Xiong, D. Y. Petrovykh, L. Liu, *Adv. Funct. Mater. 26* (2016) 4067.

Figures

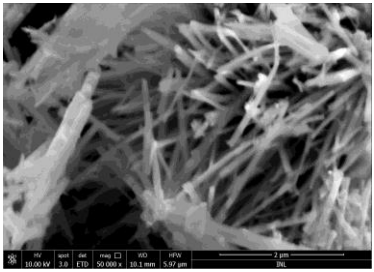

Figure 1: SEM image at high magnification of the as-fabricated CoNiP (10:1) powders.

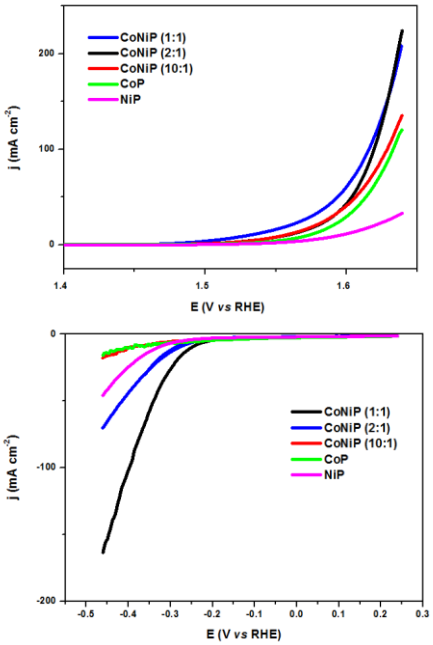

Figure 2: iR-corrected polarization curves of CoNiP with different ratios of Co:Ni on glassy carbon electrode for (top) OER and (bottom) HER in 1.0 M KOH.