Effects of the composition and structure of mesoporous Ni-Pt films on their corrosion behaviour in acidic media used for hydrogen evolution reaction

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Hydrogen is an energy source with increasing interest and importance. A focus for the production of hydrogen is through hydrogen evolution reaction (HER) in either alkaline or acidic media using efficient electrolysers. However, the durability of electrocatalysts is still an issue, especially in acidic media.

In this work, mesoporous single phase Ni-Pt films with a homogeneously distributed porosity in the order of 10 nm are presented. Their synthesis is achieved by a one-step micelle-assisted electrodeposition onto Cu-coated Si wafer from aqueous solution containing metal salts and a block copolymer. By varying the deposition potential of the potentiostatic deposition process, films with varying composition are deposited, ranging from ca 50 to 99 at-% Ni.

Linear sweep voltammetry (LSV), carried out by sweeping the potential between 0 V and -0.3 V vs RHE over 200 cycles in 0.5 M H_2SO_4 solution, show a strong activity towards HER, which initially increases and stabilises over time for all samples within the composition range. However, EDX analyses before and after HER on a series of samples indicates a loss of Ni (leaching) of the films within a few atomic percent. It is suspected that the loss of Ni gives access to more Pt on the surface of the films and thus the HER activity increases; on the other hand, the stabilisation indicates that this loss of Ni may take place during the first cycles only.

To further investigate corrosion effects during HER, polarisation measurements are conducted in the same media for samples with different Ni to Pt ratios. Corrosion potentials and corrosion current density rates are determined for all samples and related to the composition of the films. Electrochemical impedance spectroscopy is conducted with the aim to develop a model representing the corrosion resistance of the thin films. On a number of selected samples, the corrosion on microscale is investigated using electrochemical microcell techniques (EMT) to investigate effects of possible inhomogeneity within a sample. All samples are analysed by SEM/EDX before and after corrosion measurements to monitor eventual changes on surface morphology, porosity, and chemical composition.

Acknowledgement:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 764977