Highly nanoporous Ni-based electrocatalysts by electrodeposition

Konrad Eiler[a,b]
Roberto Fagotto Clavijo[a], Arántzazu González-Campo[c], Jordi Sort[a,d], Eva García-Lecina[b], Maria Lekka[b], Eva Pellicer[a]
[a]*Universitat Autònoma de Barcelona, Campus de la UAB, 08193 Bellaterra, Spain*
[b]*CIDETEC Surface Engineering, P^o Miramón 191, 20014 Donostia – San Sebastián, Spain*
[c]*Institut de Ciència de Materials de Barcelona (ICMAB-CSIC), Campus de la UAB, 08193 Bellaterra, Spain*
[d]*Institució Catalana de Recerca i Estudis Avançats (ICREA), Pg. Lluís Companys 23, 08010 Barcelona, Spain*
konrad.eiler@uab.cat

Global developments demand for fossil free, renewable energy solutions. The hydrogen energy cycle through water splitting by electrolysers and electric power generation by fuel cells can provide a sustainable solution for energy consumption and storage. In order to increase the accessibility of hydrogen energy systems, the cost efficiency is tackled by development of platinum-free electrocatalysts such as nickel-based alloys. The catalytic reactions in focus are hydrogen evolution reaction (HER) and oxygen reduction reaction (ORR), which, in absence of platinum group metals (PGMs), are investigated in alkaline media. The electrodeposition of Ni-based alloys from aqueous media allows for the synthesis of well-defined nanostructures of thin films with increased efficiency at HER with respect to dense thin films due to their nanoporosity [1]. In this work, Cu-Ni alloy films are electrodeposited within a wide compositional range by simple modification of the deposition potential. The addition of a block copolymer in the electrolyte results in the spontaneous formation of polymeric micelles. In this way, the so-called micelle-assisted electrodeposition yields a homogeneous mesoporosity independent of composition, with a pore size of approx. 10 nm (Figure 1). HER is evaluated by linear sweep voltammetry in 1 M KOH as a function of the composition. The study is complemented by common characterisation such as SEM/EDX, XRD, and XPS. In addition, it was determined that although the pore size of 10 nm leads to high efficiencies at HER due to high surface-to-volume ratio, higher pore size may be advantageous for the electrocatalytic activity. A high-molecular weight block copolymer was developed for the generation of larger micelles in order to obtain larger pore sizes. As a result, electrodeposited Ni films using this polymer do not only show larger pores up to 600 nm, but the porosity is also very obviously interconnected as demonstrated by SEM imaging. Most importantly, the efficiency at HER in alkaline media is significantly improved with respect to the 10 nm pore size.

References

[1] K. Eiler, S. Suriñach, J. Sort, E. Pellicer, Appl. Catal. B, 265 (2020) 118597

Figures

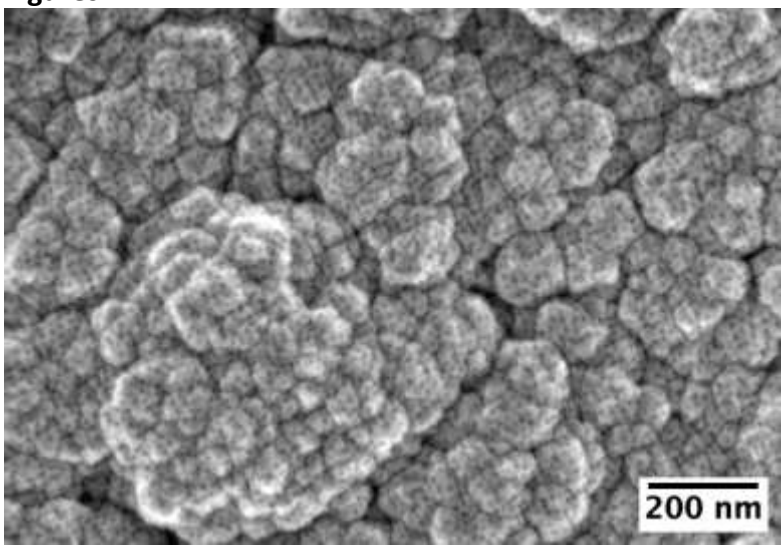

Figure 1: SEM micrograph of a mesoporous $Cu_{68}Ni_{32}$ alloy thin film produced by micelle-assisted electrodeposition.