Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary Information

for

Synergistic Electrochemical Activity of Titanium Carbide and Carbon Towards Fuel Cell Reactions

*Vankayala Kiran, K. L. Nagashree, and Srinivasan Sampath**

Department of Inorganic and Physical Chemistry, Indian Institute of Science, Bangalore 560012, India

Contents

Estimation of Titanium in the composites

Quantity of titanium (Ti) present in the TiC-C composites is estimated based on a known procedure [1]. The calibration plot for determination of Ti is constructed as follows. Known amounts of TiC are dissolved in 1:1 mixture of H_2SO_4 and 30 wt% H_2O_2 and stirred for 2 h. The resulting solutions are yellow in color, confirming the formation of Ti-H_2O_2 complex that absorbs at 410 nm. A calibration plot is constructed by following absorbance of the complex at 410 nm as a function of Ti content in the standard solutions. Using this calibration plot, the amounts of Ti present in the composites are found out and the results are shown in the following table I and figure S1. A slight over estimation is observed and this may be because of the scattering of carbon present in composites. This study clearly confirms that the samples are almost homogeneous.

(a)

Name	Quantity of TiC / mg (in 3 mL H_2SO_4+3 mL H_2O_2)
TiC-1	1
TiC-2	2
TiC-3	3
TiC-4	4
TiC-5	5

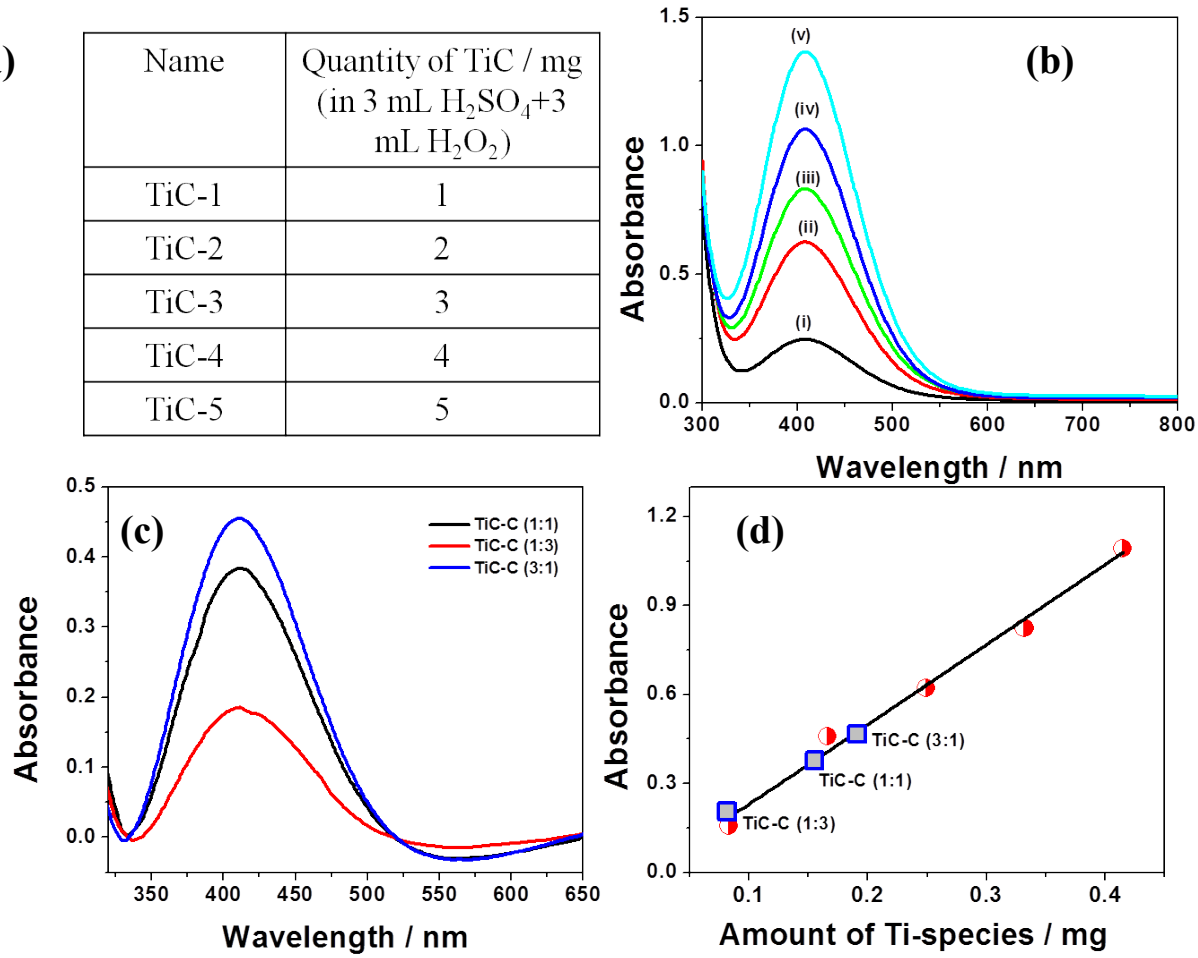

Figure S1. (a) Standard samples - TiC-1, (ii) TiC-2, (iii) TiC-3, (iv) TiC-4, (v) TiC-5, correspond to 1,2,3,4 and 5 mg of TiC dissolved in the acid solutions mentioned above; (b) UV-Vis spectra of the standard samples, 1-5 correspond to the TiC-1 to TiC-5 samples; (c) UV-Vis data for the three composites TiC-C = 1:1; 1:3 and 3:1 and (d) calibration plot obtained from (b). The points marked in grey color [1(d)] represents data points for the three composites

Table I: Calculated Vs. Observed Ti content in the composites

Catalyst	Observed (mg)	Calculated (mg)
TiC-C (1:1)	63.2	50
TiC-C (1:3)	34	30
TiC-C (3:1)	74.8	70

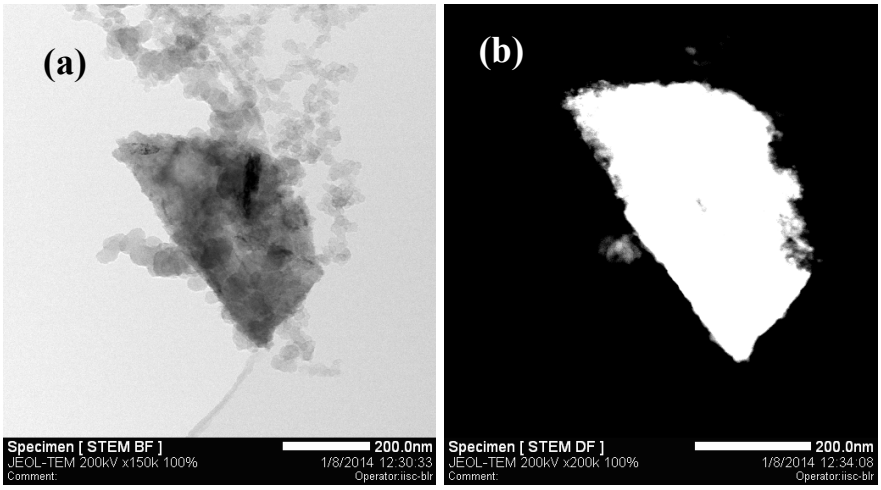

Figure S2. STEM (a) bright field and (b) dark field images of TiC-C composties.

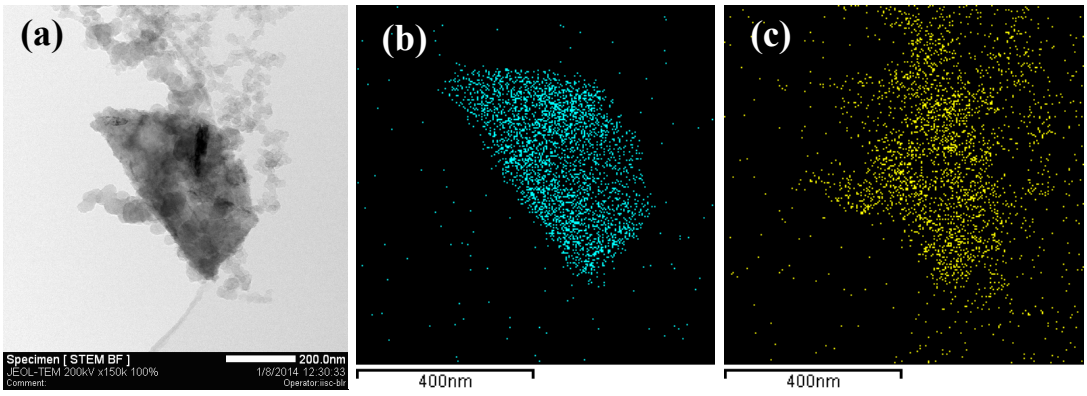

Figure S3. (a) STEM bright field image and corresponding (b) Ti and (c) C maps.

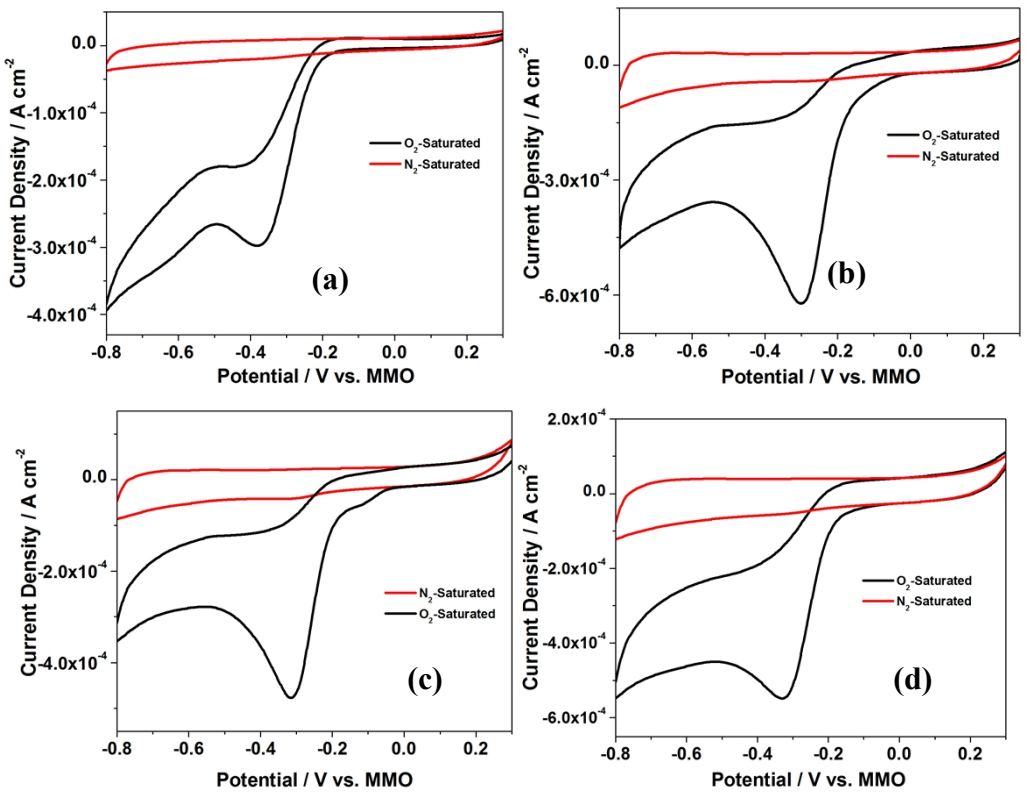

Figure S4. Cyclic voltammograms for ORR obtained using (a) bare TiC, (b) TiC-C (1:1), (c) TiC-C (3:1) and (d) TiC-C (1:3) catalysts. Supporting electrolyte used is 0.5 M KOH and scan rate used is 0.05 Vs^{-1}.

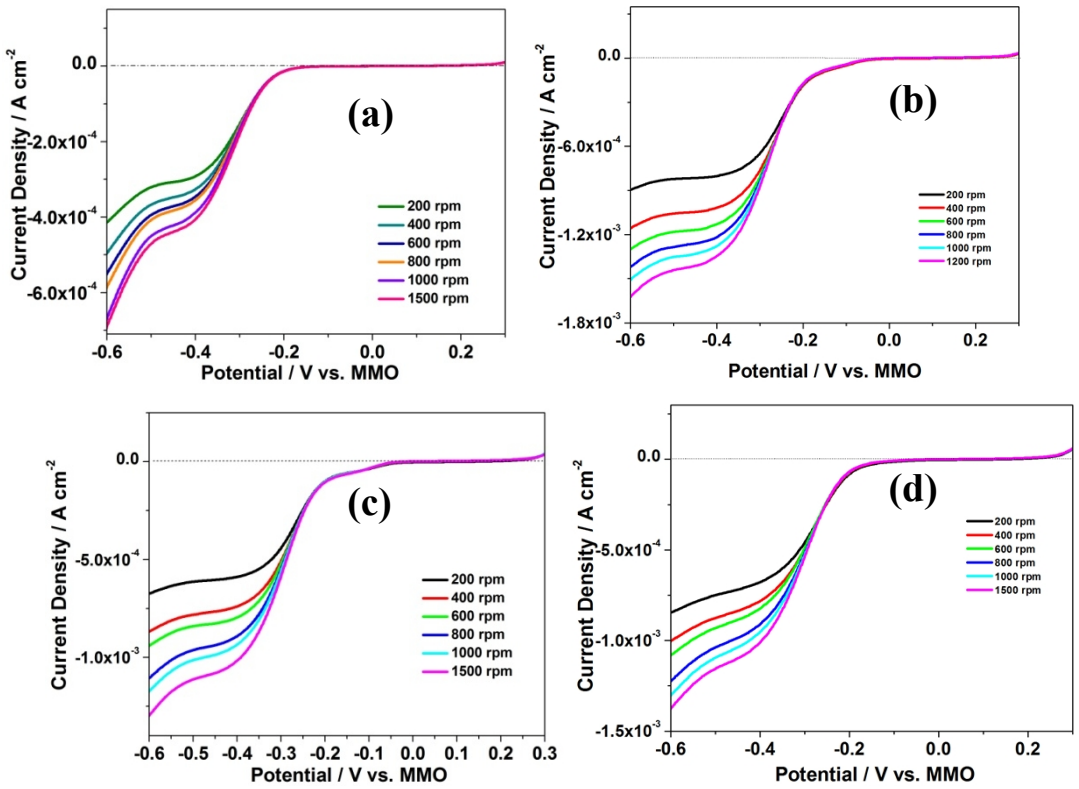

Figure S5. Linear sweep voltammograms showing the effect of rotation rate for ORR on (a) bare TiC, (b) TiC-C (1:1), (c) TiC-C (3:1) and (d) TiC-C (1:3) catalysts. Scan rate used is 0.005 Vs^{-1}.

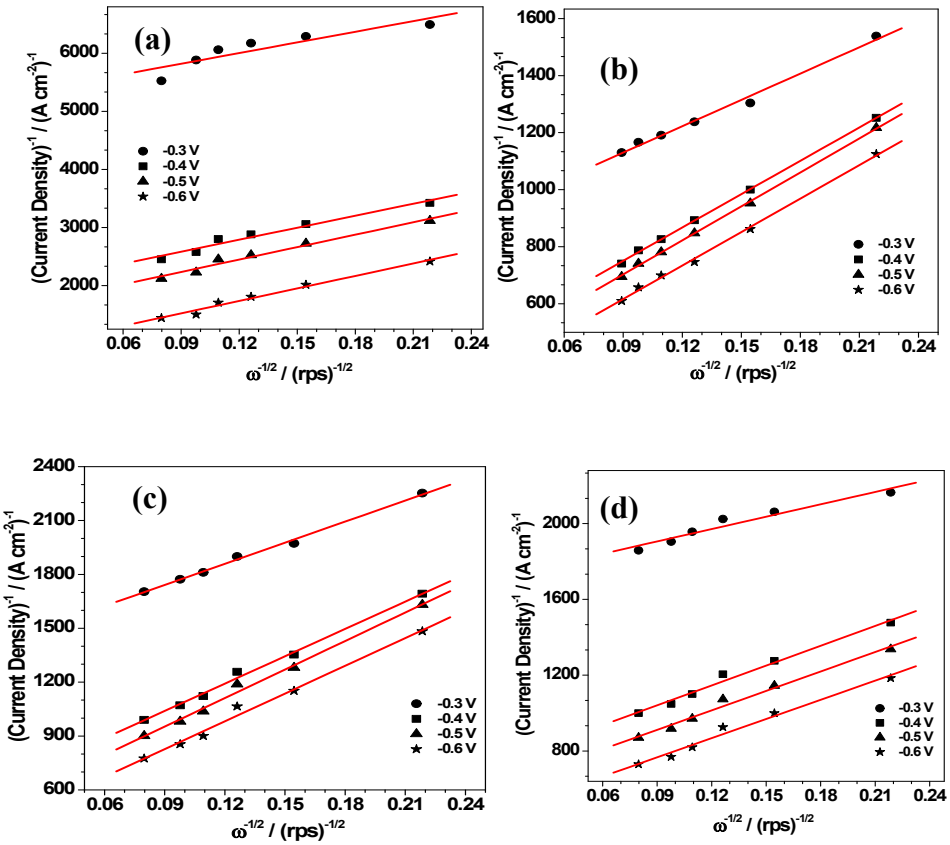

Figure S6. K-L plots at various DC bias values obtained using (i) bare TiC, (ii) TiC-C (1:1) (iii) TiC-C (3:1), (iv) TiC-C (1:3) catalysts in O_2-saturated 0.5 M KOH electrolyte.

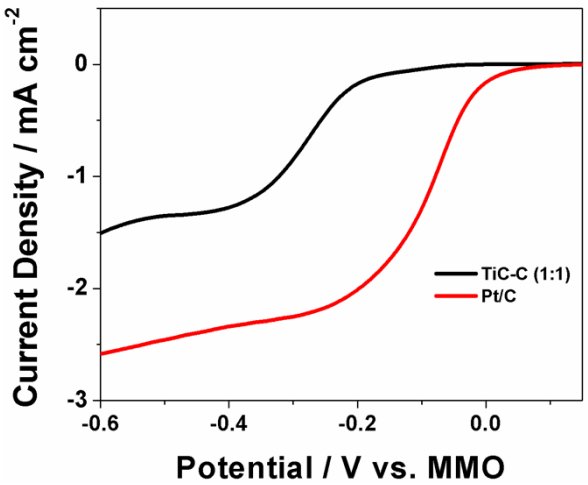

Figure S6-I. Linear sweep voltammograms recorded in O_2-saturated 0.5 M KOH using TiC-C (1:1) (black) 40 wt% Pt/C (red) at 1000 rpm.

(a) (b)

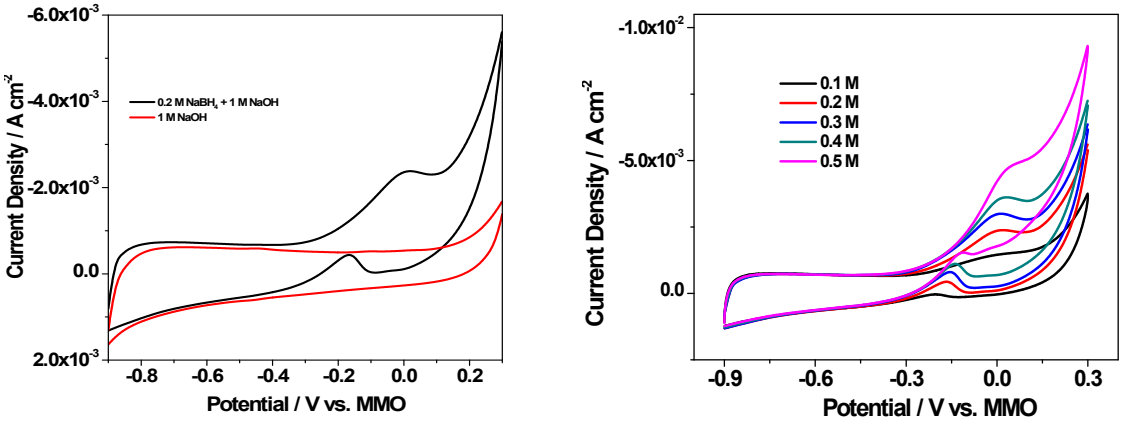

Figure S7. (a) Cyclic voltammograms of 0.2 M $NaBH_4$ in 1 M NaOH recorded using TiC-C(3:1) at a scan rate of 0.05 Vs^{-1} and (b) represents voltammograms recorded at 0.05 Vs^{-1} with varying concentrations of $NaBH_4$.

References

[1] W. D. Myers, P. A. Ludden, V. Nayigihugu, B. W. Hess, J. Anim. Sci. 82 (2004) 179.