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# Electrochemical hydrogenation of nickel thin film electrodes

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## Introduction

Fossil fuels need to be replaced by greener energies due to their devastating impact on the environment. In this context, hydrogen produced by water electrolysis from renewable electricity is one of the most promising candidates since it is a high energy density carrier with no point-of-use emissions. Even though alkaline water electrolysis has already been intensively studied, several barriers such as production cost or electrochemical cells efficiency have to be overcome before it can be used on a larger scale.

## Results and Discussion

In the case of alkaline water electrolysis, Ni is usually the electrode material of choice for the hydrogen evolution reaction (HER), due to its low cost, relative abundance, high activity and long-term stability in alkaline solutions. Most studies focus on the effect of morphology and crystallographic structure on the electrochemical performance, but it is also necessary to point out that during operation, structural modifications of the electrode can occur as a result of electrochemical hydrogenation [1]. Indeed, knowing that Ni has a strong Ni-$H_{ads}$ bond strength leading to the blocking of available reaction sites, Kim et al. demonstrated that hydrogenation increases the number of electron states far from the Fermi level, thus enhancing the HER activity [1]. Another study showed that nickel hydride formation modifies the reaction pathway to a condition in which the HER is limited by desorption [2]. In our contribution, Ni thin film electrodes will be tailored to investigate different conditions of electrochemical formation of Ni hydrides.

Our Ni thin film electrodes were obtained by magnetron sputter deposition using several deposition pressures in order to create different internal stresses in the films. Stresses obtained this way varied between 0 and 0.9 GPa. Cyclic voltammetry and chrono-amperometry have then been coupled to an in-situ multi-beam optical stress sensor in order to measure the internal stress evolution in real time during electrochemical Ni hydriding. The internal stress was then linked to the amount of H-incorporation into the film, based on a detailed high-resolution TEM analysis.

## References

1. S-M. Kim, S-H. Jin, Y-J. Lee, M.H. Lee, *Electrochim. Acta*, 252 (2017) 67-75
2. D.M. Soares, O. Teschke, I. Torriani, *J. Electrochem. Soc*., 139 (1992) 98