Investigation of Steel based Bipolar Plates for PEM Water Electrolysers

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ABSTRACT

The Proton Exchange Membrane Water Electrolyser (PEMWE) is an efficient technology for hydrogen production, operating at high pressures and high currents. Its fast response to dynamic energy inputs, makes the PEM electrolyser the best alternative to be connected to intermittent sources like wind and solar energy [1]. Although efficient, the PEM electrolyser still suffers from high capital costs, dominated by the Bipolar Plates (BPP) [2]. The typical BPP material is titanium, which can withstand the corrosive environment in the anode chamber. However, Ti is expensive and hard to machine, and its cost is higher when noble metal coatings are used to protect the BPP from the increase in Interfacial Contact Resistance (ICR) during operation [2]. Stainless steel based BPPs are an attractive alternative to titanium because of their lower cost, easy manufacturing, and high mechanical and electronic properties [3]. Because steel is prone to corrosion in the PEMWE environment, these BPPs must be coated by protective layers with high conductivity and low density of defects.

In this work, steel BPPs were coated by magnetron sputtering with titanium, niobium

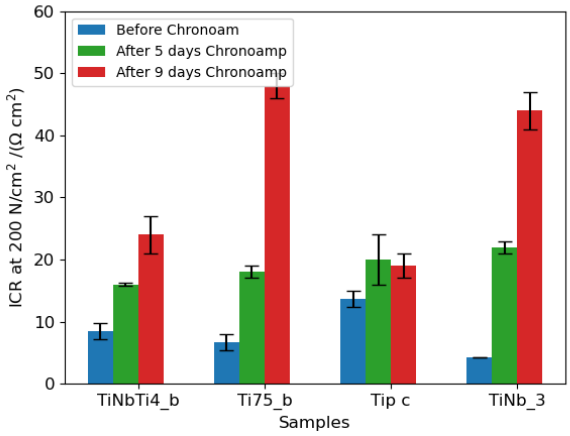

Figure 1 ICR measured before, after 5 and 9 days of chronoamperometry at 1V_{SHE}. From left to right: multilayer (Ti+Pt+Ti) on steel, Ti on stainless steel, pure Ti and alloy (Ti/Nb) on steel.

and platinum in various compositions. The plates were investigated ex-situ and in-situ as alternative anode BPPs for PEM water electrolysers.

Stainless steel substrates were coated with titanium and niobium in different compositions and studied ex-situ. The corrosion tests were carried out applying constant voltage of 1.0V_{SHE} in electrolyte at pH 5.5. ICR was measured before the test, after day 5 and day 9, and the results in Fig.1 show similar trends for the coated steels and the pure Ti reference. Steel BPPs were coated with titanium, niobium and platinum in different compositions and investigated in-situ. The protocol included a short durability test at 2V to promote oxidation and degradation of the BPPs, and the ICR was measured before and after the tests (Fig.2). While the ICR measured for the pristine Ti plate increased by three times, all coated steel BPPs did not show significant change from before to after the test.

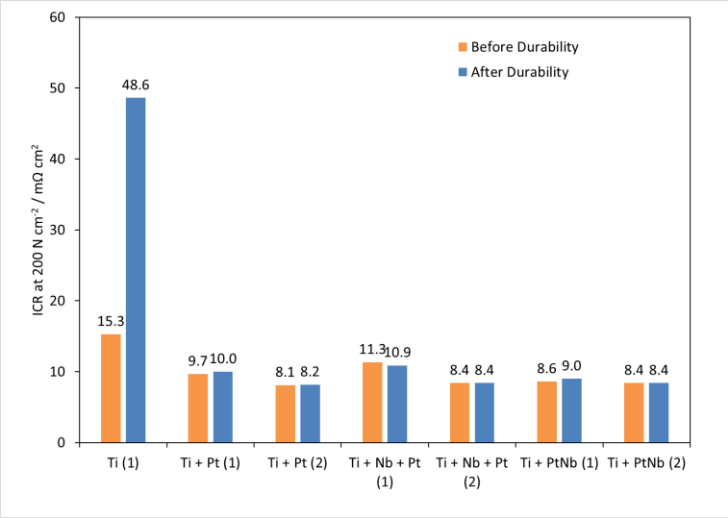

Figure 2 ICR before and after in-situ testing including steady state operation at 2V for 76 hours. The plates from left to right are pristine Ti, Ti and Pt on steel (x2), multilayer Ti+Nb+Pt on steel (x2) and Ti + alloy Pt/Nb on steel.

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