SUPPORTING INFORMATION

Exploring PANI-TiN Nanoparticle Coatings In PEFC Environment: Enhancing Corrosion Resistance And Conductivity of Stainless Steel Bipolar Plates

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Coating deposition via Cyclic Voltammetry

The coating was applied on the stainless steel surface by electrochemical deposition of PANI-TiN composite. Aniline is polymerised in the presence of sulphuric acid on the surface of the stainless steel substrate using CV. Aniline polymerisation peak was observed after the 5th cycle.

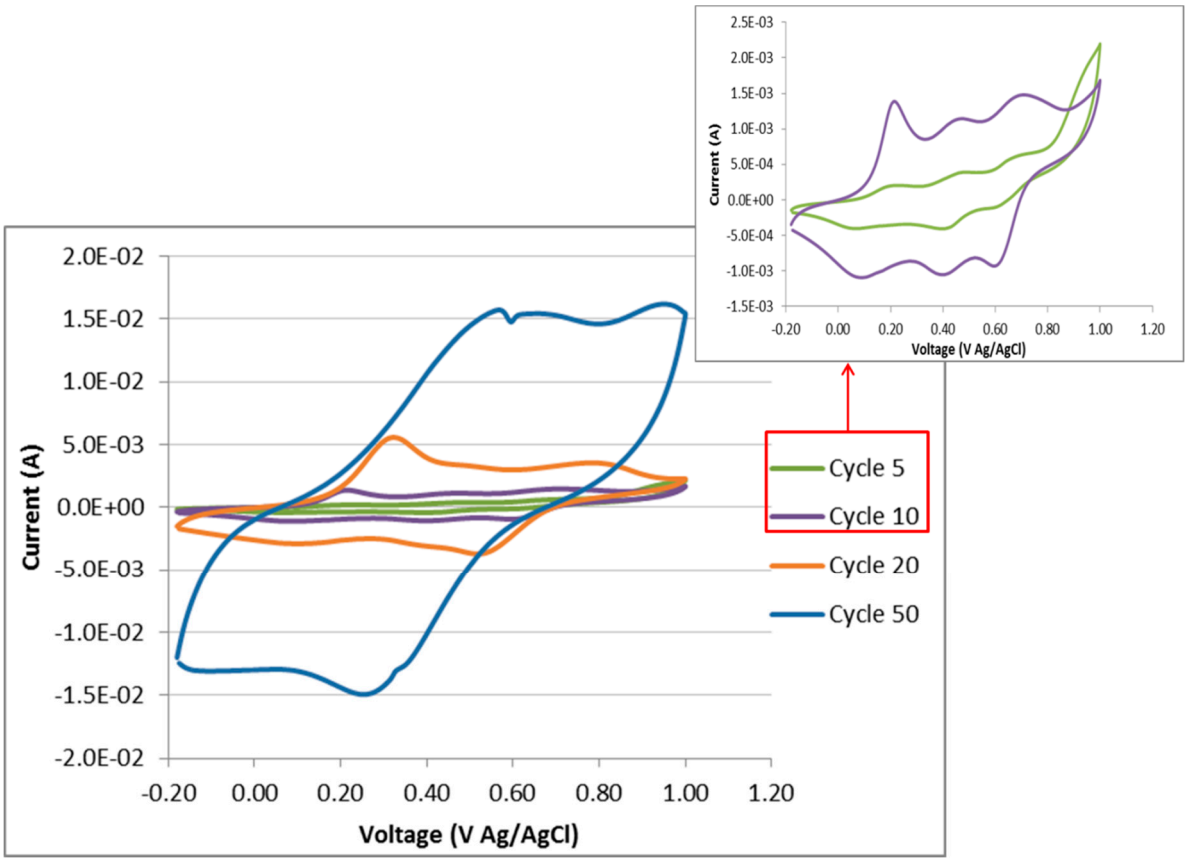

Figure S1: Electropolymerisation and deposition of the PANI-$TiN_{0.5}$ coating.

The CV curves for the electro-polymerisation of aniline in the PANI-$TiN_{0.5}$ coating is shown in Figure S1. The CV curves show a comparable shape and trend to that of PANI only

coatings (not shown here) and were in agreement with the cyclic voltammograms of PANI coatings published in the literature [1]. At low number of cycles, one pronounced oxidation peak at 0.20V Vs Ag/AgCl is seen followed by another two ill-defined peaks coupled with three reduction peaks. With higher number of cycles, the first oxidative peak shifts towards higher potentials with an exponential increase in the current density. Moreover, the first and second peaks merge and the third peak becomes equally pronounced, coupled with two reductive peaks.

As there were no changes observed in the CV peaks between PANI and PANI-TiN coatings, it can be suggested that the TiN in the coating solution does not interfere with the polymerisation of Aniline.

FTIR analysis

To investigate this further, the coating was analysed using FTIR. FTIR spectrum was obtained for the 50 cycles coating of PANI and PANI-$TiN_{0.5}$ as shown in figure S2. Both the spectrum show the relevant peaks for PANI structure as reported in literature [2,3]

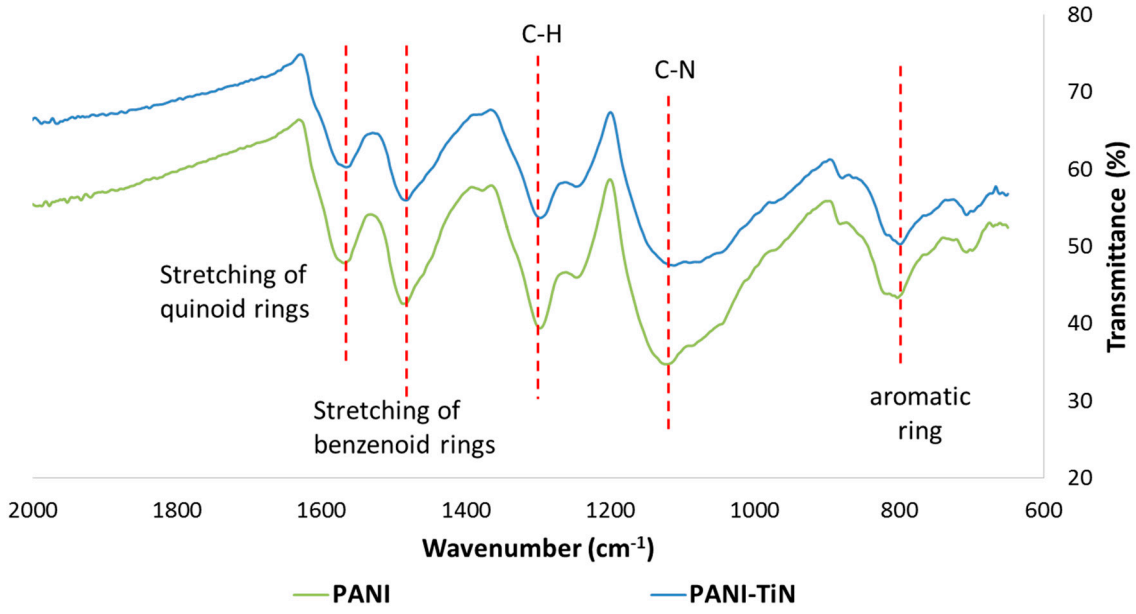

Figure S2: FTIR spectrum as obtained for PANI and PANI-$TiN_{0.5}$ coated SS samples.

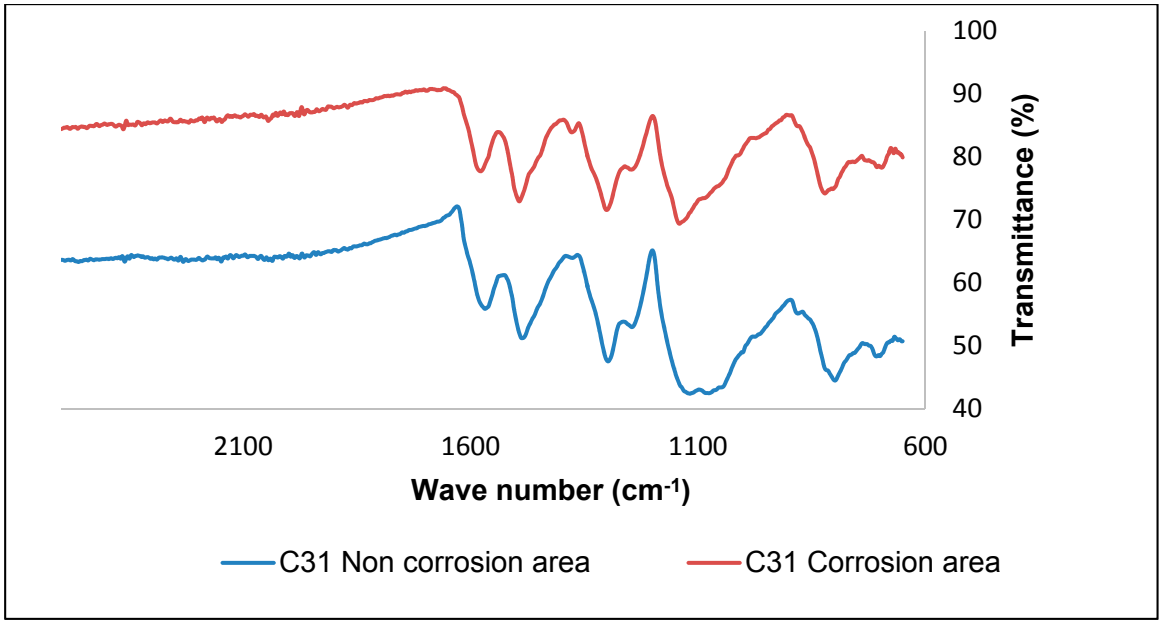

Figure S3: FTIR spectrum for PANI-TiN (0.5) before and after corrosion.

FTIR measurements were conducted on the samples post corrosion studies. It was noticed that post the corrosion test, the coating changes colour from a fresh green colour to a navy blue colour suggesting the further oxidation of PANI. However, the FTIR spectrum shown in Figure S3 shows no change in its signature peaks. However, it is noted that the spectrum after corrosion have generally moved into higher emittance percent.

ICR studies

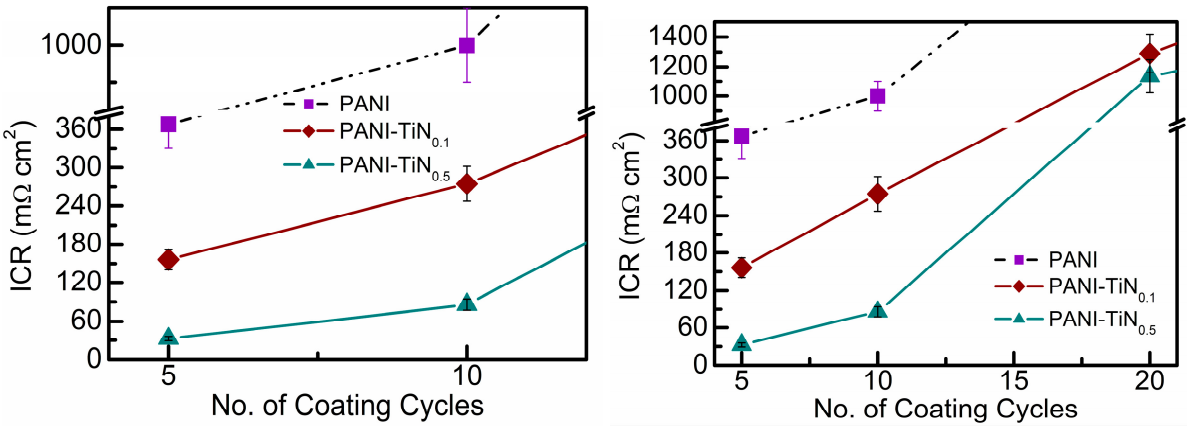

Figure S4: ICR values for coatings deposited at 5, 10 and 20 CV coating cycles

Table S1: ICR values before and after corrosion tests

No. of coating cycles / Type of Coating	ICR (mΩ cm^2)						
	5 Cycles		10 Cycles		20 cycles	50 Cycles	
	Before	After	Before	After	Before	Before	After
PANI	367.5	495	1000	1350	2492	5530	4450
PANI-$TiN_{0.1}$	156.25	265	274.5	514	1290	3287	3000
PANI-$TiN_{0.5}$	32.6	63	85.75	150	1135	2283.5	1975

Table S2: Maximum TiN NP loading in the composite coatings calculated on the hypothetical overestimation that all TiN NPs were consumed during the electrochemical deposition process of 50 cycle.

No. of CV cycles	**TiN NP loading (mg/cm^2) for**	
	PANI-$TiN_{0.1}$	**PANI-$TiN_{0.5}$**
5 cycles	0.01	0.05
10 cycles	0.02	0.1
20 cycles	0.04	0.2
50 cycles	0.10	0.51

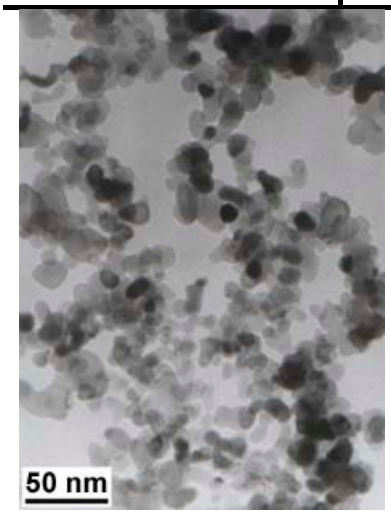

Figure S5: TEM image showing particle size distribution of TiN NPs (courtesy: SkySpring Nanomaterials Inc.)

References

[1] S. Joseph, J.C. McClure, R. Chianelli, P. Pich, P.J. Sebastian, Conducting polymer-coated stainless steel bipolar plates for proton exchange membrane fuel cells (PEMFC), Int. J. Hydrogen Energy. 30 (2005) 1339–1344. doi:10.1016/j.ijhydene.2005.04.011.

[2] S. Sathiyanarayanan, S. Syed Azim, G. Venkatachari, Preparation of polyaniline-TiO2 composite and its comparative corrosion protection performance with polyaniline, Synth. Met. 157 (2007) 205–213. doi:10.1016/j.synthmet.2007.01.012.

[3] D.P. Le, Y.H. Yoo, J.G. Kim, S.M. Cho, Y.K. Son, Corrosion characteristics of polyaniline-coated 316L stainless steel in sulphuric acid containing fluoride, Corros. Sci. 51 (2009) 330–338. doi:10.1016/j.corsci.2008.10.028.