

# Improvement of Bubble Detachment and Overpotential during Hydrogen Evolution on (de-)alloyed Nickel Electrodes

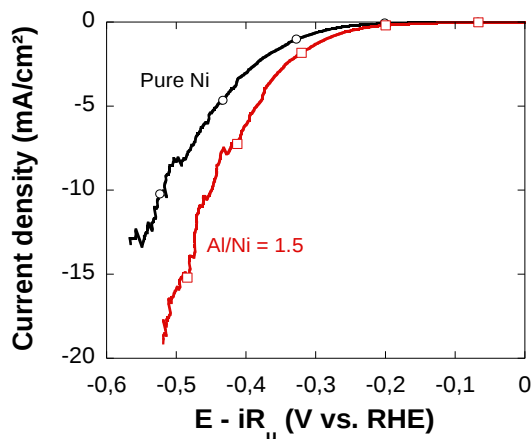
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Water electrolysis from renewable electricity may enable the widespread use of hydrogen as a high energy density carrier with no point-of-use emissions. Production of hydrogen by water electrolysis has already been intensively studied, but efficiency of electrochemical cells still needs to be improved before they can be used on large scales. The electrochemical performance of the electrodes itself is currently still one of the limiting factors. Improvements in efficiency can be obtained by increasing the rate of electron transfer between water and the electrode, or by improving mass transport of reactants and gaseous products. The objective of this work consists in improving the mass transfer aspect by tailoring the electrode morphology in order to favor bubble detachment. In this respect, earlier reports have shown how optimal synthesis conditions for DSA-type anodes leading to mud-crack type surfaces showed enhanced bubble detachment for the oxygen evolution reaction [1].

In the current contribution, we use de-alloyed nickel thin film electrodes to evaluate performance enhancements resulting from improved bubble detachment at the electrode surface. These nanostructured nickel electrodes were obtained by magnetron co-sputtering of Al-Ni alloys from pure Ni and Al targets, followed by annealing at 400°C and selective Al leaching in concentrated hydroxide solutions. Cyclic voltammetry on this new type of de-alloyed electrodes shows a significant decrease of the overpotential for the hydrogen evolution reaction as compared with pure Ni electrodes (Figure 1). The aim of this study is then to discuss on the one hand the morphology and microstructure of these nanostructured Ni electrodes as a function of their processing conditions, and on the other hand how these structural features impact the electrochemical performance.

[1] A.R. Zeradjanin, A.A. Topalov, Q. Van Overmeere, S. Cherevko, X. Chen, E. Ventosa, W. Schuhmann, K.J.J. Mayrhofer, RSC Adv. 4 (2014) 9579.



**Figure 1:** Cyclic voltammogram for hydrogen evolution on (black circles) a pure Ni thin film electrode and (red squares) an annealed de-alloyed Ni thin film electrode with an initial atomic ratio of Al/Ni = 1.5 prior to leaching. Forward and backward sweeps were averaged to subtract capacitive current contributions.

**Keywords:** hydrogen production, water electrolysis, nickel thin film electrodes, de-alloying