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Effect of a PTL Coating and The Clamping Pressure on The Performance of a PEM Electrolyzer Cell.

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The temperature of the earth is slowly increasing due to the excess CO₂ production from the use of fossil fuels in the energy consumption and power production cycles. The International Energy Agency (IEA) has placed a goal for the decarbonization of the power production system. By 2050, The IEA has devised the net zero energy plan to allow the hydrogen use to extend to several parts of the energy sectors and grow to meet 10% of total final energy consumption by that year. All the hydrogen produced should be supplied from low-carbon sources[1]. A key player in the decarbonization plan is electrolysis technology. Specifically, PEM electrolysis has gained popularity throughout the years and has started to become more commercialized and its coupling to renewables allowed the technology to produce fully green hydrogen. Researchers' goal now is to optimize this technology and reduce its cost. As it uses a protonic membrane in an acidic media, it requires expensive components that need to sustain harsh acidic conditions[2].

Usually, a PEM water electrolysis unit is made up of a CCM (catalyst coated membrane made with a Nafion 115 coated with iridium oxide on the anode side and nanoparticles of platinum on a carbon support on the cathode side) sandwiched between a titanium porous layer at the anode and a carbon GDL on the cathode. All the components are contained with feeding plates usually made from titanium[3]. The electrolyzer is tightened enough to prevent leaks and ensure a good contact resistance. However, too much clamping can damage the components of the cell as it can reduce the GDL porosity, furthermore can reduce the protonic conductivity of the membrane due to the decreasing of its water content; hence limiting the electrolyzer performance. Another effect is the thinning of the membrane which can affect the hydrogen permeation rate and possibly cause a safety issue as the hydrogen in oxygen content should be less than 2%[4]. Each component has its influence on the contact resistance, the most influential one is that between the porous titanium PTL and the anodic catalytic layer. One uncoated PTL and three coated PTLs (Au, Pt, Ir) were implemented. The precious metal deposit has a positive effect on the interfacial contact resistance between the catalyst layer and the PTL as it decreases compared to an uncoated PTL: the gain is about 150mV at 2A/cm² for a 6.6 MPa clamping pressure – see Fig. 1a. The three deposits lead to the same performances below 2.5A/cm² and for higher current densities the Iridium deposit is less good than the gold and platinum ones at the beginning of life. After an activation of few hundred hours of operation, the iridium deposit leads to the same performance as the platinum deposit and the gold deposit began to dissolve. To explore higher clamping pressure, the carbon GDL was replaced by a more rigid titanium felt and clamping experiment with an uncoated PTL were performed from 2.9 to 13.22MPa – see figure 1.b. Then decreasing it to see the effect of excessive tightening and relaxation, but unexpected increase in performance was observed up until a certain clamping (6.6MPa) (Fig. 1b) during the relaxation phase then the performances started

to decrease. We attribute this behavior to the better water absorption of the membrane during the relaxation phase once the electrical contact is achieved at high pressures. These results might show an efficient method in assembly and clamping of an electrolyzer cell to obtain better performances.

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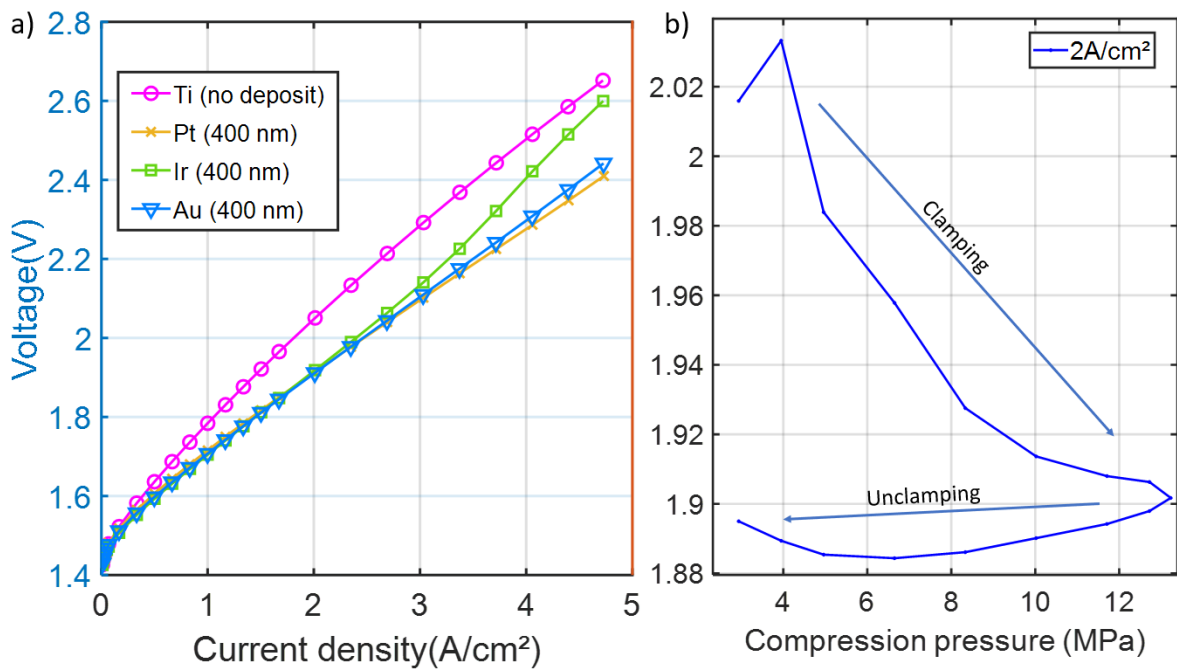


Fig. 1: representation of: a) The Polarization curves for the different PTLs at 6.9 MPa with a carbon GDL at the cathode side, b) The potential during the clamping/unclamping tests for the uncoated PTL at 2 A/cm² and with a titanium felt at the cathode side.