Silicon carbide-silicon as a support material for oxygen evolution reaction in PEM steam electrolysers

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There is a demand to develop a corrosion resistant and conductive substrate for the anode electrocatalyst, which can assist in the reducing of noble catalyst loading without a significant loss of performance [1]. It was shown that SiC can act as a support material for platinum electrocatalyst in fuel cells [2,3].

In the present work a commercial SiC-Si, produced by the Acheson process, with a fraction of free silicon around 20% wt. was investigated as a catalyst support for anode electrocatalyst in PEM steam electrolysers.

This electrocatalyst system was characterized using several techniques such as XRD, cyclic voltammetry, SEM, EDX and steady state electrochemical polarisation in a working PEM steam electrolyser.

Several SiC-Si-IrO_2 electrodes have been prepared and tested. The iridium oxide content at the electrode active layer varied from x=0.2 to x=1, corresponding to the general formula (1-x)(SiC-Si)-x(IrO_2). Compositions in this range were tested with the step difference in x=0.1.

A diameter of about 5-6 nm of individual IrO_2 crystallites was measured by X-ray diffraction and calculated from the Scherrer equation. The particle size distribution of SiC-Si was measured by the X-Ray sedimentation technique and the average particle diameter of silicon carbide-silicon was found to be in the range of 5-10 µm, while its specific surface area was about 5 m^2/g.

The oxygen evolution reaction was studied by the cyclic voltammetry technique in 85% phosphoric acid solution at temperatures between 22°C and 150 °C in a conventional three-electrode cell.

Fig. 1 shows cyclic voltammograms, recorded with the prepared supported and unsupported iridium oxide on tantalum electrodes. There was an evident increase in associated voltammetric capacitance value corresponding to the supported catalyst compared to the pure oxide catalyst material. This indicates a relatively higher number of active sites deduced from the charge transferred when cycling the potential between two preselected values.

Based on the above results, the SiC-Si compound is a potential candidate as a support for the anode electrocatalyst for phosphoric acid doped membrane steam electrolysers.

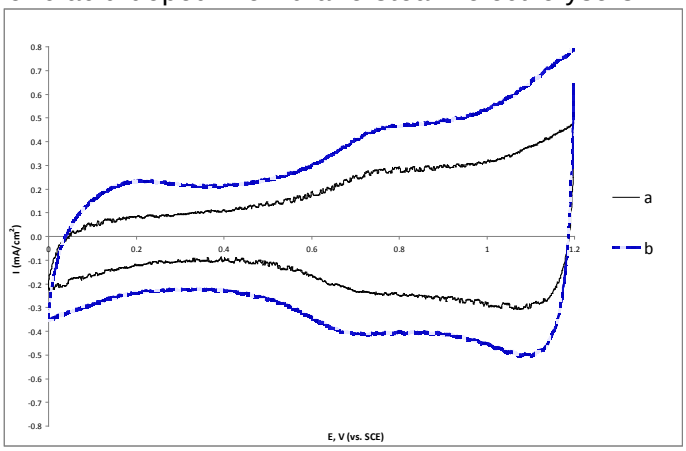

Figure 1. Cyclic voltammograms for (a) IrO_2, (b) IrO_2 supported on SiC-Si (IrO2 90% wt.)

References

1. S.Song, H. Zhang, X. Ma, Z. Shao, R.T. Baker, B. Yi, **Electrochemical investigation of electrocatalysts for the oxygen evolution reaction in PEM water electrolyzers**, *International Journal of Hydrogen Energy, 33, 2008, 4955-4961*

2. A. Honji, T. Mori, Y. Hishinuma, K. Kurita, Platinum supported on silicon-carbide as fuel cell electrocatalyst, Journal of the Electrochemical Society, 135 (4): 917-918, April 1988.

3. C.V. Rao, S.K. Singh and B. Viswanathan. Electrochemical performance of nano-SiC prepared in thermal plasma, Indian Journal of Chemistry, 47(11), 1619-1625, November 2008