Impedance spectroscopy of water splitting reactions on nanostructured metal-based catalysts

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Hydrogen production by water splitting using nanomaterials as electrocatalysts is a promising route for replacement of fossil fuels by renewable energy sources. In particular, development of inexpensive non-noble metal-based catalysts is necessary in order to replace currently used expensive Pt-based catalysts on a large scale. Impedance spectroscopy is a versatile method to study the hydrogen and oxygen evolution reactions, thus laying the groundwork for an increased understanding of the connection between material properties and performance.

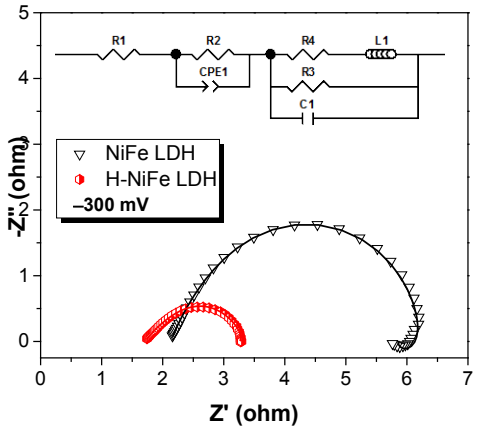

Fig.1 Nyquist plots for two NiFe-based catalysts at -300 mV overpotential versus RHE. The inset shows the equivalent circuit, where the right-hand part is one of the H-C models [1] and pertains to the hydrogen evolution reaction.

In this paper we report on a detailed impedance study of Ni-Mo and Ni-Fe based electrocatalytic materials deposited onto porous and compact substrates. The impedance parameters depend greatly on the morphology and character of the substrates. Results were interpreted within the framework of Harrington-Conway (H-C) [1] and double R-CPE [2] equivalent circuit models. Optimized Ni-Fe based catalyst showed very promising properties, yielding an electricity-to-fuel conversion efficiency of up to 83% at current densities of 10 $mAcm^{-2}$. The materials were analyzed in terms of their frequency response during the water splitting reaction. Ni-Fe displayed an inductive impedance response at low frequencies, which is related to the presence of an adsorption step in the reaction.

References

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2. J. Fournier, L. Brossard, J.-Y. Tilquin. R. Cote, J.-P. Dodelet, D. Guay and H. Ménard, J. Electrochem. Soc. **143**, 919 (1996)