

Development of Nanomaterials for High-Performance energy storage technology

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By

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Tianyi Wang, certify that the work presented in this thesis has not been previously submitted for a degree nor has been submitted as a part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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DEDICATION

This thesis is dedicated to my family. Thank you for all of your love and support.

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REPSEARCH PUBLICATIONS

1. **Tianyi Wang**, Xiaoyu Sun, Xin Guo, Jinqiang Zhang, Jian Yang, Shouxuan Tao, Jun Guan, Lin Zhou, Jie Han, Chengyin Wang, Hang Yao and Guoxiu Wang, Ultraefficiently Calming Cytokine Storm Using $Ti_3C_2T_x$, *Small methods*, 2020, DOI: 10.1002/smt.202001108.
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TABLE OF CONTENTS

CERTIFICATION OF ORIGINAL AUTHORSHIP	2
DEDICATION	3
ACKNOWLEDGEMENTS.....	4
RESEARCH PUBLICATIONS	5
TBLE OF CONTENTS.....	7
LIST OF TABLES	10
LIST OF FIGURES	11
ABSTRACT.....	21
INTRODUCTION	22
Chapter 1 Introduction.....	22
Chapter 2 Literature Review	25
2.1 The Working Mechanism and Challenges of Li-S batteries.....	26
2.2 Flexible Cathode Hosts for Lithium-Sulfur Batteries	28
2.3 Electrolyte Membranes for Flexible Li-S Batteries	41
2.3.1 Solid Polymer Electrolyte for Flexible Li-S Batteries	43
2.3.2 Gel Polymer Electrolytes for Flexible Li-S Batteries.....	46

2.3.3 Composite Polymer Electrolytes for Flexible Li-S batteries.....	47
2.4 Separator for Flexible Li-S Batteries	51
2.5 Summary	41
Chapter 3 Experimental section	56
3.1 Overview	57
3.2 Material Preparation.....	60
3.2.1 Co-precipitation experiment	60
3.2.2 High temperature calcination.....	60
3.2.3 Melt diffusion and sulfur injection experiment	60
3.2.4 Electrospinning experiment	61
3.2.5 Finite element simulation (FES)	62
3.3 Characterization methods.....	62
3.3.1 X-ray powder diffraction (XRD).....	62
3.3.2 X-ray photoelectron spectroscopy (XPS).....	63
3.3.3 Fourier-transform infrared spectroscopy (FT-IR).....	63
3.3.4 Raman spectroscopy	63
3.3.5 Thermogravimetric Analysis (TGA)	64
3.3.6 Scanning electron microscopy (SEM).....	64
3.3.7 Transmission electron microscopy (TEM)	64

3.3.8 Two-photon excitation microscopy (TPEM).....	64
3.3.9 Cryogenic transmission electron microscopy (Cryo-EM).....	65
3.4 Preparation procedure of electrode and assembly of batteries.....	65
3.4.1 Preparation of electrodes.....	65
3.4.2 Battery assembly.....	66
3.5 Electrochemical performances.....	66
3.5.1 Cyclic Voltammetry (CV).....	66
3.5.2 Galvanostatic Charge-Discharge.....	66
3.5.3 Electrochemical Impedance Spectroscopy (EIS).....	67

Chapter 4 Biomimetic 3D Fe@CeO₂ decorated N-doped Carbon nanotubes architectures for high-performance Lithium-Sulfur batteries..... 67

4.1 Introduction.....	70
4.2 Experiment section.....	70
4.2.1 Synthesis of Fe/CeO ₂ -CNTs hybrids.....	70
4.2.2 Synthesis of S/Fe/CeO ₂ -CNTs hybrids.....	70
4.2.3 Structural and Physical Characterization.....	70
4.2.4 XPS characterization.....	71
4.2.5 Electrochemical Testing.....	71
4.3 Results and discussion.....	73

Chapter 5 Immunizing lithium metal anodes against dendrite growth using protein molecules to

achieve high energy batteries	94
5.1 Introduction	94
5.2 Experiment section	95
5.2.1 Materials	95
5.2.2 Characterization	96
5.2.3 Electrochemical measurements	98
5.2.4 Cryogenic TEM (Cryo-EM) characterization	98
5.2.5 COMSOL™ simulation	99
5.3 Results and discussion	100
5.3.1 Self-defense mechanism of fibroin	100
5.3.2 Dense Li deposition with fibroin	109
5.3.3 Characterization of SEI with fibroin	115
5.3.4 Electrochemical performance of performance of Li anodes with fibroin.....	119
5.3.5 Electrochemical performance of performance of Li Li ₄ Ti ₅ O ₁₂ full cells	122
5.4 Conclusion	133
Chapter 6 Conclusion and future perspective	134
APPENDIX NOMENCLETURE	136
REFERENCES	136

LIST OF TABLES

Table 3.1 Chemicals details in the research project.....	59
Table 5.1 Comparison of mechanical properties of fibroin interlayer before and after immersed in ether-based electrolyte.....	120

LIST OF FIGURES

Figure 2.1 (a) The fabrication process of the laminated hybrid sulfur cathode and (b) schematic image of structure of the flexible Li–S battery. (c) Comparison to explain the differences in electronic conductivity between aligned CNTs and random CNTs. [25]. Copyright 2015, John Wiley & Sons. (d) The preparation method for the S-rGO paper. (e) The rate capability of 3D–NGS with current densities ranging from 100–1500 mAh g⁻¹ and the first discharge–charge profiles at different current densities [20]. Copyright 2014, Royal Society of Chemistry. (f) The preparation method for synthesizing S-CNT/G and (g) its electrochemical performance when used as flexible Li–S battery cathode. [26]. Copyright 2015, Royal Society of Chemistry..... 33

Figure 2.2 (a) The preparation process of NPCFs by an electrospinning method. (b) Typical tensile stress–strain curves of the as-prepared membrane and photograph of the tensile stress–strain testing instrument. [28]. Copyright 2017, Royal Society of Chemistry. (c) The preparation process of the CNT–rGO/S composite. (d). The physical performance of CNT–rGO/S. (e) SEM image of sulfur particles and holder materials. [24]. Copyright 2015, American Chemical Society. (f) The sulfur particles that are protected by GTS. (g) The preparation process of the 3DGS hydrogel. [29]. Royal Society of Chemistry. (h) The electrochemical performance of a Li–S battery using 3DGS hydrogel as cathode material at various current densities. [30]. Copyright 2016, Royal Society of Chemistry. 37

Figure 2.3 (a) The flexible porous structure of the material and (c) the discharging capacity at various current densities. [32]. Copyright 2016, Royal Society of Chemistry. (d) Li–S battery with sandwich-structured cathode that can be curved or bent. Source: Song et al. 2014 [25]. Copyright 2014, Royal Society of Chemistry. (e) SEM view of sulfur particles that are attached on carbon foam. (f) The charge

and discharge curve of the battery.^[34] Copyright 2016, Royal Society of Chemistry. (g) The structure of 3DCNT/Graphene-Li₂S aerogel. (h) Electrochemical performance of scaffold material. ^[35]. Copyright 2016, American Chemical Society.42

Figure 2.4 (a) Cycling performance of GPE-based batteries, and those of liquid-based ones at 0.1 C. (b) Rate performance of GPE-based batteries and the liquid-based ones from 0.1 to 1 C. (c) The polysulfide immobilization mechanism of GPE-based batteries and the liquid-based ones. Dendrites continually grow on the sulfur electrodes' surface in the liquid electrolyte-based batteries while the GPE-based ones can maintain a smooth morphology.^[48] Copyright 2016, Elsevier B.V. (d) With the increasing weight ratio of sucrose in the sucrose-PEO electrolyte, the ionic conductivity increases obviously. (e) Cycling performance of Li-S batteries with sucrose-PEO electrolyte and the electrochemical impedance spectroscopy (EIS) spectrum of the battery. (f) Specific capacity of cells using the sucrose-PEO electrolyte. The value remained almost constant after 200 cycles.^[10] Copyright 2017, Electrochemical Society..... 45

Figure 2.5 (a) 50PEO–50SiO₂ composite electrolyte membranes, that were flexible enough to be rolled into a tube. (b) Capacity retention of Li–S battery with (1) common liquid electrolyte and (2) the 50PEO–50SiO₂-based electrolyte.^[54] Copyright 2013, Electrochemical Society. (c) Preparation and mechanism of the flexible halloysite nano-clay electrolyte. Cast and dried after HNF, LiTFSI, and PEO were mixed to obtain a thin film and the ordered 3D channels promoted ionic conduction. (d) Photos of initial and final tension state of the halloysite nanoclay electrolyte film. (e) Discharge and charge curves of a battery with halloysite nano-clay electrolyte at 25 C. (f) Cycling performance of a battery with the halloysite nanoclay electrolyte at 25 C.^[55] Copyright 2017, Elsevier B.V. (g) Stress–strain of

GPE assisted by ETU. (h) Charge and discharge stability test of a battery with ETU-assisted GPE.^[56]

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Figure 2.6 (a) SEM images of electrodes with PETEA (3 right) and liquid (3 left) electrolytes' surface after 2 and 50 charge and discharge cycles. (b) The PETEA-based GPE under serious deformation could power a light-emitting diode (LED) lamp while the liquid one could not. Compared with liquid electrolyte, PETEA-based GPE could maintain its stability when bent and had the same specific capacity as before when returned to a flat shape. Source: Liu et al. 2016 ^[48]. Copyright 2016, Elsevier B.V. (c) How the charge capacity of TiO₂-SiO₂-modified CPE depends on the number of cycles. (d) SEM images of the porous structure of TiO₂-SiO₂-modified CPE. ^[61]. Copyright 2015, Springer Nature. 51

Figure 2.7 (a) Schematic of electrode configuration illustrating the process of combining sulfur and graphene@PP membrane to form an integrated electrode-separator structure. (b) Cross-section SEM image of sulfur electrode and corresponding EDS spectrum. (c) Stability of electrode-separator combination in terms of conductivity after 5000 bending cycles. (d) Rate performance of the S-G@PP separator, G- + PP separator and Al foil-S + PP separator batteries at different current densities. ^[74]. Copyright 2015, Wiley. (e) Cross section of MoS₂-Celgard layer. (f) Schematic Li-S battery configuration of MoS₂ CelgardTM separator. (g) The cycling performance for CelgardTM, GO/CelgardTM, and MoS₂/CelgardTM separators at 0.5 C. ^[31]. Copyright 2017, Wiley. 54

Figure 2.8 (a) The porous structure of a graphene-modified separator ^[75]. (b) The flexibility of a Li-S battery using the separator and metal Li as anode material. (c) The flexibility of the separator. (d) Schematic diagram of a modified CelgardTM separator restricting the polysulfide migration while

maintaining good lithium ion transportation. (d) Comparison of hydrophilic separator (before and after modification).^[76]. Copyright 2015, Royal Society of Chemistry. (g, h) The structure of the modified membrane ^[10]. (i) The schematic diagram of the experimental battery.^[77]. Copyright 2015, Elsevier B. V..... 57

Figure 3.1 The diagram that demonstrates procedures of the experiment. 59

Figure 4.1. (a) Illustration of the synthesis process for preparing Fe/CeO₂-CNTs hybrids. (b) SEM images of precursor Prussian blue analog nanosheets. (c) SEM images of the typical Fe/CeO₂-CNTs structure after annealing at 900 °C. 74

Figure 4.2 SEM images of Ce[Fe(CN)₆] precursor nanoplates before calcination..... 75

Figure 4.3 The pattern of X-ray diffraction data of Fe/CeO₂-CNTs hybrids... .. 76

Figure 4.4 Comparison of 3D Fe/CeO₂-CNTs hollow structures by changing the ratio of PBA to melamine. (a & b) Seaweed-like, (d & e) sea anemone-like, (g & h) sea cucumber-like and j & k rocky seabed-like Fe/CeO₂-CNTs, corresponding to different ratios of PBA : melamine (3 : 1, 2 : 1, 1 : 1 and 1 : 2). 78

Figure 4.5 Comparison of 3D morphologies of Fe/CeO₂-CNT hybrids calcinated at various temperature: (a) 850 °C, (b) 900 °C and (c) 950 °C. 80

Figure 4.6 (a) HR-TEM image of Fe/CeO₂-CNTs and the specific feature of its catalyst particle. (b) HR-TEM image of one CNT growing by two different growth schemes. (c) A cluster of sea anemone-like CNTs catalyst particles of which have been marked in red color. (d) The TEM image of one sea anemone-like Fe/CeO₂-CNTs. 80

Figure 4.7 (a) The HR-EM image of Fe/CeO₂-CNT and the specific feature of its catalyst particle. b

HR-TEM image of conjunction between catalyst and carbon nanotube. (c) One TEM image of a hollow CNT (PBA : melamine is 2 : 1). (d) A broken CNT (PBA : melamine is 1 : 1) (yellow) of which its catalyst is exposed (red). (e) The inset is the schematic diagram of CNT growth. 81

Figure 4.8 (a) Comparison of Raman spectra of Fe/CeO₂-CNTs synthesized with different proportion of melamine. (b) XPS N1s spectrum of Fe/CeO₂-CNTs. (c) C 1s XPS spectrum of Fe/CeO₂-CNTs. (d) XRD patterns of Fe/CeO₂-CNTs, Sulfur and S/Fe/CeO₂-CNT. 82

Figure 4.9 (a) EDS spectrum mapping revealing uniform distribution of (b) Ce, (c) S and (d) Fe elementals. 83

Figure 4.10 TEM images of S contained CNTs. 61

Figure 4.11 (a) The 1st-5th CV curves of S/Fe/CeO₂-CNTs electrode at a scan rate of 0.1 mV s⁻¹. (b) Typical charge and discharge profiles for the 1st, 20th, 60th, and 100th cycles at 0.2 C. (c) Typical charge and discharge profiles of S/Fe/CeO₂-CNTs with different percentages of N-dopant. (d) Rate performance of S/Fe/CeO₂-CNTs hybrids at varied current rates (0.2, 0.5, 1, 2 and 5 C). (e) EIS comparison of Li-S batteries after 10 cycles employing Fe/CeO₂ CNT and traditional CNT as sulfur holder materials. (f) The adsorption experiment of Li₂S₆, Li₂S₆ + CNTs and Li₂S₆ + Fe/CeO₂ CNTs (1 : 1) after 10 min absorption time (H₂O < 0.1 ppm, O₂ < 0.1 ppm). 84

Figure 4.12. TGA curve of S/Fe/CeO₂ CNTs (1 : 1) hybrid. 88

Figure 4.13. (a) Discharge/charge curve of Li-S battery with high sulfur loading at the first, 5th, 10th and 50th cycle at 0.2 C. (b) Cycling stability of high sulfur loading Li-S battery at the current density of 0.2 C. 88

Figure 4.14. Comparison of SEM images of Li metal foils after 15 cycles at the current density of 0.2 C using high sulfur loading S/CNTs (a & b) and (c & d) S/Fe/CeO₂ CNT as cathodes. 89

Figure 4.15 The *ex-situ* XPS of (a) Li, (b) Fe, (c) S and (d) Ce of electrodes discharged down to 1.7 V. (e) Cycling performances of S/Fe/CeO₂-CNTs electrode at 1 C rate. (f) Comparison of stability of batteries using CNT, Fe/CNT and Fe/CeO₂-CNT as cathode sulfur holder and cycled for 500 cycles at the current density fo 1 C. 91

Figure 4.16. The consistency of cycling performances of S/Fe/CeO₂ CNTs (1 : 1) cathodes when cycled at the current density of 1 C. 92

Figure 4.17. *Ex-situ* XPS results of nitrogen of electrode materials after the 100th cycle. 93

Figure 5.1 Schematic diagram of the self-defense mechanism of fibroin. (a) Illustration of the secondary structural transformation of fibroin molecules and the self-defense mechanism of immunizing Li metal anode against Li dendrite growth. (“R” groups are known as side chains of amino acids (-H to Glycine residue, -CH₂OH to Serine residue, and -CH₃ to Alanine residue)). (b, c) CD spectra (b) and ATR-FT-IR spectra (c) of pristine fibroin and recovered fibroin from the cycled cell after 100 cycles. (d) A fluorescent image of fibroin molecule distribution around the edges and protrusions on a Li metal foil under UV-light. The corresponding 2D (e) and 2.5 D (f) simulations of fluorescence intensity. The scale bars on the top in (e) and (f) correspond to the intensity increase from blue to red. Scale bars, (d, e) 100 μm. 105

Figure 5.2 Digital photo of Tyndall effect in ether-based electrolytes with and without fibroin..... 106

Figure 5.3 Tyndall effect of fibroin dispersed electrolyte during Li | Li plating/stripping process.

Tyndall effect can be observed in a transparent Li | Li symmetric cell during plating/stripping process at a current density of 1 mA cm^{-2} , which confirms that fibroin molecules are dispersed homogeneously in the electrolyte during cycling. 107

Figure 5.4 Comparison of FT-IR curves of fibroin before and after immersed in the ether-based electrolyte for 1 month. 108

Figure 5.5 COMSOLTM simulation of the change of electric field distribution around Li buds. (a) before and (b, c) after covered by fibroin molecules with the height ratio of (b) 30% and (c) 100%. 109

Figure 5.6 Characterization of Li deposition in ether-based electrolyte with fibroin additive. (a, b) Top-view (a) and cross-section (b) SEM images of Li metal anodes cycling in the cells with blank (i.e. no fibroin) electrolyte. (c, d) Top-view (c) and cross-section (d) SEM images of Li metal anodes cycling in the cells with fibroin additive in the electrolyte. The insets in (a) and (b) are the corresponding high magnification SEM images. Scale bars, (a-d) $20 \mu\text{m}$ and inserts in (a, c) $5\mu\text{m}$. (e, f) Low-resolution (e) and high-resolution (f) cryo-EM images of Li deposit in the ether-based electrolyte with fibroin. Scale bars, (e) $1 \mu\text{m}$ and (f) 20 nm . The white line delineates the boundary between metallic Li and SEI. The blue line delineates the boundary between adsorbed fibroin and SEI. The yellow line delineates the boundary between adsorbed fibroin and electrolyte. g, h *In situ* observations of Li deposition behavior in the glass capillaries filled with the blank electrolyte (g) and the electrolyte with fibroin (h) at a current density of 3 mA cm^{-2} . Scale bars, (g, h) $500 \mu\text{m}$ 111

Figure 5.7 SEM images of Li metal surface after 100 cycles. (a, b) In the electrolyte with fibroin. (c,

d) In the electrolyte without fibroin. The current density is 1 mA cm^{-2} and the capacity limitation is 1 mAh cm^{-2} . Scale bar, (a, c) $10 \text{ }\mu\text{m}$ and (b, d) $2 \text{ }\mu\text{m}$ 112

Figure 5.8 Schematic illustration of the configuration of Li | Li symmetric cells assembled in a homemade glass capillary. 113

Figure 5.9 X-ray photoelectron spectroscopy (XPS) characterization of SEI formed in ether-based electrolyte with and without fibroin. Li deposition was carried out at a current density of 1 mA cm^{-2} and a capacity of 1 mAh cm^{-2} on Cu foil for 10 cycles. (a) N1s spectra, (b) C1s spectra, (c) O1s spectra and (d) F1s spectra. 115

Figure 5.10 XPS spectra of pristine fibroin. (a) Survey spectrum. (b) C1s spectra. (c) N1s spectra. (d) O1s spectra. 116

Figure 5.11 XPS spectra of cycled Li metal anode. XPS survey spectra of the SEI after different degrees of etching by Ar-ion sputtering (a) with and (b) without fibroin additive in the ether-based electrolyte. 117

Figure 5.12 In-depth XPS profiles of the SEI formed in ether-based electrolyte without fibroin. Li deposition was carried out at a current density of 1 mA cm^{-2} and a capacity of 1 mAh cm^{-2} on Cu foil for 10 cycles. 118

Figure 5.13 In-depth XPS profiles of the SEI formed in ether-based electrolyte with fibroin. Li deposition was carried out at a current density of 1 mA cm^{-2} and a capacity of 1 mAh cm^{-2} on Cu foil for 10 cycles. 119

Figure 5.14 Comparison of Coulombic efficiencies of Li | Cu cells using electrolyte containing different concentrations of fibroin. 123

Figure 5.15 Schematic illustration of the synthesis process of fibroin interlayer. (a-d) Schematic illustration of electrospinning system for preparing a non-woven fibroin interlayer. (e) The architecture of Li metal battery using $\text{Li}_4\text{Ti}_5\text{O}_{12}$ (LTO) as cathode, one piece of fibroin interlayer between the CelgardTM separator and Li metal anode. 123

Figure 5.16 Digital photos of fibroin interlayer. (a) A piece of flat fibroin interlayer. (b) A piece of flexible fibroin interlayer wrap around a pencil. 124

Figure 5.17 SEM observation of fibroin interlays. (a) Low magnification and (b) high magnification SEM images of an electrospun fibroin interlayer. The SEM images of the interconnected structure of fibroin interlayers show rich pore structure, contributing to its excellent flexibility and excellent wettability towards electrolyte. Scale bars, 10 μm 125

Figure 5.18 Stability test of fibroin interlayer in ether-based electrolyte. (a, b) Digital photos of (a) the pristine fibroin interlayer and (b) the fibroin interlayer retrieved from electrolyte after immersed for 3 days. 126

Figure 5.19 The electrochemical performance of Li anode in ether-based electrolyte with or without a fibroin interlayer. (a) Galvanostatic cycling of symmetric Li | Li cells with (blue line) or without (red line) a fibroin interlayer. The current density is fixed at 3 mA cm^{-2} with a plating/stripping capacity of 1 mAh cm^{-2} . Insets: The blow-up of voltage profiles during 0-2 h, 200-202 h, 800-802 h and 1000-1002 h, respectively. The y-axis scale of the insets is shown on the left. (b) Comparison of cycling

performances of Li | Cu half cells with or without a fibroin interlayer between Cu foil and separator. The amount of Li deposited in each cycle is 1 mAh cm⁻² and the current density is 1 mA cm⁻². (c) The corresponding voltage profiles at the 100th cycle of the Li plating/stripping processes on Cu foil with or without a fibroin interlayer. (d) Comparison of the hysteresis of Li plating/stripping for cells with or without interlayers. (e) Long-term cycling stability of the Li || LTO full cells with or without a fibroin interlayer at a current density of 2 C (1C =175 mA g⁻¹). (f) Rate capabilities from 0.2 C to 10 C of the Li | LTO cells with or without fibroin additive in the electrolytes. 127

Figure 5.20 The cycling stability of Li | Li symmetrical cells at a high current density. A current density of 5 mA cm⁻² and a capacity of 1 mAh cm⁻² were applied. 128

Figure 5.21 Comparison of the cycling stability of Li | Li symmetrical cells at high capacities. (a) The capacity limitation is 3 mAh cm⁻² and the current density is 1 mA cm⁻². (b) The capacity limitation is 5 mAh cm⁻² and the current density is 1 mA cm⁻². 129

Figure 5.22. Comparison of the cycling performances of Li | Cu half cells. (a, b) The voltage profiles of Li plating/stripping on Cu foils at different cycles (a) without and (b) with fibroin interlayer. 130

Figure 5.23 The EIS measurement of Li | Cu half cells at different cycles. (a) without and (b) with the fibroin interlayer at the current density of 1 mA cm⁻² with the capacity imitation of 1 mAh cm⁻². .. 131

Figure 5.24 Cycling performance of Li || LTO full cells. (a, b) Galvanostatic charge/discharge curves of Li || LTO full cells (a) with and (b) without fibroin interlayer. 132

ABSTRACT

Entering the 21st century, with the continuous energy crisis and the aggravation of environmental pollution, energy storage technologies of renewable energy has become the focus of whole human society. Compared with other energy storage systems, lithium-sulfur (Li-S) batteries have been regarded as one of the most promising systems for next-generation rechargeable batteries owing to their high energy density and low cost. However, both cathode and anode materials encounter serious bottleneck defects in practical applications. For cathode materials, the “Shuttle effect” and the loss of cathode active materials caused by volumetric expansion during cycling are often considered as the main reasons for the energy decline of lithium sulfur batteries. For anode materials, the failure to inhibit the growth of lithium dendrite often leads to the internal short circuit of the battery, resulting in the serious thermal runaway of the battery. At the same time, the rapid development of nanotechnology has brought technological breakthroughs to various scientific fields. In this thesis, some latest nanotechnologies which have been systematically applied for largely improving the electrochemical performances of lithium sulfur batteries have been reviewed. Moreover, we rationally designed some strategies to alleviate the negative effects from “Shuttle effects” and suppress the growth of lithium dendrites. The usage of nanotechnologies can effectively enhance discharge capacity, improve cycling stability and increase the safety of high energy density lithium sulfur batteries. This thesis may provide an insight into the development of nanotechnologies for large scale energy storage.