Supplementary information

Three-Dimensional Construction of Electrode Materials Using TiC Nanoarrays Substrates for Highly Efficient Electrogeneration of Sulfate Radicals and Molecular Hydrogen in a Single Electrolysis Cell

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Table S1. Comparison of PDS generation capability of BDD@TiC NWs with recently reported BDD anodes.

Cell configuration					PDS generation			Ref.
Anode (dopant conc. / area)	Cathode	Electrolyte	pH	Volume (L)	Applied current density (mA cm^{-2})	PDS conc. (mol L^{-1})	Time	
BDD@TiC NWs (8,000 ppm / 1 cm^2)	Platinum	0.1 M Na_2SO_4	6.5	0.05	44 (@ 4.5 V)	1.97	1 hour	This work
BDD (8,000 ppm / 1 cm^2)					25 (@ 4.5 V)	0.45	1 hour	
BDD (8,000 ppm / 6 cm^2)	Graphite	0.8 M Na_2SO_4	-	0.08	30	4 - 4.5	1 hour	S1
BDD (8,000 ppm / 7.5 cm^2)	Platinum	0.1 M Na_2SO_4	3	-	20	0.15 - 0.2	10 min.	S2
BDD (- ppm / 7.065 cm^2)	Titanium	0.4 M Na_2SO_4	9	0.15	30	21.25	5 hours	S3
BDD (- ppm / 12.5 cm^2)	Platinum	0.1 M Na_2SO_4	5	0.1	30	1.4 - 1.6	3 hours	S4
BDD (- ppm / 63 cm^2)	Zirconium	2.0 M H_2SO_4	-	1	40	0.15	5 hours	S5
BDD (- ppm / 10 cm^2)	Titanium	0.03 M Na_2SO_4	5	0.16	10	0.25 - 0.3	40 min.	S6

Ref.

S1. T. Niu, J. Cai, P. Shi and G. Zhao, *Chem. Eng. J.*, 2020, **386**, 123971.

S2. L. Chen, C. Lei, Z. Li, B. Yang, X. Zhang and L. Lei, *Chemosphere*, 2018, **210**, 516-523.

S3. F. Zhang, Z. Sun and J. Cui, *RSC Adv.*, 2020, **10**, 33928.

S4. J. Cai. T. Niu, P. Shi and G. Zhao, *Small*, 2019, **15**, 1900153.

S5. J. Cai, M. Zhou, Y. Liu, A. Savall, K. G. Serrano, *Chemosphere*, 2018, **204**, 163-169.

S6. Y.-U. Shin, H.-Y. Yoo, Y.-Y. Ahn, M. S. Kim, K. Lee, S. Yu, C. Lee, K. Cho, H.-I. Kim, J. Lee, *Appl. Catal. B-Environ.*, 2019, **254**, 156-165.

Table S2. Comparison of HER activity of Pt@C@TiC NWs with recently reported Pt-based composite catalysts.

Catalyst	Electrolyte	Overpotential (mV)	Current density (mA cm^{-2})	Tafel slope (mV dec^{-1})	Pt in catalyst (wt. %)	Total Pt loading mass (mg cm^{-2})	Ref.
Pt@C@TiC NAs	0.5 M H_2SO_4	33.1	10	31.2	-	0.029	This work
Pt@TiN NAs		39.7		38.6	0.087	-	S7
Pt/LSG		131		72	20 - 23	0.04	S8
Pt/def-WO_3@CFC		42		101	-	-	S9
Mo_2C@NC@ Pt		27		28	7.49	-	S10
Pt/G_5-$(MoS_2)_5$		33		23	19.1	0.027	S11

Ref.

S7. C. Wang, H. Shi, H. Liu, J. Fu, D. Wei, W. Zeng, Q. Wan, G. Zhang and H. Duan, *Electrochim. Acta*, 2018, **292**, 727-735.

S8. P. Nayak, Q. Jiang, N. Kurra, X. Wang, U. Buttner and H. N. Alshareef, *J. Mater. Chem. A*, 2017, **5**, 20422.

S9. H. Tian, X. Cui, L. Zeng, L. Su, Y. Song and J. Shi, J. *Mater. Chem. A*, 2019, **7**, 6285.

S10. J.-Q. Chi, J.-Y. Xie, W.-W. Zhang, B. Dong, J.-F. Qin, X.-Y. Zhang, J.-H. Lin, Y.-M. Chai and C.-G. Liu, *ACS Appl. Mater. Interfaces*, 2019, **11**, 4047-4056.

S11. Z. Gao, M. Li, J. Wang, J. Zhu, X. Zhao, H. Huang, J. Zhang, Y. Wu, Y. Fu and X. Wang, *Carbon*, 2018, **139**, 369-377.

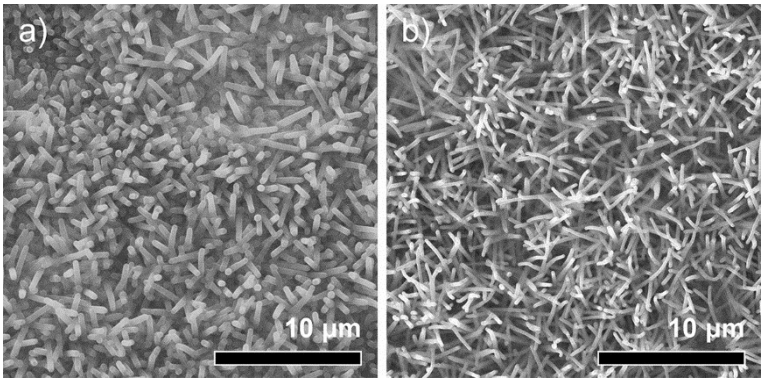

Figure S1. SEM images of C@TiC NAs prepared using a) N_2-purged acetone and b) air-purged acetone.

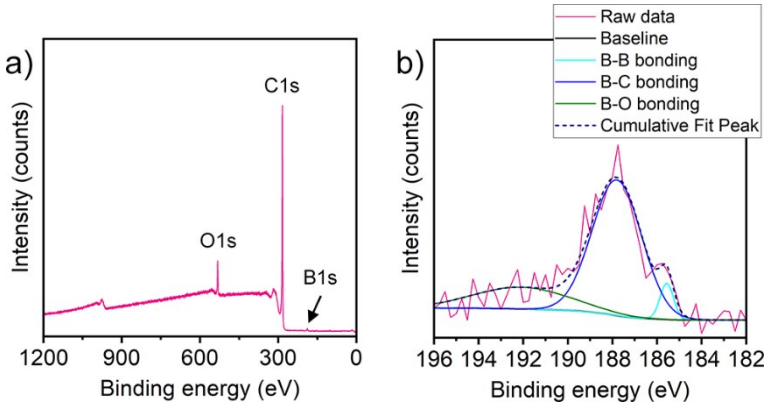

Figure S2. a) XPS survey spectrum and b) deconvoluted B1s narrow spectrum of BDD@TiC NAs.

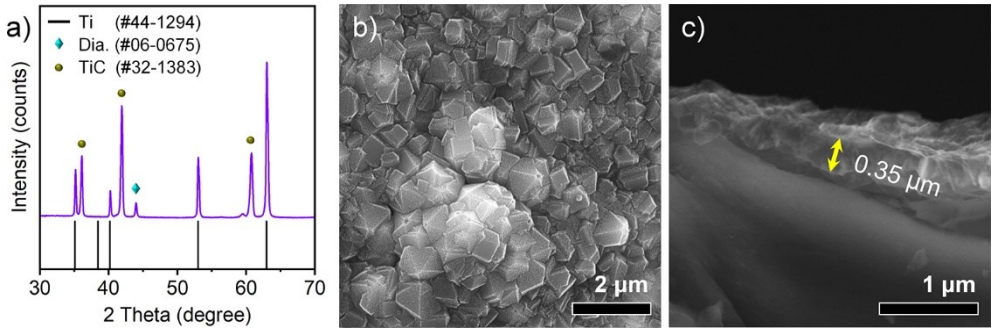

Figure S3. a) XRD pattern of flat BDD@Ti. b and c) Top-view and cross-section SEM images of BDD@Ti.

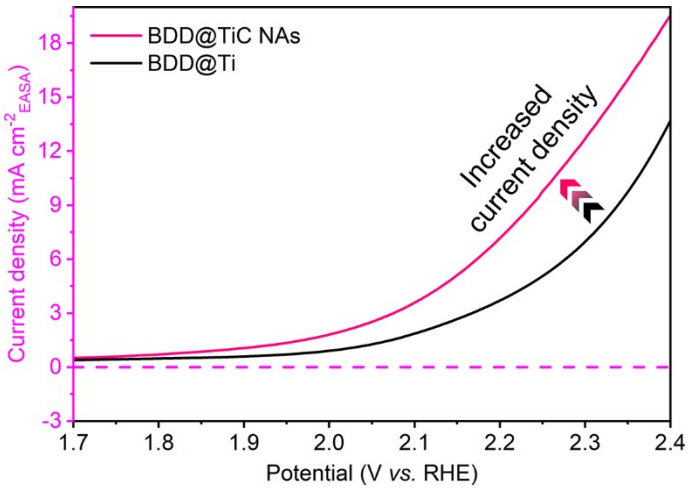

Figure S4. Magnified CV curves at initial OER step (current adjusted by ECSA).

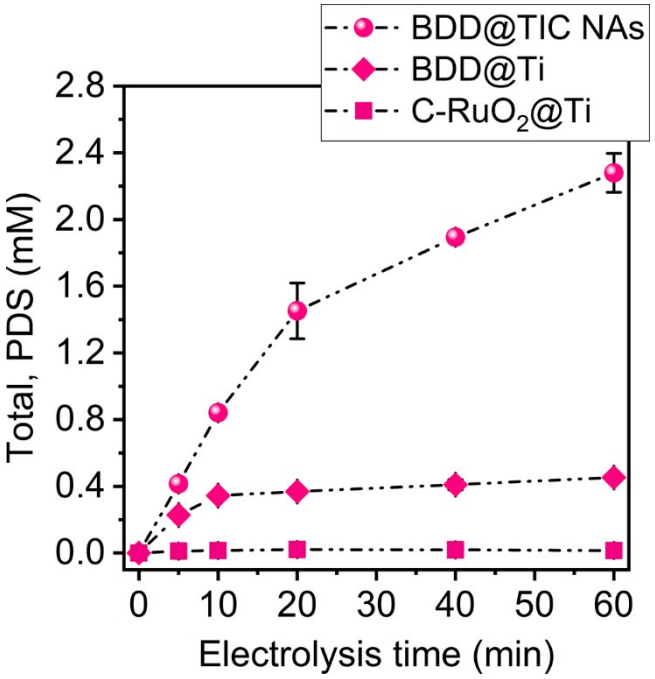

Figure S5. Time-dependent concentration profiles of PDS measured by ion chromatography.

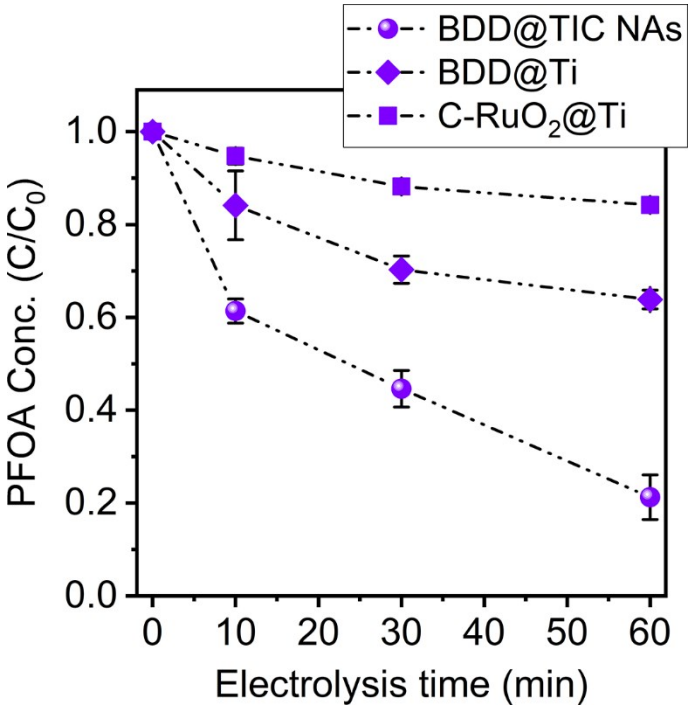

Figure S6. Degradation efficiencies for PFOA at each electrode ($[Na_2SO_4]_0$ = 0.1 M, $[PFOA]_0$ = 0.1 mM, [applied voltage] = 4.5 V).

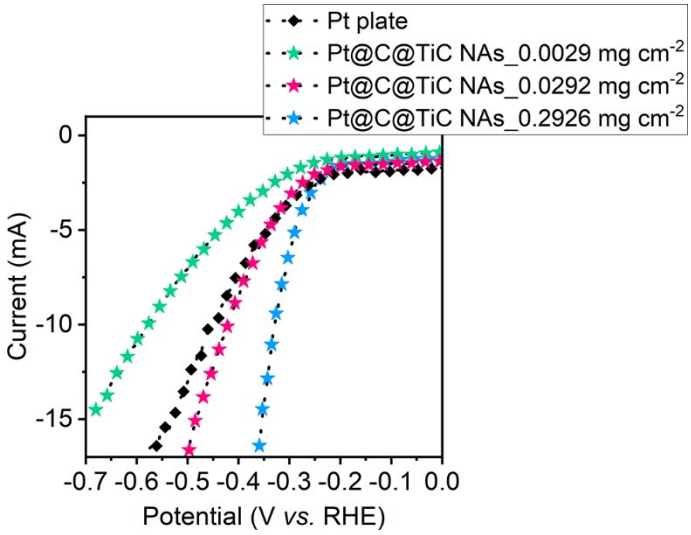

Figure S7. LSV curves of each electrode measured in 0.1 M Na_2SO_4 (pH = 6.5).

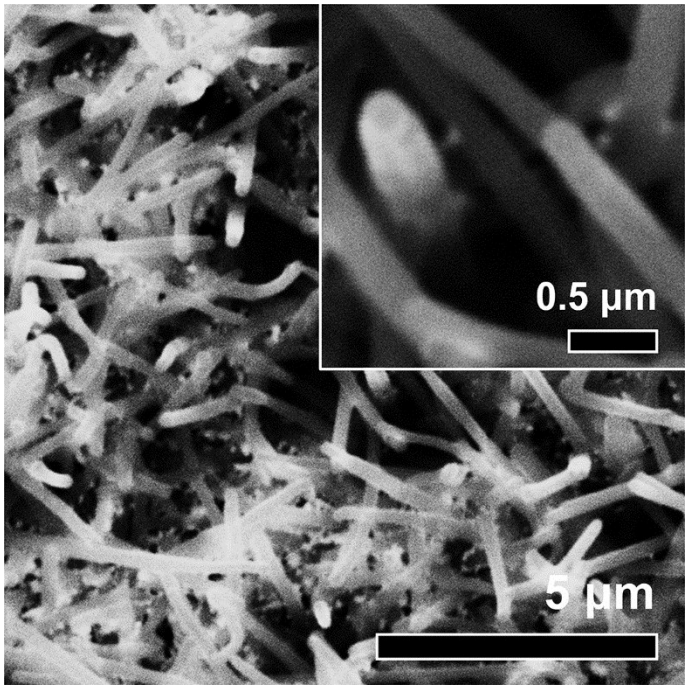

Figure S8. SEM images of Pt@C@TiC NAs_0.29.