Hydrogen and Oxygen bubble detachment from nanowire-based electrode in alkaline electrolyzers.

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Green hydrogen is one of the most promising solutions for integrating renewable energy sources, allowing excess energy to be stored and used when needed. Green hydrogen can be used in various sectors, from industry to transport. However, its main drawback remains the high cost compared to hydrogen produced from fossil sources. Many studies focus on optimizing electrolysis technology to reduce costs and improve efficiency. An efficient way to improve the performance of electrolysis is based on the use of nanostructured electrodes with low cost and high electrocatalytic activity.

In this work, the template electrosynthesis method was used to fabricate the electrodes. The template is a commercially available porous polycarbonate membrane (PMC - Whatman, Cyclopore, 20 µm thick) which, due to its morphology, allows the formation of nanostructures in the form of nanowires, which are highly interconnected and have the advantage of having a high surface area.

The aim of this work is to investigate how electrode structure can affect hydrogen and oxygen bubble size and bubble detachment from the surface of the nanostructured electrode compared to a planar electrode. The tests were carried out in a three-electrode configuration cell in 1M KOH solution. The electrochemical cell has two observation windows. It is worth highlighting the possibility of simultaneously recording side and top views of the hydrogen and oxygen generating electrode to capture the bubble evolution over time from two different perspectives. Two high-speed cameras (IDT OS-7 S3, USA), each equipped with a precision micro-imaging lens with a magnification of 2 (Optem® FUSION, USA), were used at a sample rate of 500 fps and a bit depth of 12 bit. An LED-based illumination source as backlight completed the shadowgraph measurement system. The image analysis procedures were performed in Python 3.8.

The analysis of the tests carried out allows us to derive both information on the size of the gas bubbles developed on the electrode surface and a quantitative analysis of the volume of gas developed for the same electrode geometric area and current density. The potentials recorded during the tests are also compared to demostrate how much a nanostructured electrode can improve the performance of an electrolyzer in terms of energy savings.

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