Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Synthesis of TiC nanotube arrays and their excellent supercapacitor performance

Tongxiang Ma[1], Yuzheng Pan[1], Junyu Chen[1], Zhiming Yan[2], Buxin Chen[1], Lang Zhao[1], Liwen Hu[1], Liangying Wen[1], Meilong Hu [1]**

1. School of Materials Science and Engineering, Chongqing University, 400044, China.

2. Warwick Manufacturing Group （WMG）, University of Warwick. Coventry, CV47AL, UK.

* Corresponding author.

E-mail address: zhiming.yan@warwick.ac.uk (Zhiming Yan), hml@cqu.edu.cn (Meilong Hu)

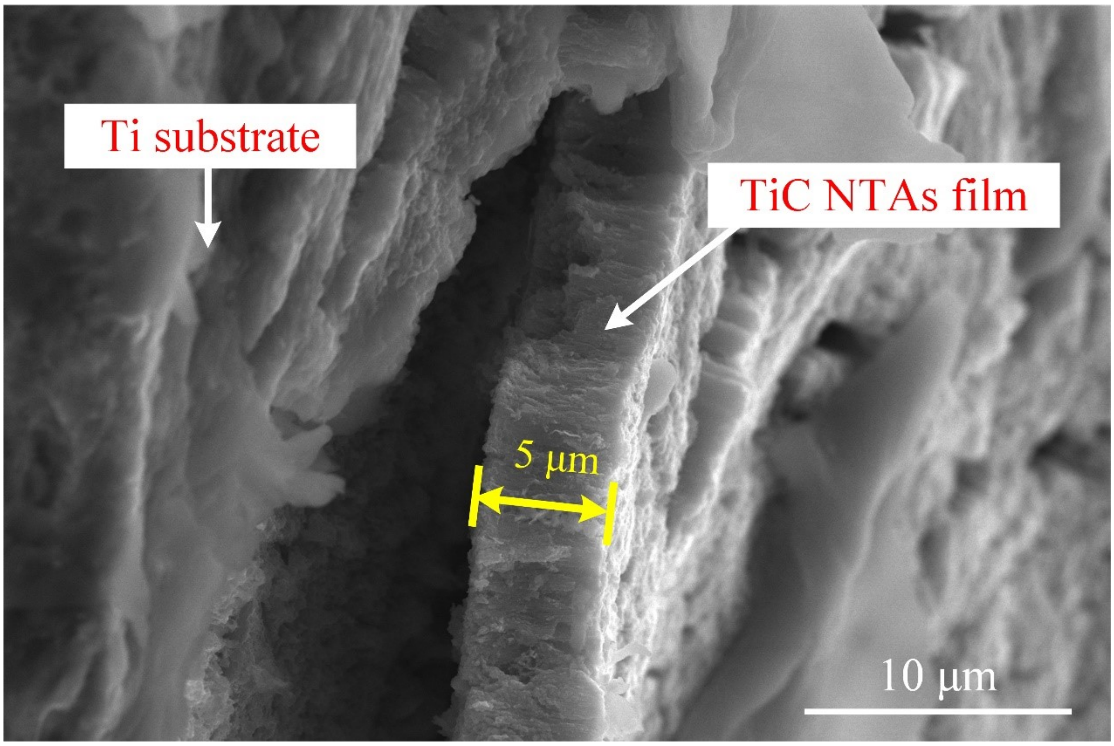

Fig. S1 Side view of TiC NTAs thin layer.

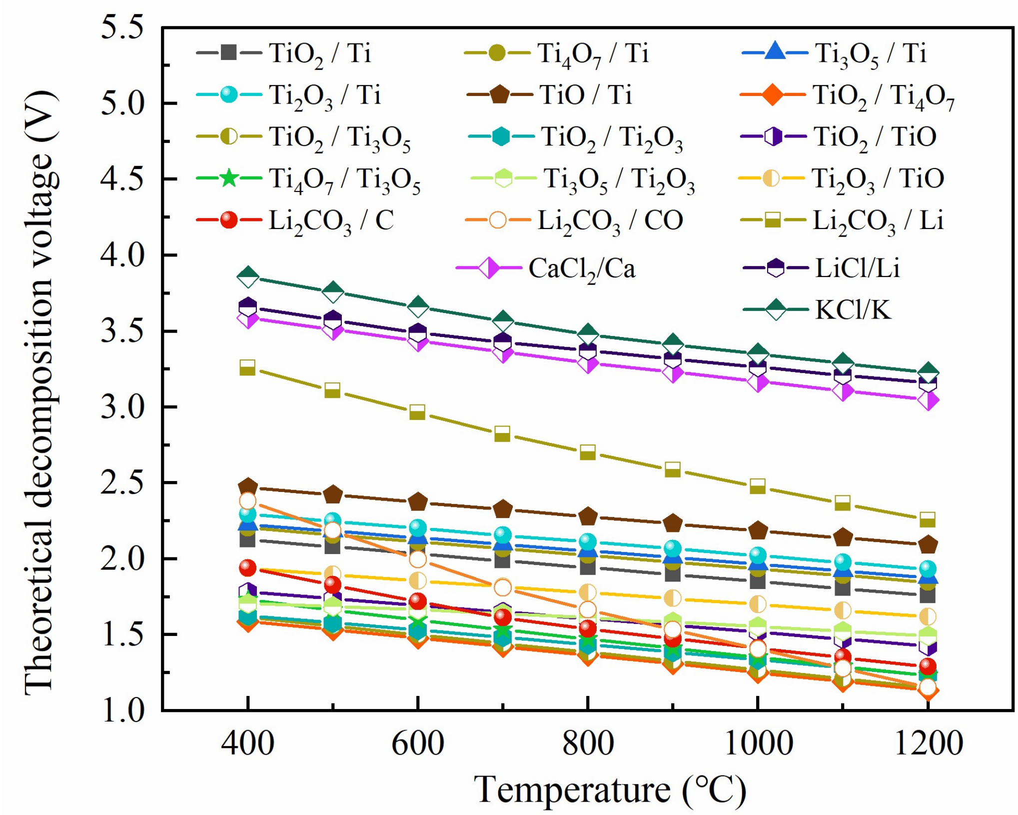

Fig. S2 Theoretical decomposition voltage calculated from thermodynamic data

Table S1. Comparison of areal capacitance between TiC NTAs and different electrode materials in the literature.

Electrode material	Areal capacitance	Ref.
TiC nanotube arrays	**53.3 mF cm^{-2}** **GCD: 0.2 mA cm^{-2}**	**This work**
Diamond network	**3.53 mF cm^{-2}** GCD: 0.1 mA cm^{-2}	Yu[1] 2017
Porous BDD	**7.7 mF cm^{-2}** GCD: 0.2 mA cm^{-2}	Petrák[2] 2017
Porous Ti/BDD	**6.3 mF cm^{-2}** GCD: 0.05 mA cm^{-2}	Wang[3] 2019
Graphite flakes/polypyrrole	**23 mF cm^{-2}** GCD: 0.1 mA cm^{-2}	Raj[4] 2015
BDD electrode	**6.44 mF cm^{-2}** GCD: 0.1 mA cm^{-2}	Zhang[5] 2020
c-oriented anatase TNAs	**8.21 mF cm^{-2}** CV: 100 mV s^{-1}	Pan[6] 2014
TiO_2 nanotube	**7.4 mF cm^{-2}** CV: 5 mV s^{-1}	Raj[7] 2015

3D-graphene/ graphite paper	**9 mF cm^{-2}** GCD: 0.05 mA cm^{-2}	Ramadoss[8] 2017
SiC NWAs	**22.3 mF cm^{-2}** CV: 10 mV s^{-1}	Li [9] 2019
SiC nanowire nanoarray	**4.7 mF cm^{-2}** CV: 10 mV s^{-1}	Chen[10] 2015
MoS_2@rGO–carbon-nanotube	**13.7 mF cm^{-2}** GCD: 0.1 mA cm^{-2}	Yang[11] 2017
Graphene oxide	**8.55 mF cm^{-2}** CV: 100 mV s^{-1}	Giannakopoulou[12] 2020
Flexible planar graphene–PANI film	**2.56 mF cm^{-2}** CV: 10 mV s^{-1}	Chen[13] 2017
MXene/Fe_3O_4/MXene thin film	**14.2 mF cm^{-2}** CV: 10 mV s^{-1}	Li[14] 2021
Polyester @ MXene nanofibers-based yarn	**18.39 mF cm^{-2}** CV: 5 mV s^{-1}	Shao[15] 2018
Reduced graphene oxide (rGO) film	**15.38 mF cm^{-2}** GCD: 0.1 mA cm^{-2}	Wu[16] 2016
Graphene/carbon nanotube	**9.81 mF cm^{-2}** GCD: 0.05 mA cm^{-2}	Wang[17] 2020

Table S2. Comparison of Energy density/Power density between TiC NTAs and different electrode materials in the literature.

Electrode material	Electrolytes	Energy density Power density	Ref.
TiC nanotube arrays	**0-0.8 V** **PVA-H_3PO_4**	**4.6 μWh cm^{-2}** **78.9 μW cm^{-2}**	**This work**
Graphene thin film	0-0.8 V PVA-H_3PO_4	0.235 μWh cm$^{-2,}$ 106 μW cm$^{-2,}$	Chen[18] 2014
3D-graphene/ graphite paper	0-1V PVA-H_2SO_4	1.24 μWh cm$^{-2,}$ 24.5 μW cm$^{-2,}$	Ramadoss[8] 2017
Carbon Nanotube/MnO_2/Polymer Fiber	0-1V PVA-LiCl	2.6 μWh cm^{-2} 66.9 μW cm$^{-2,}$	Choi[19] 2015

MoS_2@rGO–carbon-nanotube	0-1V PVA-H_2SO_4	1.9 μWh cm^{-2} 42.7 μW cm^{-2}	Yang[11] 2017
MXene/Fe_3O_4/MXene thin film	0-0.7V PVA-Li_2SO_4	0.97 μWh cm^{-2} 176 μW cm^{-2}	Li[14] 2021
$Ti_3C_2T_x$ /cellulose nanofiber/porous carbon	0-0.7V PVA-KOH	2.4 μWh cm^{-2} 17.5 μW cm^{-2}	Chen[20] 2021
Polyester @ MXene nanofibers-based yarn	0-0.6V PVA-H_2SO_4	0.38 μWh cm^{-2} 39 μW cm^{-2}	Shao[15] 2018
rGO/Ti_3C_2	0-0.6 V PVA-H_3PO_4	2.1 μWh cm^{-2} 301.2 μW cm^{-2}	Radha[21] 2019
Graphene/carbon nanotube	0-1V PVA-H_3PO_4	1.36 μWh cm^{-2} 260 μW cm^{-2}	Wang[17] 2020
V_2O_5@PEDOT nanobelts/graphene hybrid film	0-1.4 V PVA-LiCl	0.18 μWh cm^{-2} 11 μW cm^{-2}	Wang[22] 2020
porous SiC/C	0-1V PVA-H_3PO_4	1.64 μWh cm^{-2} 290 μW cm^{-2}	Yang[23] 2021

References

1. S. Yu, N. Yang, H. Zhuang, S. Mandal, O. A. Williams, B. Yang, N. Huang and X. Jiang, *Journal of Materials Chemistry A*, 2017, **5**, 1778-1785.
2. V. Petrák, Z. Vlčková Živcová, H. Krýsová, O. Frank, A. Zukal, L. Klimša, J. Kopeček, A. Taylor, L. Kavan and V. Mortet, *Carbon*, 2017, **114**, 457-464.
3. X. Wang, Y. He, Z. Guo, H. Huang, P. Zhang and H. Lin, *New J. Chem.*, 2019, **43**, 18813-18822.
4. C. J. Raj, B. C. Kim, W. J. Cho, W. G. Lee, S. D. Jung, Y. H. Kim, S. Y. Park and K. H. Yu, *ACS Applied Materials and Interfaces*, 2015, **7**, 13405-13414.
5. J. Zhang, X. Yu, Z. Q. Zhang and Z. Y. Zhao, *Appl. Surf. Sci.*, 2020, **506**.
6. D. Pan, H. Huang, X. Wang, L. Wang, H. Liao, Z. Li and M. Wu, *Journal of Materials Chemistry A*, 2014, **2**, 11454-11464.
7. C. C. Raj, R. Sundheep and R. Prasanth, *Electrochim. Acta*, 2015, **176**, 1214-1220.
8. A. Ramadoss, K. Y. Yoon, M. J. Kwak, S. I. Kim, S. T. Ryu and J. H. Jang, *J. Power Sources*, 2017, **337**, 159-165.
9. W. Li, Q. Liu, Z. Fang, L. Wang, S. Chen, F. Gao, Y. Ji, W. Yang and X. Fang, *Advanced Energy Materials*, 2019, **9**.
10. Y. Chen, X. Zhang and Z. Xie, *ACS Nano*, 2015, **9**, 8054-8063.
11. W. Yang, L. He, X. Tian, M. Yan, H. Yuan, X. Liao, J. Meng, Z. Hao and L. Mai, *Small*, 2017, **13**.
12. T. Giannakopoulou, N. Todorova, A. Erotokritaki, N. Plakantonaki, A. Tsetsekou and C. Trapalis, *Appl. Surf. Sci.*, 2020, **528**.
13. X. Chen, T. Xiang, Z. Li, Y. Wu, H. Wu, Z. Cheng, J. J. Shao and Q. H. Yang, *Advanced Materials Interfaces*, 2017, **4**.
14. H. Li, Y. Liu, S. Lin, H. Li, Z. Wu, L. Zhu, C. Li, X. Wang, X. Zhu and Y. Sun, *J. Power Sources*, 2021, **497**.
15. W. Shao, M. Tebyetekerwa, I. Marriam, W. Li, Y. Wu, S. Peng, S. Ramakrishna, S. Yang and M. Zhu, *J. Power Sources*, 2018, **396**, 683-690.
16. M. Wu, Y. Li, B. Yao, J. Chen, C. Li and G. Shi, *Journal of Materials Chemistry A*, 2016, **4**, 16213-16218.
17. Y. Wang, Y. Zhang, G. Wang, X. Shi, Y. Qiao, J. Liu, H. Liu, A. Ganesh and L. Li, *Adv. Funct. Mater.*, 2020, **30**.
18. Q. Chen, X. Li, X. Zang, Y. Cao, Y. He, P. Li, K. Wang, J. Wei, D. Wu and H. Zhu, *RSC Advances*, 2014, **4**, 36253-36256.
19. C. Choi, S. H. Kim, H. J. Sim, J. A. Lee, A. Y. Choi, Y. T. Kim, X. Lepró, G. M. Spinks, R. H. Baughman and S. J. Kim, *Scientific Reports*, 2015, **5**.
20. W. Chen, D. Zhang, K. Yang, M. Luo, P. Yang and X. Zhou, *Chem. Eng. J.*, 2021, **413**.
21. N. Radha, A. Kanakaraj, H. M. Manohar, M. R. Nidhi, D. Mondal, S. K. Nataraj and D. Ghosh, *Appl. Surf. Sci.*, 2019, **481**, 892-899.
22. L. Wang, T. Shu, S. Guo, Y. Lu, M. Li, J. Nzabahimana and X. Hu, *Energy Storage Materials*, 2020, **27**, 150-158.
23. B. Yang, R. Sun, X. Li, M. Ma, X. Zhang, Z. Wang, W. Yi, Z. Zhang, R. Yang, H. Sun, G. Gao, Y. Chu, Z. Zhao and X. Liu, *J. Mater. Sci*, 2021, **56**, 16068-16081.