

LO – H2 Project n°2

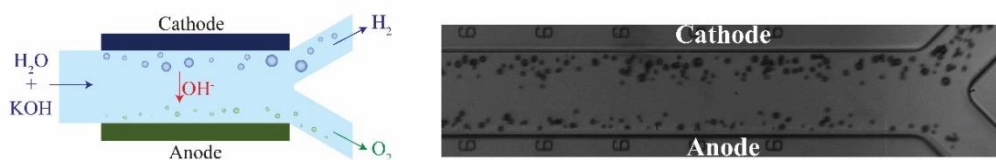
Title: Energy storage in the form of hydrogen using membrane-less electrolyzers

Project: Master project / Semester project

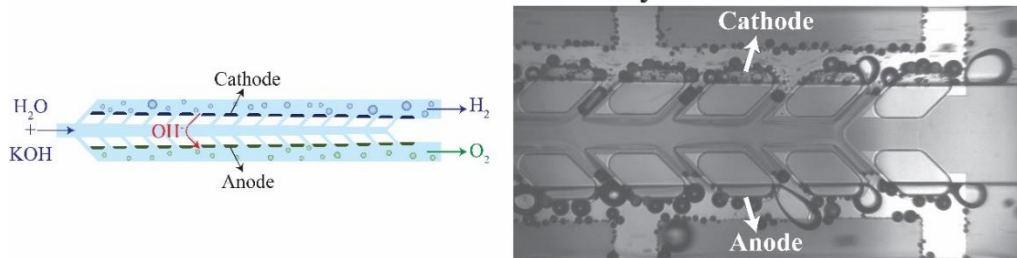
Introduction:

Renewable energies have been developed significantly in the last decade in an effort to reduce the need for hydrocarbon fuels. Consequently, the cost of energy from renewable sources is becoming competitive compared to fossil fuels. However, the renewable energy sources are intermittent and a storage mechanism is required to compensate for their intermittency. Energy storage in the form of hydrogen has been regarded as one of the primary storage strategies due to the high energy density of hydrogen. Water electrolysis is the major technology for clean hydrogen production. However, hydrogen produced through water electrolysis is too expensive due to the high capital and operating costs of electrolyzers. Technological innovations are required to improve the performance of water electrolyzers and reduce the cost of hydrogen production.

a. Parallel electrode electrolyzer



b. Porous wall electrolyzer



c. 3D printed membrane-less electrolyzer

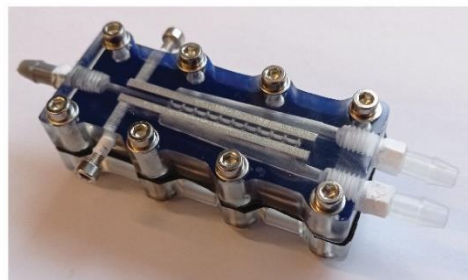


Figure 1. Membrane-less electrolyzers developed at LO: a) Parallel electrodes electrolyzer relies on the fluidic flow to separate the oxygen and hydrogen bubbles, b) Porous wall electrolyzer utilizes fluidic flow and geometrical topographies to achieve highly pure hydrogen production, c) a picture of the 3D printed membrane-less electrolyzer.

A water electrolyzer requires catalysts to split water molecules into hydrogen and oxygen and an ion-conducting medium (electrolyte) to conduct ions between the catalysts. The products of water electrolysis are in gas form. Therefore, we need a mechanism to separate hydrogen and oxygen

bubbles. Commercial electrolyzers use a membrane or a separator to keep hydrogen and oxygen bubbles separated. This gas separation mechanism can limit the operating conditions of the water electrolyzer and increase the hydrogen production costs. Optics Laboratory (LO) is developing a novel flow-based electrolyzer called “**membrane-less electrolyzer**” that resolves many technological issues of commercial electrolyzers.

A membrane-less electrolyzer utilizes flow to separate the bubbles and eliminates the need for the membrane. Figure 1 shows two membrane-less electrolyzers. Figure 1.a shows the parallel electrodes membrane-less electrolyzer where the electrolyte flow applies inertial forces on bubbles to keep the two streams of oxygen and hydrogen bubbles separated. Figure 1.b depicts the porous wall membrane-less electrolyzer that separates the oxygen and hydrogen bubbles using electrolyte flow and geometrical topographies. Figure 1.c shows a picture of 3D printed membrane-less electrolyzer.

Project description:

The area of the electrode determines the efficiency and hydrogen production rate of electrolyzers. Increasing the depth of channels leads to a larger active electrode area. However, the fluidic flow inside the electrolyzer and the performance of the device can change. In this project, you are going to increase the area of the electrode by designing and fabricating a membrane-less electrolyzer with deep fluidic channels as shown in Figure 2. The initial design of the electrolyzer is available. You will use 3D printing technologies to fabricate the electrolyzer. Afterwards, you can test the device using a test bench available in the lab to measure the production rate, efficiency, and hydrogen purity. This project provides an exceptional opportunity to learn or improve your knowledge and expertise in CAD designing, 3D printing technologies, electrochemistry, and fluid mechanics.

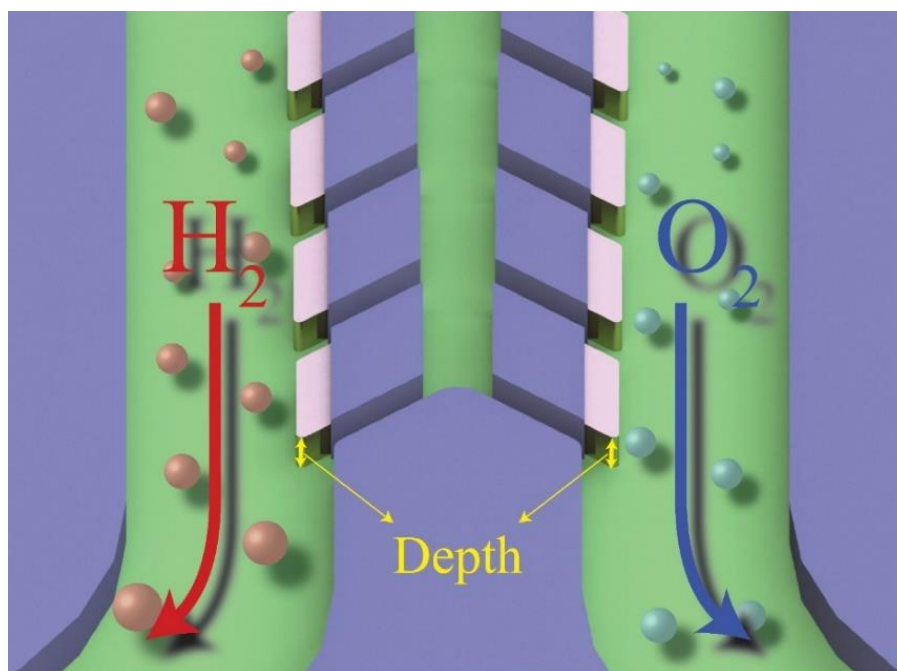


Figure 2. The goal of this project is to increase the depth of membrane-less electrolyzers to achieve higher hydrogen production rates while maintaining the high purity of produced hydrogen.