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Supplementary information

Ultra‐light and Elastic Graphene Foams with a Hierarchical Structure and a High Oil Absorption Capacity

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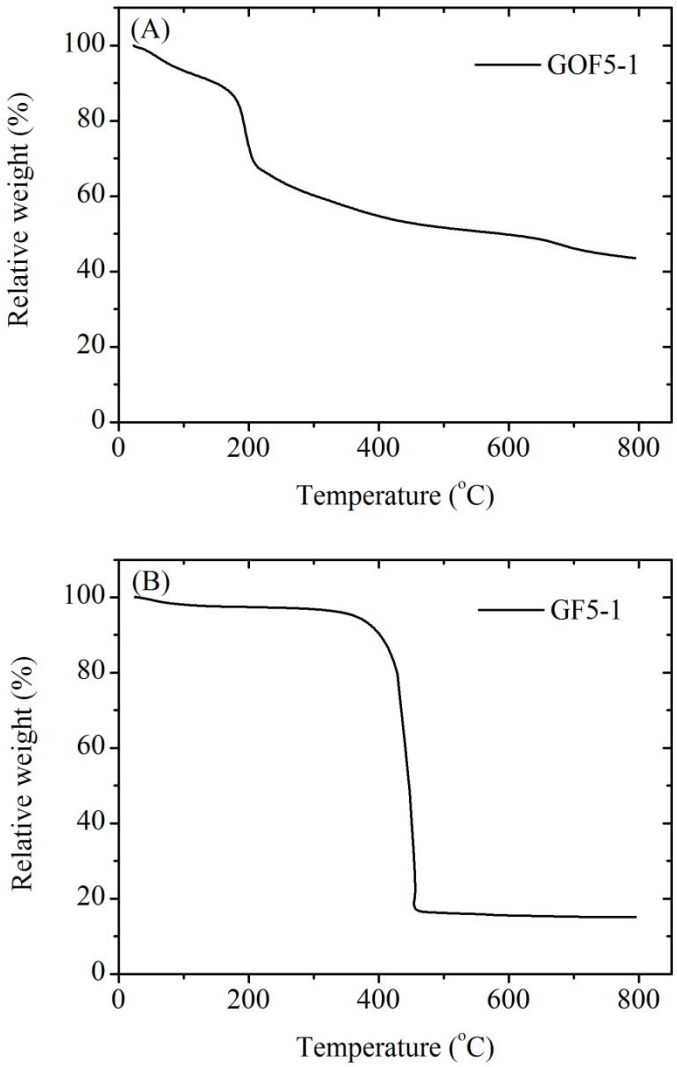

Figure S1. (A) TGA curve of GOF5-1 measured in the nitrogen. (B) TGA curve of GF5-1 measured in air.

As shown in this Figure S1A, before 200 ºC, a small weight loss of GOF5-1 is observed, owing to the loss of adsorbed water. There was a sharp weight loss between 180 ºC and 210 ºC, due to the decomposition of oxygen containing groups on the GO sheets. Therefore, at 400 ºC, GOFs could be efficient reduced. Figure S1B depicts the TGA curve of GF5-1. It clearly demonstrates that GFs is stable in air at 350 ºC. At 420 ºC the GF begins to decompose, and finally burnt up at 450 ºC.

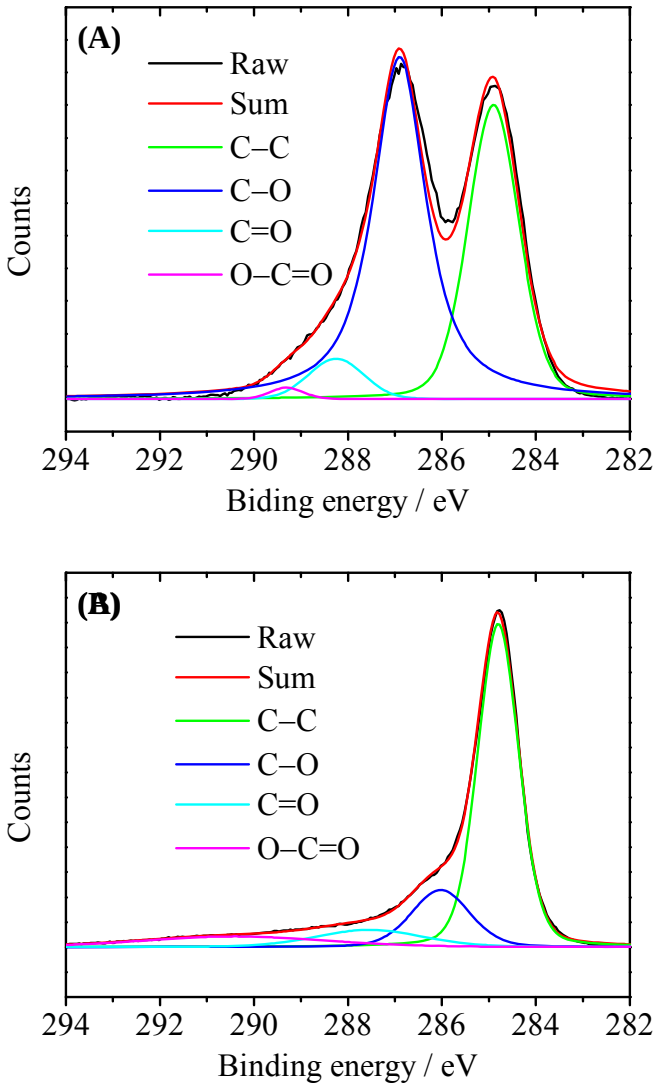

Figure S2. XPS C 1s lines of GO (A) and GF5-1 (B).

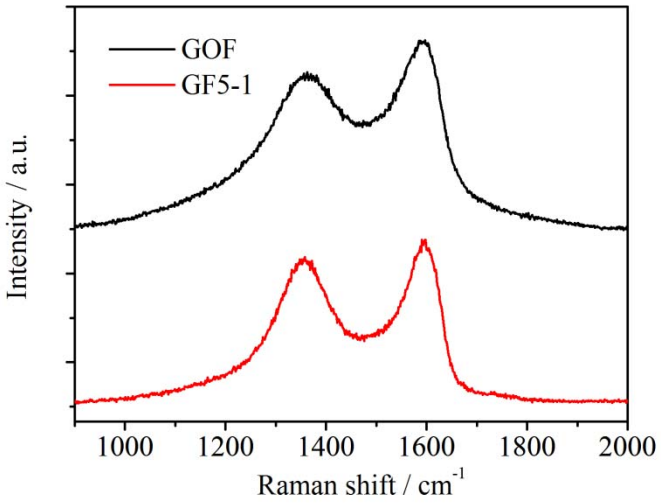

Figure S3. Raman spectra of the GOF-1 and GF5-1

The bands at 1590 and 1360 are attributed to G and D bands of chemically converted graphene. After calcination, the intensity ratio of Raman D to G bands increased from 0.88 to 0.94, demonstrating the efficient removal of oxygenated groups and partial recovery of the conjugated structures.[1-4]

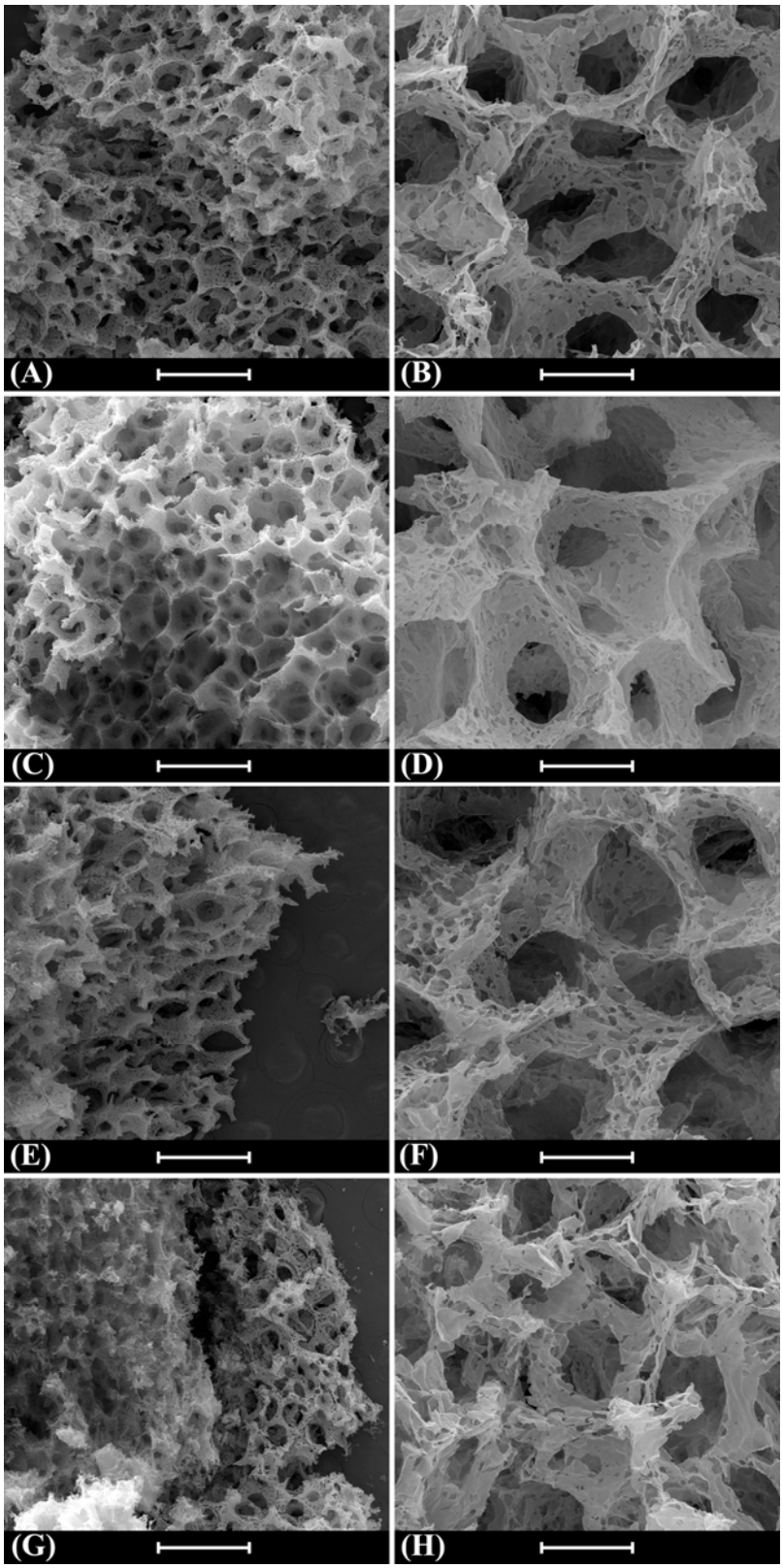

Figure S4. SEM images of different GOFs and GFs. (A)(B) GOF5-0.5. (C)(D) GF5-0.5. (E)(F) GOF5-3. (G)(H) GF5-3. Scale bar: (A) (C) (E) (G) 500 μm, (B) (D) (F) (H) 100 μm.

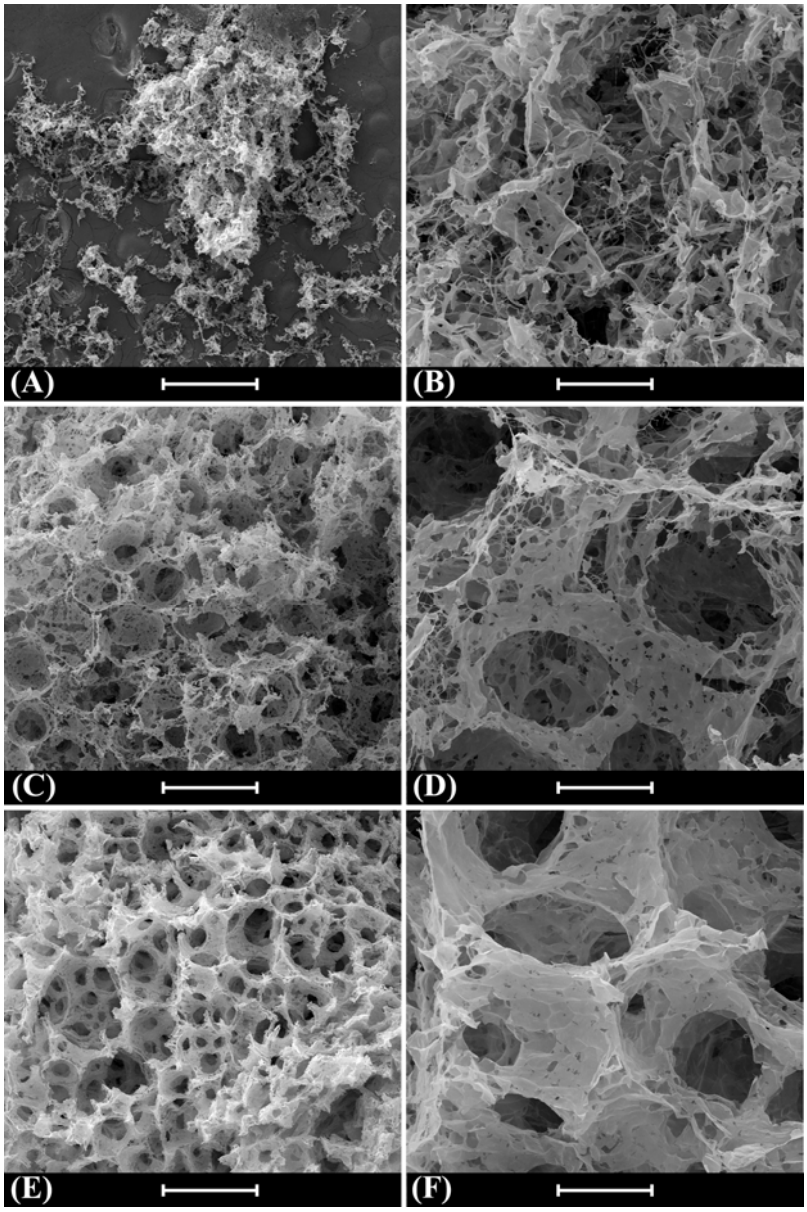

Figure S5. SEM images of different GOFs. (A)(B) GOF1-1. (C)(D) GOF3-1. (E)(F) GOF7-1. Scale bar: (A) (C) (E) 500 μm, (B) (D) (F) 100 μm.

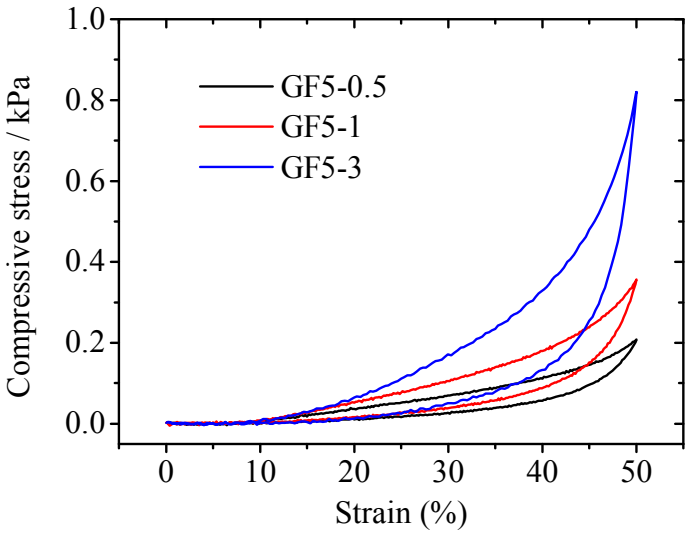

Figure S6. Compressive stress-strain curves of GFs prepared with GO dispersions of different concentrations.

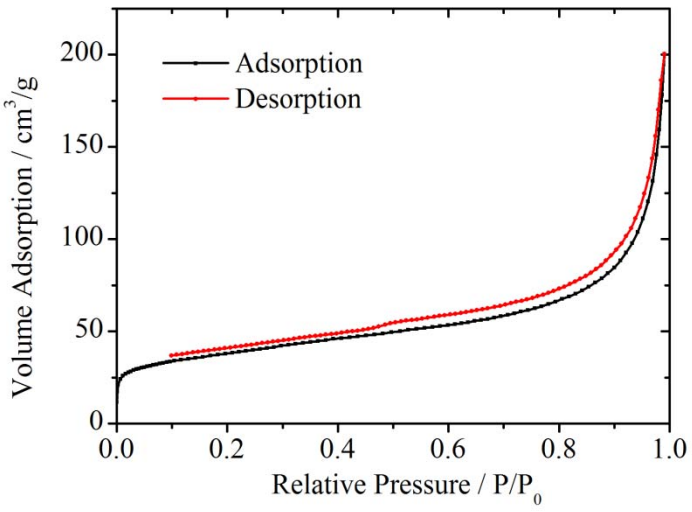

Figure S7. Nitrogen adsorption/desorption isotherm curves of GF5-1.

The curve is characterized by type II isotherm without the hysteresis loop, indicating the macroporous structure of GF5-1. And the BET specific surface area was calculated to be 134.2 m^2/g, which is comparable to that of other graphene hydrogels.[5]

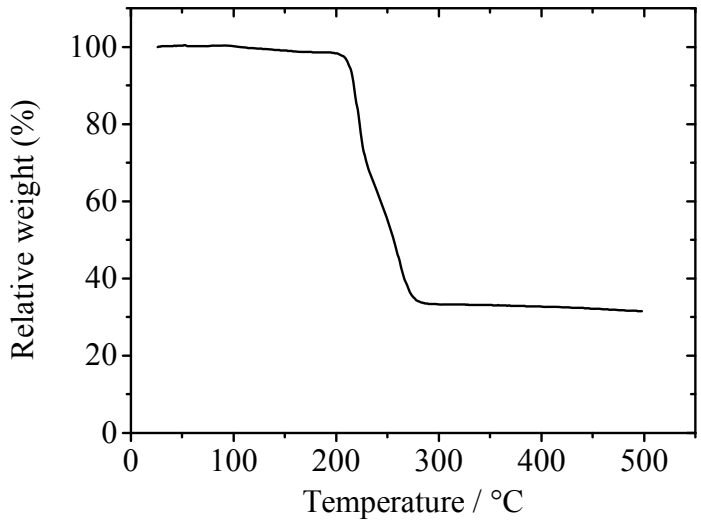

Figure S8. TGA curve of SDS.

The relative weight of the residue of SDS at 400 °C is 32.5%. The color of the residue is dark grey.

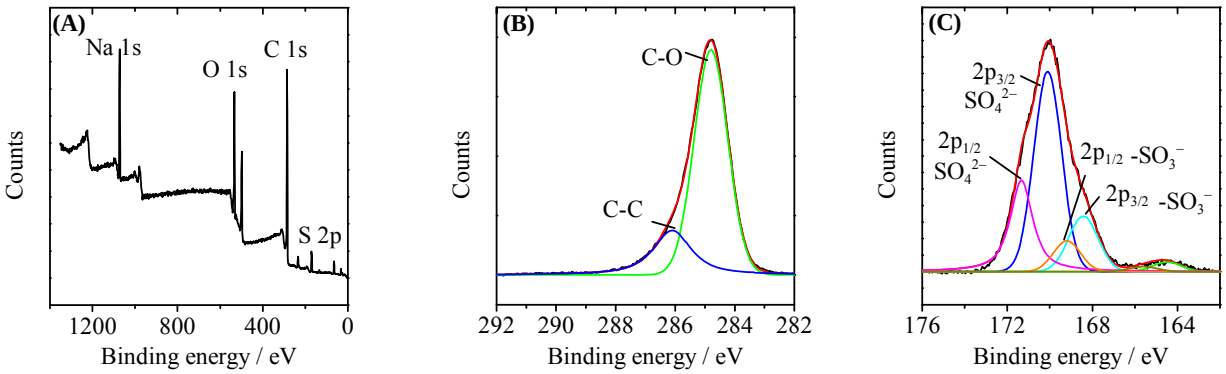

Figure S9. The XPS spectra of the residue of SDS at 400 ºC.

The residue is composed of C, O, S and Na, and C/S ratio is approximately 7.2. From Figure S9C it can be seen that the most sodium sulfonate groups were converted into sodium sulfate, which is very stable at 400 ºC.

Table S1. Absorption capacities of some carbon-based oil sorbents.

Oil absorbent	density (mg cm^{-3})	oil	*Q* (g/g)	ref
Graphene foam	0.8	chloroform	1512	This work
		toluene	938	
		gasoline	728	
		diesel oil	1079	
Graphene/CNT foam	6.9	chloroform	106	6
		toluene	125	
		sesame oil	102	
		compressor oil	85	
CNT sponge	7.5	chloroform	180	7
		vegetable oil	110	
		diesel oil	143	
nitrogen-doped graphene foam	2.1	phenixin	622	8
		chloroform	489	
		toluene	204	
		gasoline	278	
		olive oil	470	
ultra-flyweight aerogel	1.4	phenixin	743	9
		chloroform	567	
		toluene	348	
		vegetable oil	413	
		crude oil	287	
Carbon Nanofiber Aerogel	4~6	phenixin	312	10
		chloroform	284	
		toluene	157	

		sesame oil	158	
		diesel oil	171	
boron-doped CNT sponge	10.8	chloroform	125	11
		toluene	65	
		kerosene	59	
spongy graphene	12 ± 5	chloroform	86	12
		toluene	55	
		caster oil	75	
		pump oil	69	
graphene sponge	0.9~2.0	chloroform	1000	13
		toluene	731	
		pump oil	1015	
carbonaceous nanofiber aerogel	3.3	phenoxin	116	14
		vegetable oil	77	
		diesel oil	43	
rGO/NFC-50 aerogel	7.5	chloroform	265	15
		toluene	131	
		colza oil	160	
		pump oil	158	
twisted carbon fiber aerogel	12	chloroform	116	16
		toluene	85	
		olive oil	86	
		pump oil	192	
smart surface graphene foam	/	chloroform	201	17
		dichloromethane	143	
		toluene	77	
		crude oil	75	

graphene aerogel	5	phenixin	257	18
		chloroform	227	
		toluene	137	
		kerosene	148	

Reference

1 J. Li, S. Zhao, G. Zhang, Y. Gao, L. Deng, R. Sun and C. Wong, *J. Mater. Chem. A*, 2015, **3**, 15482-15488.

2 Y. Li, J. Chen, L. Huang, C. Li, J.-D. Hong and G. Shi, *Adv. Mater.*, 2014, **26**, 4789-4793.

3 H. Hu, Z. Zhao, W. Wan, Y. Gogotsi and J. Qiu, *Adv. Mater.*, 2013, **25**, 2219-2223.

4 Y. Zhao, J. Liu, Y. Hu, H. Cheng, C. Hu, C. Jiang, L. Jiang, A. Cao and L. Qu, *Adv. Mater.*, 2013, **25**, 591-595.

5 L. Zhang and G. Shi, *J. Phys. Chem. C*, 2011, **115**, 17206-17212.

6 X. Dong, J. Chen, Y. Ma, J. Wang, M. B. Chan-Park, X. Liu, L. Wang, W. Huang and P. Chen, *Chem. Commun.*, 2012, **48**, 10660-10662.

7 X. Gui, J. Wei, K. Wang, A. Cao, H. Zhu, Y. Jia, Q. Shu and D. Wu, *Adv. Mater.*, 2010, **22**, 617-621.

8 Y. Zhao, C. Hu, Y. Hu, H. Cheng, G. Shi and L. Qu, *Angew. Chem. Int. Ed.*, 2012, **51**, 11371-11375.

9 H. Sun, Z. Xu and C. Gao, *Adv. Mater.*, 2013, **25**, 2554-2560.

10 Z. Wu, C. Li, H. Liang, J. Chen and S. Yu, *Angew. Chem. Int. Ed.*, 2013, **52**, 2925-2929.

11 D. P. Hashim, N. T. Narayanan, J. M. Romo-Herrera, D. A. Cullen, M. G. Hahm, P. Lezzi, J. R. Suttle, D. Kelkhoff, E. Munoz-Sandoval, S. Ganguli, A. K. Roy, D. J.

Smith, R. Vajtai, B. G. Sumpter, V. Meunier, H. Terrones, M. Terrones and P. M. Ajayan, *Sci. Rep.*, 2012, **2**, 363.

12 H. Bi, X. Xie, K. Yin, Y. Zhou, S. Wan, L. He, F. Xu, F. Banhart, L. Sun and R. S. Ruoff, *Adv. Funct. Mater.*, 2012, **22**, 4421-4425.

13 Y. Wu, N. Yi, L. Huang, T. Zhang, S. Fang, H. Chang, N. Li, J. Oh, J. A. Lee, M. Kozlov, A. C. Chipara, H. Terrones, P. Xiao, G. Long, Y. Huang, F. Zhang, L. Zhang, X. Lepró, C. Haines, M. D. Lima, N. P. Lopez, L. P. Rajukumar, A. L. Elias, S. Feng, S. J. Kim, N. T. Narayanan, P. M. Ajayan, M. Terrones, A. Aliev, P. Chu, Z. Zhang, R. H. Baughman and Y. Chen, *Nat. Commun.*, 2015, **6**, 6141.

14 H.-W. Liang, Q.-F. Guan, L.-F. Chen, Z. Zhu, W.-J. Zhang and S.-H. Yu, *Angew. Chem. Int. Ed.*, 2012, **51**, 5101-5105.

15 X. Yao, W. Yu, X. Xu, F. Chen and Q. Fu, *Nanoscale*, 2015, **7**, 3959-3964.

16 H. Bi, Z. Yin, X. Cao, X. Xie, C. Tan, X. Huang, B. Chen, F. Chen, Q. Yang, X. Bu, X. Lu, L. Sun and H. Zhang, *Adv. Mater.*, 2013, **25**, 5916-5921.

17 H. Zhu, D. Chen, N. Li, Q. Xu, H. Li, J. He and J. Lu, *Adv. Funct. Mater.*, 2015, **25**, 597-605.

18 L. Xu, G. Xiao, C. Chen, R. Li, Y. Mai, G. Sun and D. Yan, *J. Mater. Chem. A*, 2015, **3**, 7498-7504.