Can we split water with stainless steel electrodes?

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It is no secret that power-to hydrogen is one relevant solution to store renewable electricity, and can therefore enable a more rational usage of energy, an endeavor towards the limitation of our carbon footprint. One of the means to generate “clean” hydrogen is water electrolysis, but present systems are not industrially optimized, yet. On the one hand, proton-exchange membrane water electrolyzers (PEMWE) are rather energetically-efficient and compatible with transient (intermittent) operation (a prerequisite for the storage of renewable electricity), but these systems are based on perfluorosulfonic proton-exchange membranes that are neither cheap nor “green” to produce, and platinum group metals (PGM) [1] that are both scarce in the Earth crust and expensive [2]. Besides, the durability of PEMWE is still open to question [3], as none of these systems have been used at industrial scale on the long-term. On the other hand, alkaline water electrolyzers (AWE) are industrially mature since several decades, essentially because they can operate with limited use of PGM [4] (e.g. Ni-based [5, 6]), but their performances are far inferior to those of PEMWE [7]. So there is still room to improve both the initial activity and the long-term stability of electrodes for use in alkaline water electrolysis.

Stainless steel supports have long been used in AWE systems, owing to their robustness and good electron-conducting properties. More recently, under the impulsion of, among others, Schäfer and Chatenet, it has been demonstrated that stainless steel could also consist of active materials for the water splitting reactions [8, 9]. Indeed, stainless steels contain non-negligible amounts of nickel and, if properly “activated” can form a “passivation layer” that shows very interesting activity for the evolution of oxygen [10, 11]. In this presentation, the way to activate stainless steel electrodes will be detailed, and the pros and cons of stainless steel electrodes for water splitting will be set.

References