Electronic Supplementary Material (ESI) for RSC Advances.

Ultradispersed Titanium Dioxide Nanoparticles Embedded in Three-dimensional Graphene Aerogel for High Performance Sulfur Cathodes

Table S1. The quantities of different additions for synthesizing GA-TiO_2 composites and GA.

Composite	$Ti(SO_4)_2$ /mg	Glucose /mg	GO / mL
GA-TiO_2-19	28.4	0.8	50
GA-TiO_2-42	85.3	2.4	50
GA-TiO_2-63	128.2	3.6	50
GA	-	-	50

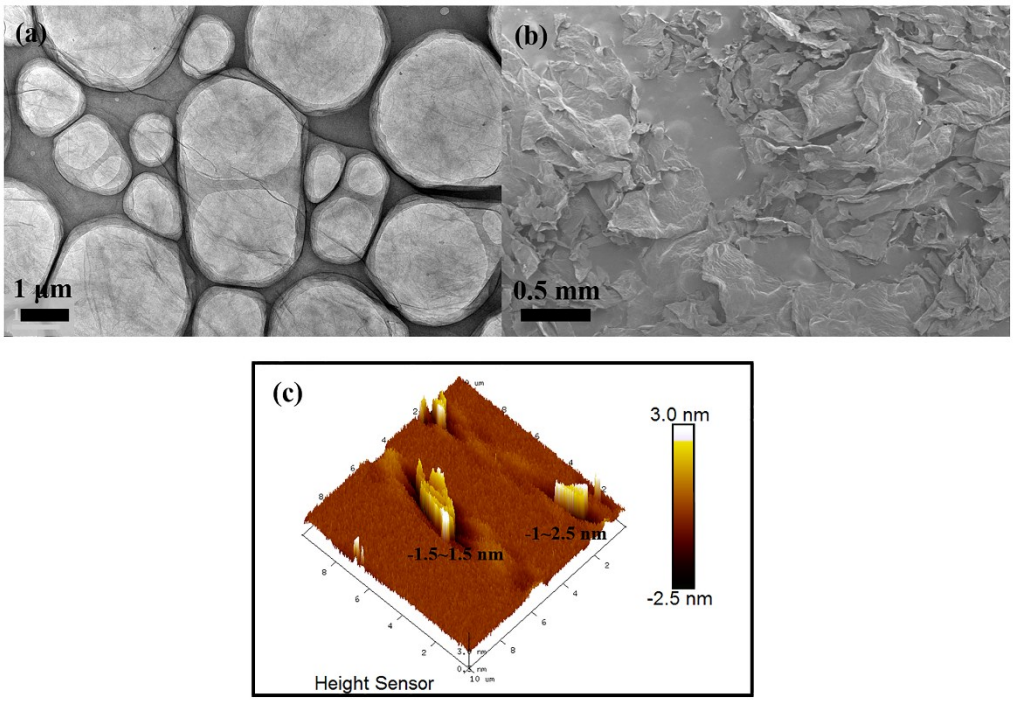

Figure S1. Low-magnification (a) TEM and (b) SEM images of GO. (c) AFM image of the GO.

As shown in the Fig. S1, the TEM and SEM images show that GO presents a lamellar structure. Because of the overlap of GO sheets, it's hard to confirm the size of one sheet. According to the atomic force microscope (AFM) test results, the thickness of GO prepared by us is about 3-5 nm, which including about 8-14 layers of GO.

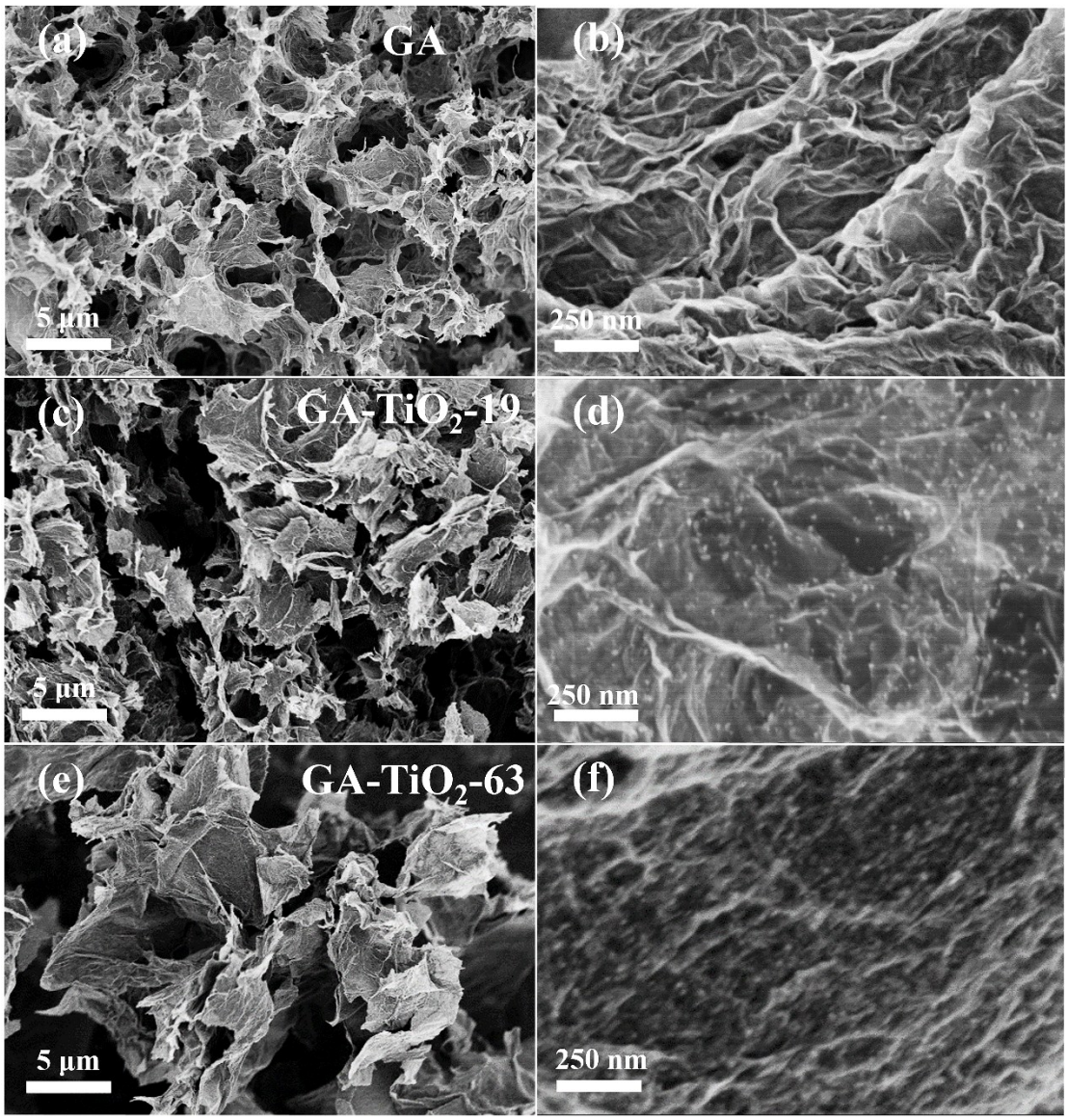

Figure S2. Low-magnification SEM images of (a) GA, (c) GA-TiO_2-19 and (e) GA-TiO_2-63. High-magnification SEM image of (b) GA, (g) GA-TiO_2-19 and (l) GA-TiO_2-63.

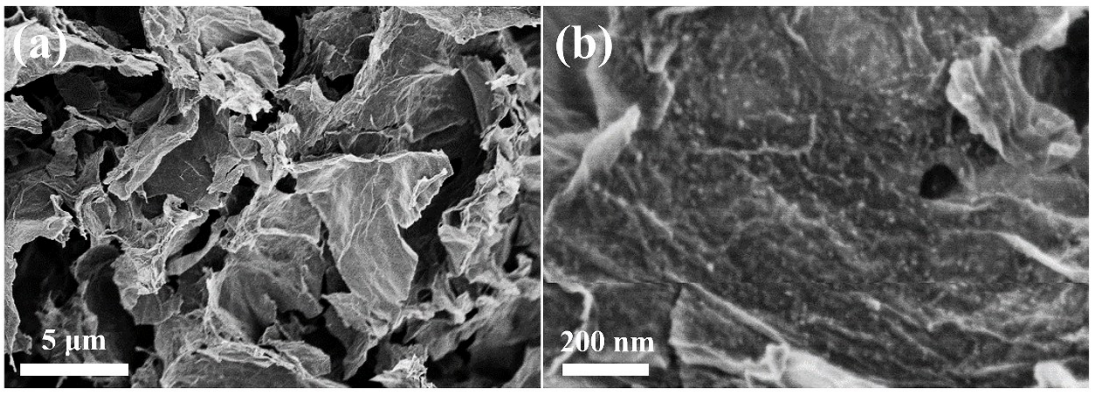

Figure S3. (a) Low-magnification SEM image and (b) High-magnification SEM image of GA-TiO_2/S. The content of TiO_2 in above tested samples is 42 wt%.

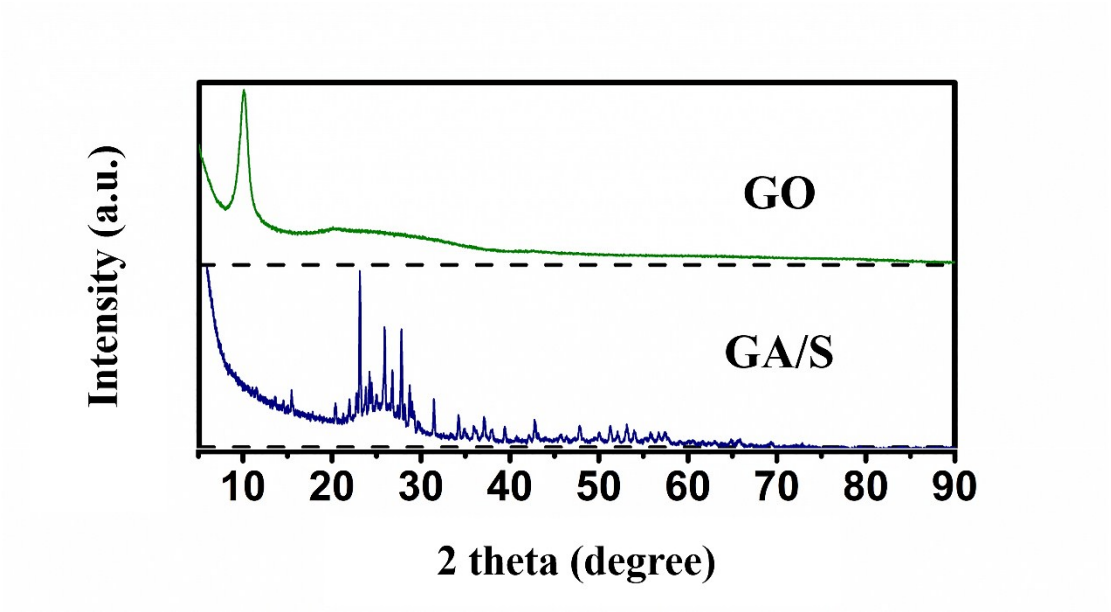

Figure S4. XRD patterns of the composites.

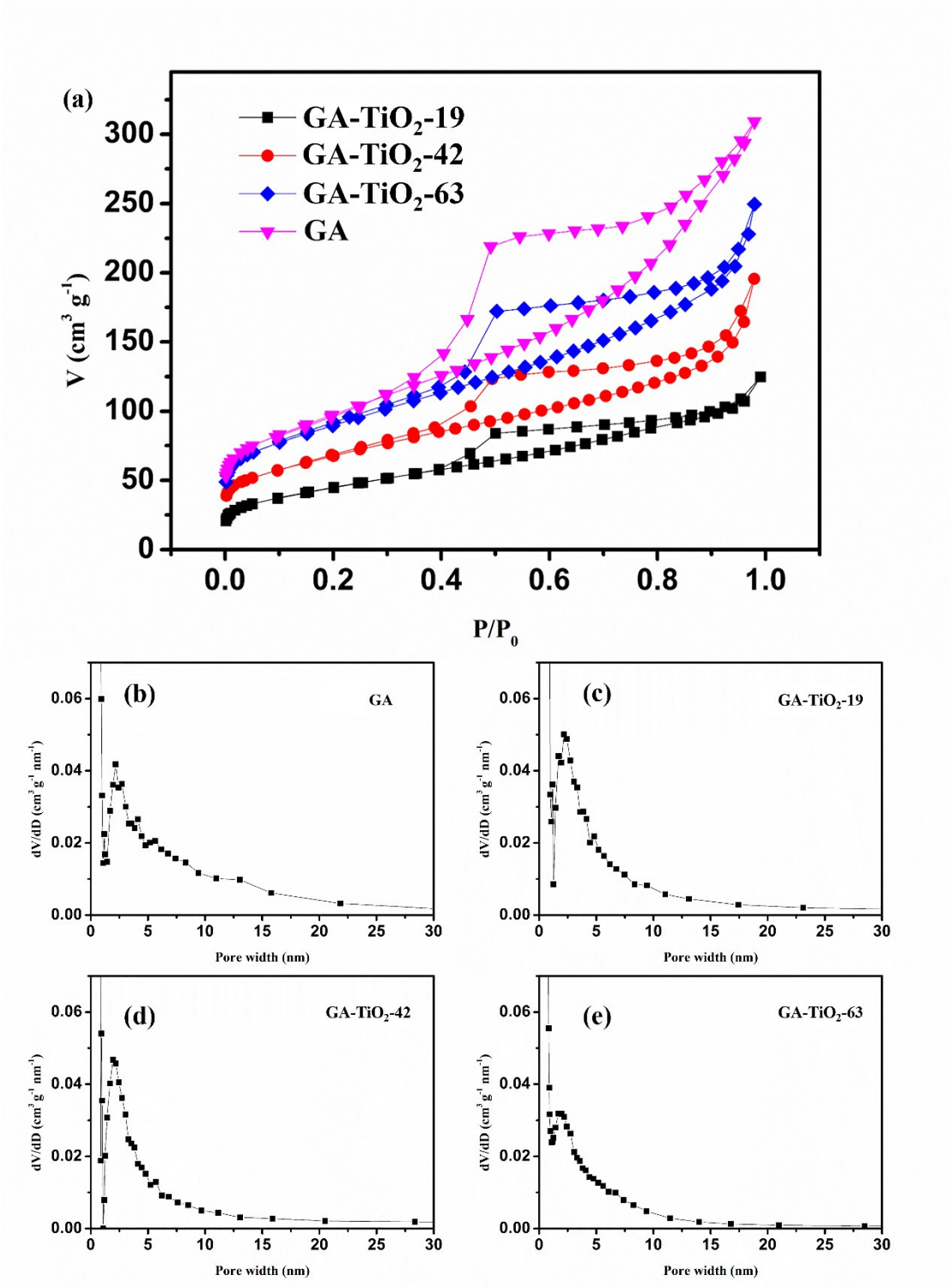

Figure S5. (a) Nitrogen adsorption-desorption isotherm and (b-e) the pore diameter distribution of GA, GA-TiO_2-19, GA-TiO_2-42 and GA-TiO_2-63 obtained using the BJH method. BET specific surface area of GA, GA-TiO_2-19, GA-TiO_2-42 and GA-TiO_2-63 is 592, 486, 360 and 297 m^2/g respectively.

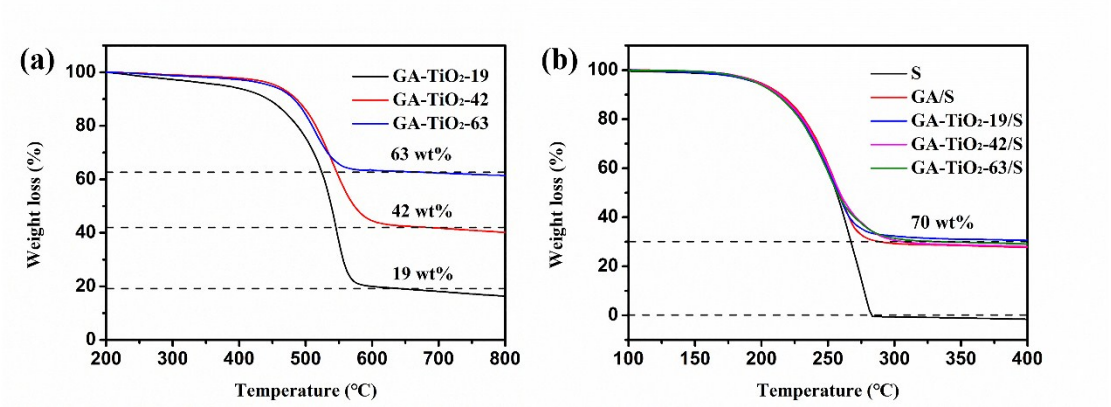

Figure S6. (a) TG curves of GA-TiO_2-19, GA-TiO_2-42 and GA-TiO_2-63 composite in flowing O_2. (b)TG curves of S, GA/S, GA-TiO_2-19/S, GA-TiO_2-42/S and GA-TiO_2-63/S composite in flowing N_2.

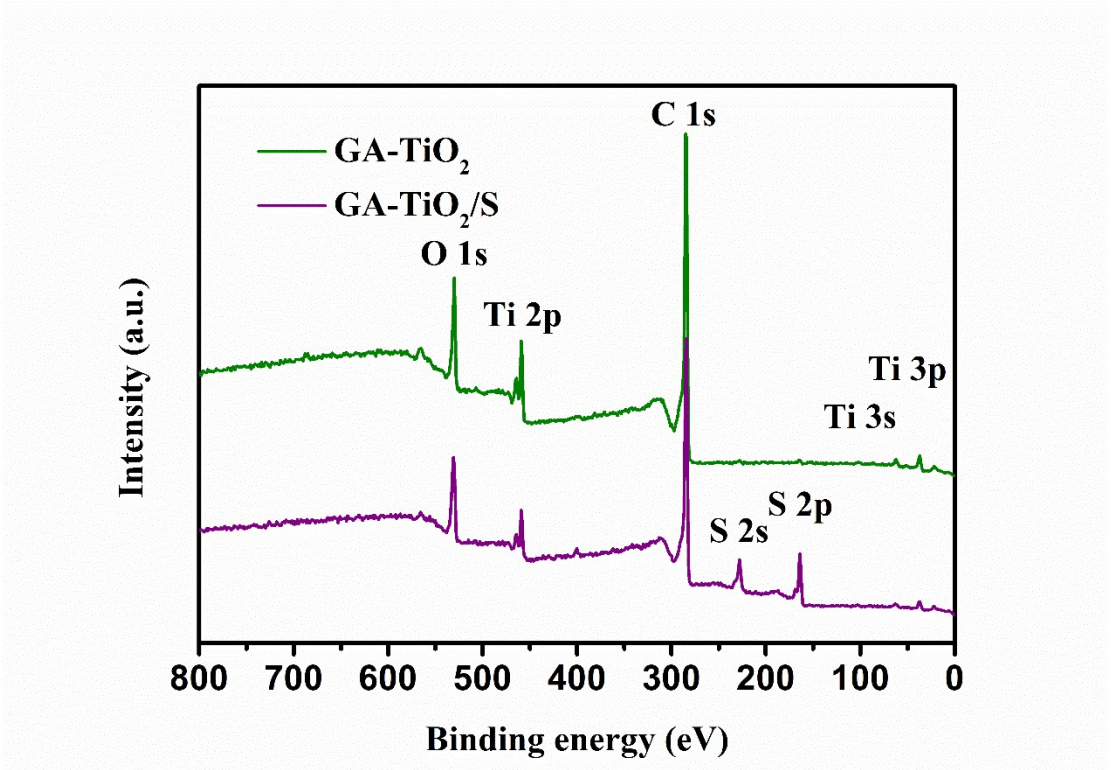

Figure S7. C1s XPS full spectra of GA-TiO_2 and GA-TiO_2/S. The content of TiO_2 in above test samples is 42 wt%.

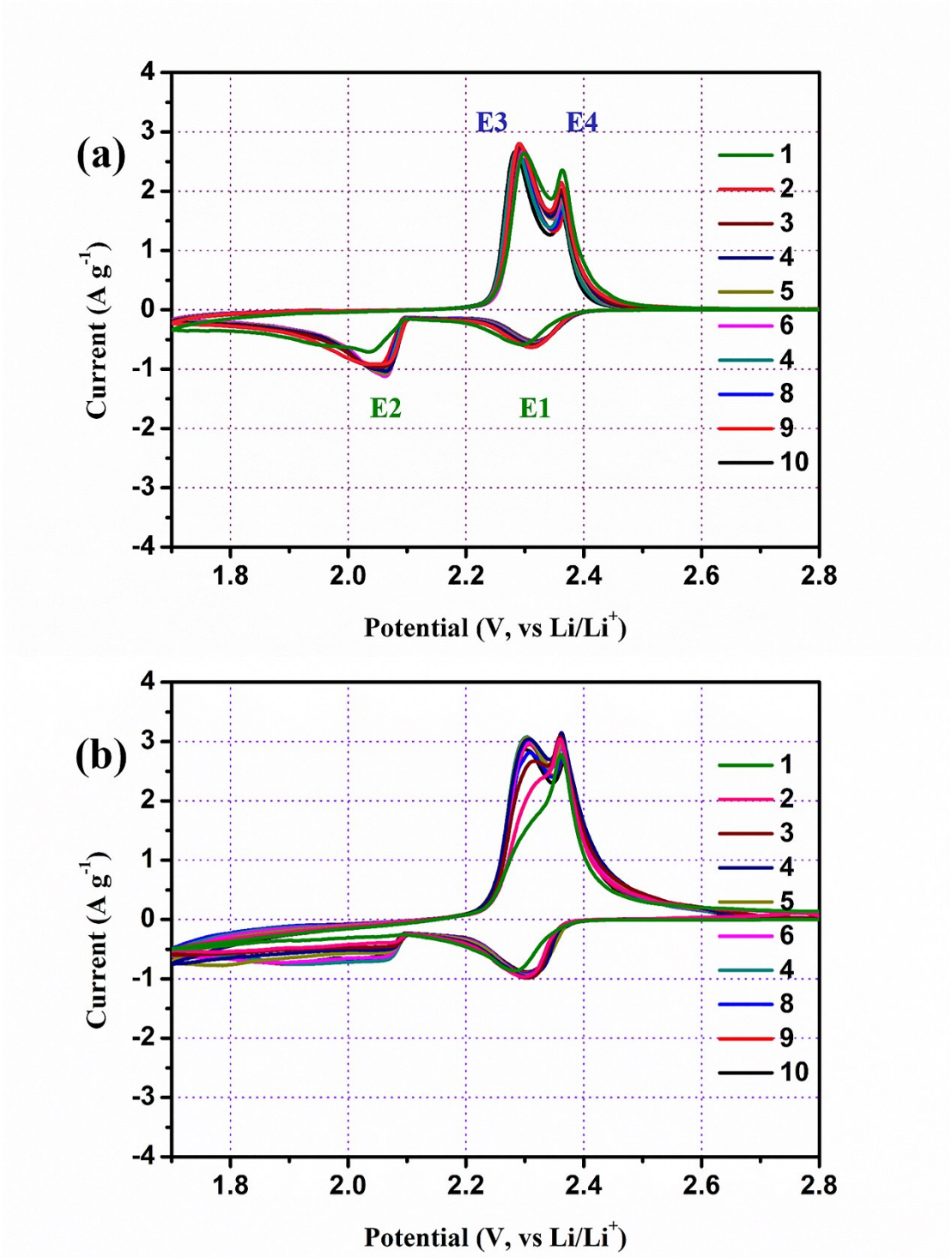

Figure S8. CV profiles of (a) GA-TiO_2-19/S and (b) GA-TiO_2-63/S cathodes at a scan rate of 0.05 mVs^{-1} in a potential window from 1.7 to 2.8 V.

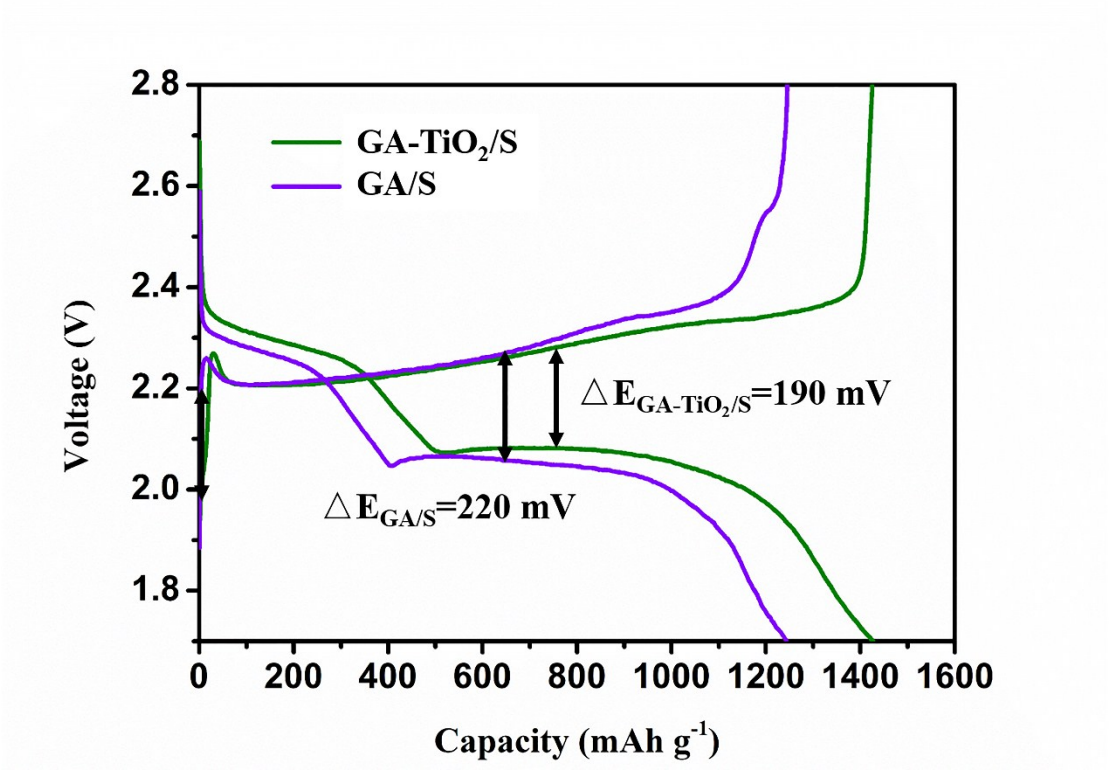

Figure S9. The second cycle Galvanostatic charge–discharge profiles of the GA/S and GA-TiO_2/S at 0.2 C. The content of TiO_2 in above test sample is 42 wt%.

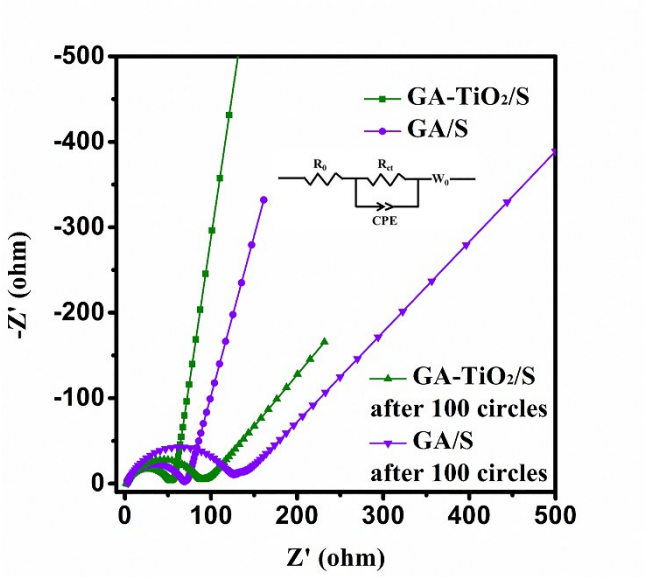

Figure S10. Electrochemical impedance spectra of the GA/S and GA-TiO_2/S cathodes. The content of TiO2 in above test sample is 42 wt%.

Table S2. The comparison of Electrochemical Performance of Li-S Batteries with Different Cathode materials.

Cathode materials	S content (wt%)	S loading (mg/cm^2)	Current rate (C)	Initial discharge capacity (mA hg^{-1})	Cycle number	Residual discharge capacity (mA hg^{-1})	reference
3D graphene/S	80	11.9	0.1	513	300	472	[1]
graphene/nano-S	53	1	0.9	657	168	592	[2]
high density graphene/S	32	0.8-1	0.5	750	300	340	[3]
mesoporous TiO_2/S	70		1	650	100	500	[4]
mesoporous hollow TiO_2 sphere/S	68		1	522	100	480	[5]
TiO_2 nanowire/graphene membrane		3.2	0.2	1100	200	1053	[6]
graphene/TiO_2/S	60	1.5-2	1	756	100	597	[7]
GA-TiO_2/S	70		0.2	1555	500	930	
	70		2	810	700	503	

Notes and references

1. S. Lu, Y. Chen, X. Wu, Z. Wang and Y. Li, *Sci.Rep.*, 2014, **4**.
2. C. Wang, X. Wang, Y. Wang, J. Chen, H. Zhou and Y. Huang, *Nano Energy*, 2015, **11**, 678-686.
3. H. Li, X. Yang, X. Wang, M. Liu, F. Ye, J. Wang, Y. Qiu, W. Li and Y. Zhang, *Nano Energy*, 2015, **12**, 468-475.
4. B. Ding, L. Shen, G. Xu, P. Nie and X. Zhang, *Electrochim. Acta*, 2013, **107**, 78-84.
5. J. Li, B. Ding, G. Xu, L. Hou, X. Zhang and C. Yuan, *Nanoscale*, 2013, **5**, 5743-5746.
6. G. Zhou, Y. Zhao, C. Zu and A. Manthiram, *Nano Energy*, 2015, **12**, 240-249.
7. B. Ding, G. Xu, L. Shen, P. Nie, P. Hu, H. Dou and X. Zhang, *J. Mater. Chem. A*, 2013, **1**, 14280-14285.