Supporting information

High Sulfur Loading and High Capacity per Area Lithium Sulfur Cathode: Binder -free Carbon Fibers Cloth/sulfur Material

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Methods

Synthesis of CFC/S. The synthesis of the carbon fibre cloth (CFC) and CFC/S is described in Fig.1S. To prepare the CFC material, some old experimental clothes were cut into 5×15 cm rectangles, and then washed away oil and fat with 1M sodium hydroxide solution, because these clothes are made of cotton fiber, cotton fiber is a hollow fiber with small amount of fat-containing. The carbonization was taken by heating these pieces of cloth at 1000 °C for 4 hours under a flow of N_2 gas. After cooling down, CFC and sulfur (1:5 weight ratios) were heated up to 158 °C and kept for 12 hours to facilitate sulfur diffusion into the carbon fibers cloth. And then, CFC/S was maintained in an oven at 200 °C for 2h to reduce sulfur residue sticking on the outer surface of carbon fibers cloth. Further, the amount of sulfur loading of CFC/S can be controlled by adjusting the heating time at 200 °C. Finally, CFC/S was punched into circular electrode (diameter 14 mm). The sulfur loading (3.8, 5.3, 6.7, 8.0 mg cm^{-2}) on the final electrode sample was calculated by weighing the same size CFC/S circular electrode and CFC one, the mass of carbon cloth per area is 4.8 mg cm^{-2} .

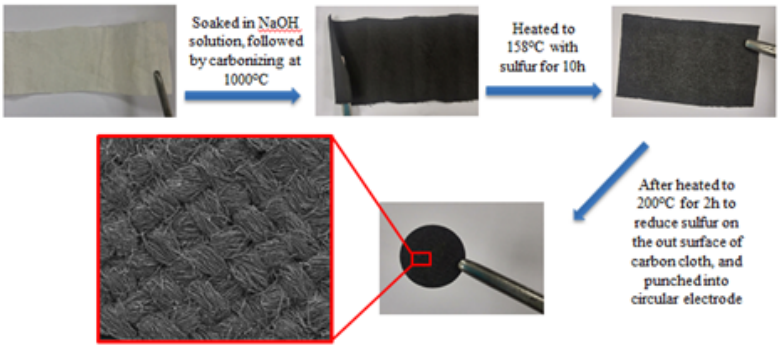

Fig. S1 Schematic illustrations of the structure and fabrication process of CFC/S

Electrode fabrication and electrochemical measurements. The electrochemical performances of the CFC/S cathodes were examined in 2032 button batteries at a current density of 0.3 mA cm^{-2} (see Fig. 3), A lithium foil, a polypropylene separator (Celgard 2400), an aluminum foil and a CFC/S cathodes were placed into the cells, the electrolyte is 1 M LiTFSI in DME:DIOX(1:1, v:v) containing 0.4M $LiNO_3$. A LAND CT2001A galvanostatic charge–discharge instrument was used to perform the measurements. The charge–discharge voltage range was 1.5-2.8 V.

Table 1 Characteristics of various carbon–sulfur composites reported in literatures

Material [Reference]	S percentage of material /electrode	Sulfur loading or thickness of cathode	Cycle performance, 1C=1.675A/g	Surface capacity/ mAh cm^{-2}
CNT@S[1]	53% /45%	0.42mg cm^{-2}/ 10~15μm	1C, 1000 cycles, 1053~535mAh g^{-1}	**0.2~0.4**
PVP-encapsulated S nanosphere[2]	70.4%,/--	1mg cm^{-2}/21.3μm	0.5C, 1000 cycles, 990~535mAh g^{-1}	**0.5~1**
Sulphur–TiO_2 yolk–shell nanoarchitecture[3]	71%/53%	0.4~0.6mg cm^{-2}/--	0.5C 1000 cycles, 1030~690mAh g^{-1}	**0.4~0.6**
S@C NW[4]	80.85%/--	1mg cm^{-2}/--	2C, 1000 cycles, 1138~863mAh g^{-1}	**0.8~1.1**
CTAB -S− GO[5]	80%/56%	0.8 mg cm^{-2}/--	1C 1500 cycles, 740~440 mAh g^{-1}	**0.3~0.6**
DTG/S nanocomposites[6]	64%/-	0.8~1.1 mg cm^{-2}/- -	5C, 200 cycles, 1200~832 mAh g^{-1}	**0.6~1.3**
GCC/S+G-separator[7]	70%/--	2~2.8mg cm^{-2} /20~30μm	0.9C, 300 cycles, 1052~ 680mAh g^{-1}	**1.4~2.9**
S−Pani yolk−shell structure[8]	58%/46.4%	2mg cm^{-2}/ --	2C, 200 cycles, 1100~765 mAh g^{-1}	**1.5~2.2**
Mesoporous carbon-sulfur (MCS)[9]	50%/40%	--/--	1C 400 cycles, 900~800 mAh g^{-1}	
PD-coated FLSNS[10]	83%/66%	<1.2mg cm^{-2} / 20μm	0.6C 500 cycles, 715~640 mAh g^{-1}	**<0.8**
PD- coated RGO/S[11]	74%/56%	<1mg cm^{-2}	0.6C 800 cycles, 715~530 mAh g^{-1}	**<0.72**
Amphiphilic surface-modified hollow CNF-S composite[12]	--	~1mg cm^{-2}	0.5C 300cycles 828~660 mAh g^{-1}	**0.6~0.8**
CFC/S	66%	6.7mg cm^{-2} / ~150μm	0.3mA/cm^{-2} 50 cycles, 1100 mAh g^{-1}	**>7.0**

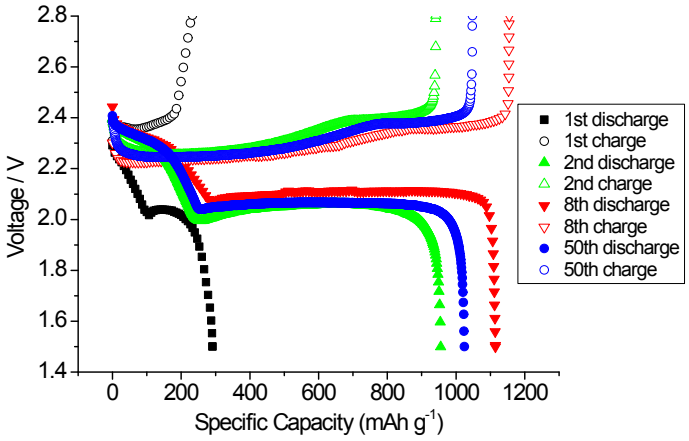

Fig. S2 Charge-discharge profile for the CFC/S composite with 6.7 mg cm^{-2} sulfur loading on 1st, 2nd, 8th, 50th cycle, current density is 0.3 mA cm^{-2}

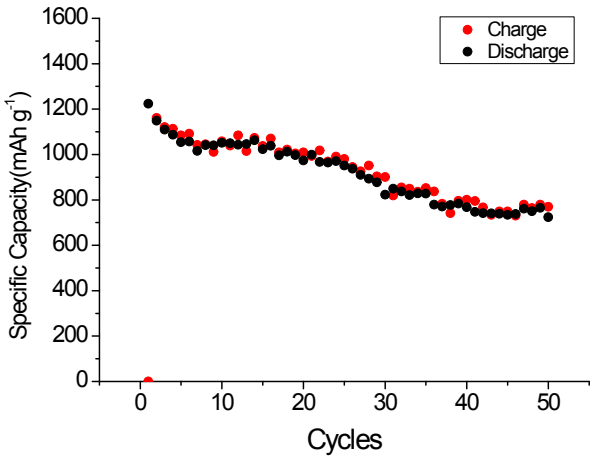

Fig. S3 Charge-discharge performance of the CFC/S electrode with 7.0mg cm^{-2} sulfur loading at a current density of 0.3 mA cm^{-2}.

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