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Interfacial contact resistance of tantalum coated construction materials for high temperature steam electrolysers and fuel cells

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Introduction

Membranes e.g. Aquivion® and Nafion® doped with phosphoric acid are typically used in PEM systems at elevated temperatures.[1] Thus the electrodes and bipolar plates should be resistant to this acidic environment.

Due to high operating potential combined with the presence of oxygen, corrosion is particularly severe in the anode compartment of electrolysers.[1] When the metals corrode, the passive films formed on the surfaces may increase the contact resistance and reduce cell performance.[2] To overcome the corrosion problems we typically employ tantalum coated stainless steel as anode material.

This work concerns the interfacial contact resistance (ICR) at the current collector/bipolar plate and current collector/catalyst layer interfaces, which contributes to efficiency losses of the cells. A way to reduce the ICR is by application of a corrosion resistant and electrically conductive coating.[3]

Bulk tantalum and tantalum coating on stainless steel are evaluated. Measurements were furthermore performed on titanium, since this is the most commonly used material for bipolar plates in Nafion® based systems.[1]

Experimental

Anodisations were performed at 2 V and 130 °C in 85% H_3PO_4.

ICR values were obtained using two pieces of foil sandwiched together. The total resistance was measured as function of clamping pressure, by holding a constant current density. This was done using a four point arrangement.

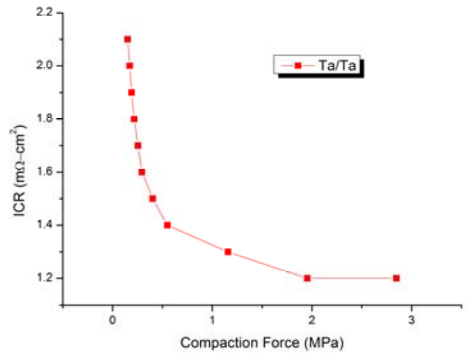
Results

This work confirms the high corrosion resistance of tantalum. The measured ICR of two tantalum plates in contact with each other was extremely low, in the area of 1.2 $m\Omega\text{-}cm^2$ (Fig. 1) and thus far below the DOE target value (10 $m\Omega\text{-}cm^2$)[4].

Tantalum is known to spontaneously form a passive oxide layer consisting of Ta_2O_5, which may grow by anodisation.[5] However, ICR values remained unchanged upon anodisation of tantalum even after 8 hours of treatment (see Fig. 2). Thus, the oxide layer does not seem to have a significant effect at these conditions. Tantalum therefore shows great potential as coating material for construction materials for PEM steam electrolysers and fuel cells.

Measurements were furthermore performed on stainless steel CVD coated with tantalum. Also in this case no increase in contact resistance was observed after anodisation, ICR values of 3.18 $m\Omega\text{-}cm^2$ and 2.92 $m\Omega\text{-}cm^2$ were measured before and after anodisation, respectively.

Titanium corroded severely even after anodisation in 5 minutes. Thus titanium should not be used in phosphoric acid doped membrane systems.



Figur 1: Interfacial contact resistance between two tantalum plates as function of compaction force.

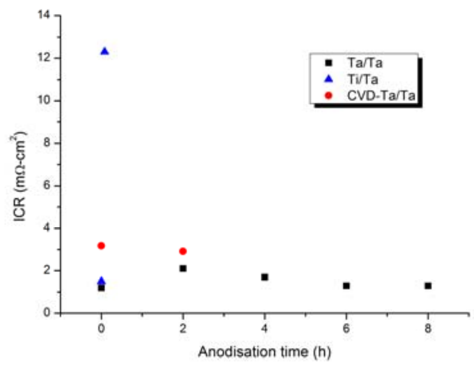


Figure 2: Interfacial contact resistance of tantalum, tantalum coated and titanium in contact with tantalum as function of anodisation time. Anodisations were performed at 130 °C, 2 V in 85% H_3PO_4.

References:

[1] A.V. Nikiforov, I.M. Petrushina, E. Christensen, A.L. Tomas-Garcia, N.J. Bjerrum. *International Journal of Hydrogen Energy* **36**, 111-119 (2011)

[2] Seok-Hyun Lee, Jong-Hee Kim, Yun-Yong Lee, Dang-Moon Wee. *International Journal of Hydrogen Energy* **35,** 725–730 (2010)

[3] Changhee Choe, Hyoseok Choi, Wonhyuk Hong, Jung-Joong Lee. *International Journal of Hydrogen Energy* **37,** 405-411 (2012)

[4] M.P. Brady, H. Wang, J. A. Turner, H. M. Meyer, K. L. More, P. F. Tortorelly, B. D. McCarthy. *Journal of Power Sources*. **195**, 5610-5618, (2010)

[5] J.P.S. Pringle. J. Electrochem. Soc. **120**, No 3 (1973)