

附件支撑材料

附件目录

1. 检索报告
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委托检索信息

委托人: 罗冲

委托人单位: 北京理工大学材料学院

委托查询时间范围: 2022~2023 年

检索数据库

1. 美国《Web of Science 核心合集: 引文索引》(网络版)
2. 美国《科学引文索引》(SCI-EXPANDED, 网络版)
3. 美国《期刊引用报告》(JCR, 网络版)
4. 中科院 SCI 分区表升级版(网络版)

检索结果

本次检索根据委托人罗冲所提供的论文目录及其检索要求, 通过对上面的数据库进行检索, 检索结果如下:

1. 在美国《科学引文索引》(SCI-EXPANDED, 网络版)中收录 2 篇。在美国《Web of Science 核心合集: 引文索引》(网络版)中, 累计被引用 34 次, 其中他引 30 次, 自引 4 次。
2. 美国《期刊引用报告》(JCR, 网络版)收录 2 种期刊。
3. 中科院 SCI 分区表升级版(网络版)收录 2 种期刊。

(注: 关于他引和自引的区分, 本证明所采用的方法是: 文献被除第一作者及合作者以外其他人的引用为他引)

(检索结果详见附件)

特此证明!

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作者论文情况概览

序号	标题/作者/来源	收录情况	引用情况	贡献情况
1	<p>Co-recrystallization induced self-catalytic Li₂S cathode fully interfaced with sulfide catalyst toward a high-performance lithium-free sulfur battery</p> <p>作者:Li, ZJ (Li, Zejian);Luo, C (Luo, Chong);Zhang, SW (Zhang, Siwei);Sun, GM (Sun, Guoming);Ma, JB (Ma, Jiabin);Wang, XL (Wang, Xinliang);He, YB (He, Yan-Bing);Kang, FY (Kang, Feiyu);Yang, QH (Yang, Quan-Hong);Lv, W (Lv, Wei)</p> <p>来源: INFOMAT 卷: 4 期: 10 出版年: 2022 文献类型: Article; Early Access Accession Number:SCIE: WOS:000843402400001</p>	SCIE	自引 4 次, 他引 27 次	
2	<p>Lithium-Sulfur Batteries at Extreme Temperatures: Challenges, Strategies and Prospects</p> <p>作者:Qu, WJ (Qu, Wenjia);Xia, JY (Xia, Jingyi);Luo, C (Luo, Chong);Zhang, C (Zhang, Chen);Chen, RJ (Chen, Renjie);Lv, W (Lv, Wei);Yang, QH (Yang, Quanhong)</p> <p>来源: ENERGY & ENVIRONMENTAL MATERIALS 卷: 6 期: 4 出版年: 2023 文献类型: Review; Early Access Accession Number:SCIE: WOS:000937707400001</p>	SCIE	自引 0 次, 他引 3 次	共同通讯作者

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附件二:

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1. 大类情况 (2023)

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Unveiling Confinement Engineering for Achieving High-Performance Rechargeable Batteries

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The confinement effect, restricting materials within nano/sub-nano spaces, has emerged as an innovative approach for fundamental research in diverse application fields, including chemical engineering, membrane separation, and catalysis. This confinement principle recently presents fresh perspectives on addressing critical challenges in rechargeable batteries. Within spatial confinement, novel microstructures and physicochemical properties have been raised to promote the battery performance. Nevertheless, few clear definitions and specific reviews are available to offer a comprehensive understanding and guide for utilizing the confinement effect in batteries. This review aims to fill this gap by primarily summarizing the categorization of confinement effects across various scales and dimensions within battery systems. Subsequently, the strategic design of confinement environments is proposed to address existing challenges in rechargeable batteries. These solutions involve the manipulation of the physicochemical properties of electrolytes, the regulation of electrochemical activity, and stability of electrodes, and insights into ion transfer mechanisms. Furthermore, specific perspectives are provided to deepen the foundational understanding of the confinement effect for achieving high-performance rechargeable batteries. Overall, this review emphasizes the transformative potential of confinement effects in tailoring the microstructure and physicochemical properties of electrode materials, highlighting their crucial role in designing novel energy storage devices.

1. Introduction

For the evolution of next-generation, high-performance energy storage devices, the rational design of lithium secondary batteries assumes paramount significance.^[1] The reversible conversion of electrical and chemical energy is governed by the intercalation and transport of lithium-ion (Li-ion) between the electrode and electrolyte.^[2] However, the design of high-performance batteries continues to face numerous challenges, particularly concerning the individual components of the battery. The potential safety hazards stemming from solvent decomposition underscore the critical need to optimize the solvation structure and de-solvation process of lithium salt. This optimization is essential for establishing a stable electrolyte system.^[3] The incorporation of solid electrolytes also encounters several challenges, including low ionic conductivity of polymer electrolytes and high grain boundary resistance.^[4] The precise construction of electrode materials remains challenging and results in the uncontrolled phase structure and limited utilization of active materials. The volume expansion of active materials typically leads to the collapse of the electrode,^[5] and the

uncontrolled growth of dendrites presents numerous safety issues, ultimately resulting in irreversible capacity decay and the overall failure of the battery performance.^[6] These aforementioned issues are primarily rooted in the lack of precise control strategies for the structural design and physicochemical properties at the molecular level, as well as the mechanisms of transmission. Therefore, achieving precise control over electrodes or electrolytes and gaining a deep understanding of transmission behavior at the nano/sub-nano scale are imperative steps in the development of high-performance batteries.

The confinement effect, characterized by robust interaction forces within nano/sub-nano space, is associated with distinctive molecular/ionic dynamics and thermodynamic states.^[7] The unique properties generated by confinement effects have been widely studied in various fields such as catalysis, electrochemical sensing, and membrane separation, especially for electrochemical reaction processes and mass transfer mechanisms

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RESEARCH ARTICLE

Co-recrystallization induced self-catalytic Li₂S cathode fully interfaced with sulfide catalyst toward a high-performance lithium-free sulfur battery

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Abstract

Lithium sulfide (Li₂S) is a promising cathode for a practical lithium-sulfur battery as it can be coupled with various safe lithium-free anodes. However, the high activation potential (>3.5 V) together with the shuttling of lithium polysulfides (LiPSs) bottleneck its practical uses. We are trying to present a catalysis solution to solve both problems simultaneously, specially with twin-born heterostructure to shoot off the trouble in interfacial contact between two solids, catalyst and Li₂S. As a typical example, a Co₉S₈/Li₂S heterostructure is reported here as a novel self-catalytic cathode through a co-recrystallization followed by a one-step carbothermic conversion. Co₉S₈ as the catalyst effectively lowers the Li₂S activation potential (<2.4 V) due to fully integrated and contacted interfaces and consistently promotes the conversion of LiPSs to suppress the shuttling. The obtained freestanding cathode of Co₉S₈/Li₂S heterostructures encapsulated in three-dimensional graphene shows a high capacity, reaching 92.6% of Li₂S theoretical capacity, high rate performance (739 mAh g⁻¹ at 2 C), and a low capacity fading (0.039% per cycle at 1 C over 900 cycles). Even under a high Li₂S loading of 12 mg cm⁻² and a low E/S ratio of 5 μL mg_{Li₂S}⁻¹, 86% of theoretical capacity can be utilized.

Zejian Li and Chong Luo contributed equally to this study.

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KEYWORDS

carbothermal reduction, heterostructures, Li_2S oxidation, lithium-sulfur batteries, polysulfides transformation, self-catalytic cathode

1 | INTRODUCTION

Lithium-sulfur (Li-S) batteries have attracted extensive attention as a promising energy storage system due to their high theoretical energy density (2600 Wh kg^{-1}) and low cost of the sulfur cathode.^{1–4} The lithium-free sulfur cathode has to couple with the lithium metal anode (LMA) to achieve high energy density. However, the dendrite growth and uncontrollable side reactions on the LMA surface cause severe safety problems and fast battery failure.^{5,6} Lithium sulfide (Li_2S) represents a promising alternative as the Li-containing cathode with high capacity (1166 mAh g^{-1}) as it can couple with Li-free anodes (e.g., silicon, graphite, tin, etc).^{7–12} It also shows good thermal stability, allowing for the synthesis of various nanostructured Li_2S cathodes, which is impossible for sulfur cathode due to the low thermal stability. Nevertheless, two critical points hinder the practical uses of Li_2S cathode. The high activation potential of Li_2S (usually $>3.5 \text{ V}$ vs. Li^+/Li) in the first charging cycle inevitably results in an incomplete conversion, low energy efficiency, and the possible decomposition of ether-based electrolytes.^{13,14} Another problem is the shuttle effect of soluble lithium polysulfide (LiPS) intermediates in the following cycles that also bottleneck the practical uses of the conventional sulfur cathode.

Several strategies have been proposed to lower the activation potential of Li_2S cathode, such as reducing the Li_2S particle size to shorten ion diffusion distance,¹⁵ having amorphous Li_2S to weaken the strength of Li–S bond, introducing the electrolyte additives (such as LiPSs,⁹ InI_3 ,¹⁶ and trace ethanol¹⁷) to destroy the superficial crystal structure and forming $\text{Li}_2\text{S}/\text{solid-state-electrolyte}$ composite to increase ionic conductivity.^{18–20} However, a complicated synthesis process is usually required to control the Li_2S particle size and crystallization, which is impractical for industrial uses. Moreover, the above strategies cannot well inhibit the shuttling of LiPSs in the following cycles. Introducing catalysts, such as transition metal sulfides,^{21,22} phosphides,²³ selenide,²⁴ and single-atom catalysts²⁵ was shown as an effective way to reduce the activation potential of Li_2S due to their strong interactions with Li atoms lowering the delithiation barrier. More importantly, these catalysts can also strongly interact with LiPSs and promote their conversion, effectively suppressing the shuttling of LiPSs and improving long cycling stability. However, in the catalyst design for Li_2S



cathode, the limited solid (Li_2S)-solid (catalyst) contact becomes a major problem, and thus having a smooth and fully contact solid–solid interface is key to guarantee a high catalytic conversion efficiency.^{26,27}

Herein, we propose a twinborn $\text{Co}_9\text{S}_8/\text{Li}_2\text{S}$ heterostructure as a self-catalytic Li_2S based cathode in which the Co_9S_8 acts as the catalyst and tightly contacts Li_2S through a smooth interface in the integrated hybrid cathode. The integrated twinborn $\text{Co}_9\text{S}_8/\text{Li}_2\text{S}$ heterostructures are characterized by small Co_9S_8 nanoparticles (NPs) embedded in a large Li_2S NP, where the fully contacted interfaces effectively improve the utilization of Li_2S and lower the activation potential ($<2.4 \text{ V}$). Thus, a smooth solid–solid interface between Li_2S and sulfide catalyst can change the Li–S bonding strength and enhance electron transfer to promote the oxidation of Li_2S .²⁸ At the same time, the Co_9S_8 catalyst also effectively suppresses the shuttle effect by catalyzing the LiPSs conversion to solid Li_2S , ensuring long cycling stability. Such a heterostructured cathode was prepared by the carbothermic conversion of an integrated $\text{Li}_2\text{SO}_4/\text{CoSO}_4$ precursor that was obtained by a controlled co-recrystallization process following the calculated $\text{Li}_2\text{SO}_4\text{–CoSO}_4\text{–H}_2\text{O}$ phase diagram. The first recrystallized CoSO_4 can act as the crystal nucleus during the freezing induced crystallization, and the Li_2SO_4 precipitated on these nuclei, forming an encapsulation structure and ensuring the formation of the above twinborn heterostructure after carbothermic reduction. As a result, the obtained $\text{Co}_9\text{S}_8/\text{Li}_2\text{S}$ heterostructure encapsulated in a three-dimensional (3D) graphene matrix (denote $\text{Co}_9\text{S}_8/\text{Li}_2\text{S}@G$) as cathode shows high Li_2S utilization and the capacity reaches 92.6% of Li_2S theoretical capacity. It also shows excellent rate performance (high capacity of 739 mAh g^{-1} at 2 C) and low capacity decay (0.039% per cycle at 1 C) for 900 cycles. Even under a high loading of 12 mg cm^{-2} and a low E/S ratio of $5 \mu\text{L mg}_{\text{Li}_2\text{S}}^{-1}$, a stable high areal capacity of $10.11 \text{ mAh cm}^{-2}$ is achieved. Moreover, the assembled full battery with graphite and Si/C anodes shows high sulfur utilization and good cycling stability.

2 | RESULTS AND DISCUSSION

The co-recrystallization strategy of Li_2SO_4 and CoSO_4 is proposed following the $\text{Li}_2\text{SO}_4\text{–CoSO}_4\text{–H}_2\text{O}$ phase diagram according to Figure 1A. The calculated ternary

Lithium-Sulfur Batteries at Extreme Temperatures: Challenges, Strategies and Prospects

Wenjia Qu, Jingyi Xia, Chong Luo*, Chen Zhang, Renjie Chen , Wei Lv*, and Quanhong Yang* 

High-energy-density-batteries working at a wide-temperature range are urgently required in many performance-critical areas. Lithium-sulfur batteries (LSB) are promising high-energy-density batteries that have the potential to maintain high performance at extreme temperatures. However, some problems like severe shuttling and safety issues at high temperatures or sluggish reaction kinetics and charge-transfer process at low temperatures decrease the performance and hinder their practical uses in extreme temperature conditions. Therefore, broadening the working temperature of LSB with stable electrochemical performance becomes a crucial topic. In this paper, the key stumbling blocks for high and low-temperature LSB are comprehensively discussed. The solutions from the aspects of electrolyte and electrode materials are discussed to solve the aggravating shuttle effect and thermal safety issues under high temperature and the sluggish reaction kinetics under low temperature. Moreover, some specific promising solutions to extend the operating temperature range of LSB are also proposed and highlighted, which provide potential research directions on the practical LSB application in future.

1. Introduction

The batteries that have high energy density and can operate safely in a wide range of temperatures (from $-40\text{ }^{\circ}\text{C}$ to $60\text{ }^{\circ}\text{C}$) are highly required to accommodate the applications in different climates, such as

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grid storage and oil exploration.^[1–3] However, the batteries usually experience different electrochemical reactions across a wide temperature range and easily trigger safety issues.^[4] For example, the widely used rechargeable lithium-ion batteries (LIBs) suffer obvious performance degradation and capacity decrease under low and high temperatures.^[5–7] Moreover, the intrinsic slow lithiation process of graphite anodes also triggers the plating of lithium metal on the surface and brings safety issues under low temperatures.^[8,9] Therefore, it will be crucial to consider alternative ion-storage strategies, which can preserve high energy density under wide temperature range. Different from the traditional intercalation mechanism of LIBs, lithium-sulfur batteries (LSBs) undergo a multi-step redox reaction that S_8 molecules transform into soluble lithium polysulfides (LiPSs) intermediate and then convert into final discharge products $\text{Li}_2\text{S}_2/\text{Li}_2\text{S}$. The conversion mechanism, not only avoids the high intercalation barrier of layered materials but also generates a

much higher capacity at a wide temperature range.^[10–13] Some recent studies demonstrate that faster redox conversion kinetics of LiPSs at high temperatures increases the sulfur utilization and Coulombic efficiencies of LSB.^[14,15] Apart from the advantage of redox conversion, the mainly used ether electrolytes in LSBs possess lower freezing points and maintain high ionic conductivity (about 4 mS cm^{-1}) even at $-40\text{ }^{\circ}\text{C}$. Thus, broadening the working temperature of LSBs has become a crucial topic for their practical applications.

However, realizing the high energy density of LSBs with stable cycling performance at low temperature or high temperature is still challenging because of many critical problems. At high temperatures, the increased solubility of LiPSs induces severe shuttling and corrosion of the lithium metal anode.^[16] In addition, some ingredients like ether electrolyte reaching the melting point at high temperature raise severe safety issues. The high sulfur loading coupled with lean electrolyte will be a necessity for practical applications, and the inevitable cracking and sluggish electron transfer raises more complicated challenges at extreme temperatures.^[17,18] Therefore, endowing the LSBs with a wide operating range is still challenging. Different electrode configurations and compositions should be designed to adapt to low-temperature and high-temperature conditions.^[19,20] Mikhaylik *et al.* first studied the low-temperature performance of LSB and showed 80% of the room temperature capacity at $-40\text{ }^{\circ}\text{C}$.^[21] Since then, some representative works on designing novel structures of sulfur cathodes or electrolytes

showed enhanced performance at extreme temperatures. However, operating LSBs in a wide temperature range is still challenging as the instable battery structures and the incomprehension of the reaction mechanism under extreme conditions.

The increased number of articles shows the importance of this topic, but it is still a new field with insufficient investigation. This review summarizes the problems and the strategies to improve the electrochemical performance of the LSBs under high temperature or low temperature, as shown in **Figure 1**, highlighting 1) the aggravating shuttle effect under high temperatures, which can be inhibited by blocking the migration of LiPSs and accelerating their conversion; 2) the thermal safety issues that can be addressed by designing thermo-stable and flame-retardant materials; 3) the sluggish reaction kinetics under low temperature can be overcome by designing the catalysts and novel electrolytes. Finally, future directions are also proposed, which may inspire a potential solution to obtain the high-performance LSB under extreme conditions to promote their practical applications.

2. Lithium-Sulfur Batteries Under High Temperature: Challenges and Remedies

Operating LSB at a high temperature can enhance the reaction activity of the sulfur and induce better sulfur redistribution, leading to higher sulfur utilization. However, the dissolution ability of LiPSs in electrolytes and the diffusion coefficient also increase, leading to severe shuttling and fast capacity decay.^[16,22,23] The internal heat accumulation also raises critical safety issues toward electrolytes due to the low melting point of the usually used ether-based electrolytes, causing safety issues. The following section discusses the strategies to solve these challenges at high temperatures.^[24,25]

2.1. Strategies to Alleviate Shuttle Effect

Numerous studies have succeeded in suppressing the shuttle effect at ambient temperature.^[26,27] However, some temperature-dependent

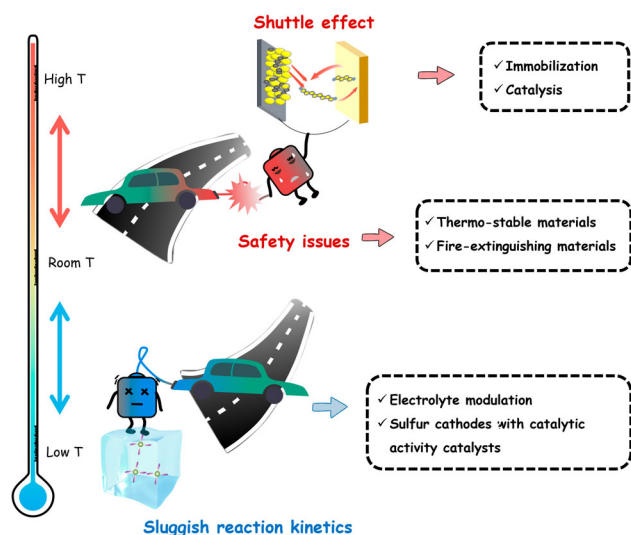


Figure 1. Summary of the main problems and solutions for LSBs working at high and low temperatures.

physicochemical properties, including electrochemical reaction and diffusion rate, can potentially affect shuttle behaviors of LiPSs at elevated temperatures. To be specific, high temperature means the increase of electrochemical reaction activity and the solubility of LiPSs. Pang et al. demonstrated that the Li_2S_6 solubility in the diethylene glycol dimethyl ether electrolyte: lithium bis(trifluoromethanesulfonyl)imide (LiTFSI) (1:1) increased from 0.52 mg mL^{-1} (25°C) to 42 mg mL^{-1} (55°C).^[28] So the LiPSs diffusing ability through the separator increases, which leads to the alteration of gradient distribution. As a result, the fast deposition of insulative Li_2S on the electrode surface and parasitic reactions with lithium metal are easy to occur, passivating the cathode and anode.

The LiPSs can be stabilized on the cathode surface by physical/chemical adsorption at room temperature. However, when the temperature increases, the thermal motion of LiPSs is accelerated to induce the desorption of physically adsorbed LiPSs due to the weak van der Waals forces. In contrast, the desorption of chemisorbed materials needs large activation energy, which is not easy to occur. To some extent, chemisorption capacities will increase slightly with the temperature rise. It is shown that the adsorbed Li_2S_8 by metal oxide increases from 77.6% (35°C) to 79.1% (60°C).^[29,30] Thus, combining physical and chemical confinements to form “dual-confinements” for LiPSs is better to suppress the shuttling of LiPSs.^[31–33] Nevertheless, the adsorption capacity increase is low relative to the increased dissolution ability of LiPSs at high temperatures and the high LiPSs concentration under the high sulfur loading for practical applications. Thus, introducing catalytic materials with multiple and high-temperature stable sites that can realize the fast conversion of sulfur species should be more promising to solve the above problems to enhance the conversion of adsorbed LiPSs to solid Li_2S , which decreases the accumulation of LiPSs and suppress their shuttling.^[34–36]

2.1.1. “Dual-Confinements” of Lithium Polysulfides

The chemisorption force is stronger than the van der Waals force under high temperatures. However, it is noteworthy that desorption is an endothermic reaction. According to Arrhenius equation:

$$k = Ae^{\frac{-E_a}{RT}}$$

where k is the rate constant, A is pre-exponential factors, E_a is activation energies, and R stands for molar gas constant. Thus, the desorption rate is increased with a higher temperature.^[29] Based on the analyses above, the dual-confinements with various functional adsorption sites and the specific structures can provide more vital adsorption ability to LiPSs. For example, the porous carbon/polar compound hosts lead to better high-temperature performance. A cathode with the host constructed by Ni nanoparticles/graphitic carbon nanocages (GCN) implanted N-doped porous carbon nanofiber (Ni/GCNsCN-PCFs) showed high-temperature stability at 55°C with a high specific capacity of 550 mAh g^{-1} after 300 cycles at 0.5 C. The hierarchical pore structures provided physical confinements and the polar Ni nanoparticles and doped N heteroatoms contributed to the chemical adsorption ability (**Figure 2a,b**).^[37] In contrast, the cathode with N-PCFs host without Ni particles showed much poor cycling stability. However, the obvious capacity decay in incipient 50 cycles at 0.1 C occurred in sulfur cathodes with Ni/GCNsCN-PCFs due to the



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一种具有应力响应界面修饰层的锌负极、制备方法
及锌离子电池

(57) 摘要

本发明涉及一种具有应力响应界面修饰层的锌负极、制备方法及锌离子电池,属于水系锌离子电池锌负极界面改性技术领域。所述界面修饰层的厚度为 $0.1\mu\text{m}\sim 20\mu\text{m}$,均匀分布在锌负极的表面;所述界面修饰层的材料为具有剪切增稠特性的聚硼硅氧烷。所述界面修饰层具有良好的电导性和应力相应特性,能够有效抑制锌枝晶的生长,优化了金属锌负极界面处的锌离子沉积行为,有助于改善水系锌离子电池的循环稳定性;本发明还提供了一种具有应力响应界面修饰层的锌负极的制备方法,采用溶剂挥发法在金属锌负极表面均匀形成了具有应力响应的界面修饰层,用于保护金属锌负极,以有效抑制锌枝晶的生长;所述水系锌离子电池为扣式电池或软包电池。

国家自然科学基金资助项目批准通知

(包干制项目)

罗冲 先生/女士:

根据《国家自然科学基金条例》、相关项目管理办法规定和专家评审意见,国家自然科学基金委员会(以下简称自然科学基金委)决定资助您申请的项目。项目批准号: 52202207, 项目名称: 葱醌类均相催化剂的理性设计及锂硫双向催化机制研究, 资助经费: 30.00万元, 项目起止年月: 2023年01月至 2025年12月, 有关项目的评审意见及修改意见附后。

请您尽快登录科学基金网络信息系统 (<https://isisn.nsf.gov.cn>), **认真阅读《国家自然科学基金资助项目计划书填报说明》并按要求填写《国家自然科学基金资助项目计划书》(以下简称计划书)**。对于有修改意见的项目,请您按修改意见及时调整计划书相关内容;如您对修改意见有异议,须在电子版计划书报送截止日期前向相关科学处提出。

请您将电子版计划书通过科学基金网络信息系统 (<https://isisn.nsf.gov.cn>) 提交,由依托单位审核后提交至自然科学基金委。自然科学基金委审核未通过者,将退回的电子版计划书修改后再行提交;审核通过者,打印纸质版计划书(一式两份,双面打印)并在项目负责人承诺栏签字,由依托单位在承诺栏加盖依托单位公章,且将申请书纸质签字盖章页订在其中一份计划书之后,一并报送至自然科学基金委项目材料接收工作组。纸质版计划书应当保证与审核通过的电子版计划书内容一致。**自然科学基金委将对申请书纸质签字盖章页进行审核,对存在问题的,允许依托单位进行一次修改或补齐。**

向自然科学基金委提交电子版计划书、报送纸质版计划书并补交申请书纸质签字盖章页截止时间节点如下:

1. **2022年10月8日16点:** 提交电子版计划书的截止时间;
2. **2022年10月14日16点:** 提交修改后电子版计划书的截止时间;
3. **2022年10月19日:** 报送纸质版计划书(一式两份,其中一份包含申请书纸质签字盖章页)的截止时间。
4. **2022年10月28日:** 报送修改后的申请书纸质签字盖章页的截止时间。

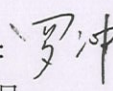


请按照以上规定及时提交电子版计划书，并报送纸质版计划书和申请书纸质签字盖章页，逾期不报计划书或申请书纸质签字盖章页且未说明理由的，视为自动放弃接受资助；未按要求修改或逾期提交申请书纸质签字盖章页者，将视情况给予暂缓拨付经费等处理。

附件：项目评审意见及修改意见表

国家自然科学基金委员会

2022年9月7日

山东省自然科学基金青年项目 资助项目立项任务书

项目 基本 信息	项目名称	催化转化抑制多硫化物浓差极化构筑高通量改性隔膜				
	项目(立项)编号	ZR2022QE061	项目类别	青年基金		
	执行期限	2023.01.01-2025.12.30		资助经费 (万元)	15	
	学科分类	无机非金属能量存储材料		学科代码	E021002	
项目 承担 人 信息	姓名	罗冲	性别	男	学位	博士
	电子邮箱	chong.luo@bit.edu.cn		手机	15701651862	
	单位名称	北京理工大学前沿技术研究院		专业技术 职务	研究员	
	所在单位(院系)	先进能源材料及智能电池创新中心		主管部门	济南高新区科技局	
	所在省级以上重点实验室	无				
需呈交科技报告(篇)						
年度进展报告(必须填,至少为1)			最终(技术)报告(必须填,一般为1)			
1			1			
注:严格按照科技报告的有关规定呈交科技报告。项目执行中,年度或中期审核前应呈交进展报告;项目完成后三个月内、开展验收前,须呈交最终(技术)报告。未完成科技报告任务的,项目不予结题。						
<p>山东省自然科学基金青年项目资助经费试行包干制管理,资助经费不再区分直接费用和间接费用,为原直接费用和间接费用之和。项目负责人需承诺:本人接受山东省自然科学基金的资助,并将严格遵守山东省自然科学基金资助项目和经费管理的各项规定,遵守科研诚信和科研伦理规范,认真开展科学研究,按照项目申请书中的内容完成各项指标。按时报送有关材料,及时报告重大变动情况,对资助项目发表的论著和取得的研究成果按规定进行标注。如违背上述承诺,本人愿接受山东省自然科学基金委员会和省科技厅等相关部门做出的各项处理决定。</p> <p style="text-align: right;">项目负责人签字:  2022年11月18日</p>						
依托单位审核意见			山东省自然科学基金委员会审查意见			
 依托单位(公章) 2022年11月10日			 (公章) 2022年11月10日			

(正反面打印,一式三份)

山东省自然科学基金委员会办公室 2021 年制

国家重点研发计划 项目任务书

项目名称：百兆瓦级动态可重构电池储能技术

所属专项：储能与智能电网技术

指南方向(榜单任务)：7.2 百兆瓦级动态可重构电池储能技术（共性关键技术）

创新分类：技术开发

项目管理专业机构：工业和信息化部产业发展促进中心

推荐单位：教育部

项目牵头承担单位：清华大学 (公章)

项目负责人：慈松

执行期限：2023年12月至2026年11月

中华人民共和国科学技术部制

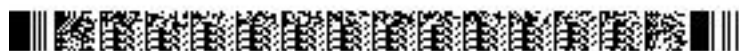
2023年12月07日

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项目基本信息表

项目名称	百兆瓦级动态可重构电池储能技术					
项目编号	2023YFB2407900					
所属专项	储能与智能电网技术					
指南方向 (榜单任务)	7.2 百兆瓦级动态可重构电池储能技术（共性关键技术）					
创新分类	技术开发					
项目实施模式	常规模式					
密级	公开	单位总数	10	课题数	5	
经费预算	总预算 25989.95 万元，其中中央财政专项资金 1989.95 万元，地方财政资金 0.00 万元，单位自筹资金 24000.00 万元，其他渠道获得资金 0.00 万元					
项目周期节点	起始时间	2023 年 12 月	结束时间	2026 年 11 月		
	实施周期	共 36 个月	预计中期时间点	2025 年 05 月		
项目 牵头 承担 单位	单位名称	清华大学		单位法定 代表人姓名	曾嵘	
	单位性质	大专院校		组织机构代码	12100000400000624D	
	单位主管部门	教育部		隶属关系	中央	
	单位所属地区	北京市		地市（市、自 治州、盟）	北京市 海淀区	
	通信地址	北京市海淀区清华大 学毕业大厦		邮政编码	100084	
	单位开户名称	清华大学				
	开户银行 (全称)	中国工商银行股份有 限公司北京海淀西 区支行营业室		汇入地点	北京市 北京市	
	银行账号	0200004509089131550		银行机构代码	102100000458	
推荐 单位	单位名称	教育部		推荐单位 性质	部门	
项目 负责 人	姓名	慈松	性别	<input checked="" type="checkbox"/> 男 <input type="checkbox"/> 女	出生日期	1970-08-26
	证件类型	身份证	证件号码	37010219700826331X		



	所在单位	清华大学				
	最高学位	■博士□硕士□学士□其他				
	职 称	■正高级□副高级□中级□初级□其他			职 务	信息能源教育部-中国移动联合实验室(筹)主任
	电子邮箱	sci@tsinghua.edu.cn	移动电话	18600891857		
项目联系人	姓 名	周杨林	电子邮箱	zhouylstu@tsinghua.edu.cn		
	固定电话	010-62770045	移动电话	15652661210		
	证件类型	身份证	证件号码	370481199112103536		
项目财务负责人	姓 名	郝永红	电子邮箱	cwzxzj@mailoa.tsinghua.edu.cn		
	固定电话	010-62783908	移动电话	13280286790		
	证件类型	身份证	证件号码	120104196609076845		
课题分解	序号	课题名称	承担单位	负责人	总经费(万元)	其中中央财政专项资金(万元)
	01	大规模动态可重构电池系统理论与创新模组设计	清华大学	慈松	360.00	360.00
	02	基于动态可重构电池系统的本质安全控制和能量控制	中国科学院电工研究所	孙玉树	1355.32	355.32
	03	百兆瓦级动态可重构电池储能系统高效集成与协同运行	西安交通大学	王金玉	1380.00	380.00
	04	百兆瓦时动态可重构电池储能系统寿命提升与智能运维	国网江苏省电力有限公司	杨毅	1357.48	357.48
	05	百兆瓦时动态可重构电池储能系统示范验证与综合评估	华电内蒙古能源有限公司	张永密	21537.15	537.15
其他参与单位	序号	单位名称	单位性质	组织机构代码		
	1	中国科学院电工研究所	事业型研究单位	121000004000124147		
	2	西安交通大学	大专院校	12100000435230200R		



	3	国网江苏省电力有限公司	国有企业	91320000134766570R
	4	华电内蒙古能源有限公司	国有企业	911500006865172576
	5	北京理工大学	大专院校	12100000400009127B
	6	中国移动通信集团设计院有限公司	国有企业	91110000710932486E
	7	合肥国轩高科动力能源有限公司	私营企业	913401007885639594
	8	云储新能源科技有限公司	私营企业	913701005970100081
	9	北京索英电气技术股份有限公司	私营企业	9111010873559070X0
项目参加人数	202人。其中：		高级职称 41人，中级职称 43人，初级职称 36人，其他 82人； 博士学位 26人，硕士学位 75人，学士学位 101人，其他 0人。	
项目简介 (限1500字以内)	<p>1、研究背景</p> <p>作为能量灵活高效时空平移的核心基础设施，电池储能在当前全球能源低碳转型革命中具有无可替代的作用，应用规模巨大且在持续飞速发展。然而，大规模电池储能系统长久以来存在海量差异化电池管理、协同控制和安全运行等难题，究其本质原因是固定串并联电池成组结构带来的短板效应。通过信息-能源交叉融合技术及创新模组技术，革新电池成组模式与能量管控机制，是解决上述问题的重要途径。</p> <p>2、研究目标</p> <p>针对电池固定串并联成组方式所带来的储能系统效率、安全性、经济性、兼容性差等痛点问题，本项目拟创新本质消除电池储能系统短板效应的能量信息化处理机制，阐明动态可重构电池储能系统本质属性与运行特性的耦合规律，提出本质安全能量控制方法，攻克系统高效集成、优化运行、智能运维等系列关键技术，研制百兆瓦时动态可重构电池储能系统装备，建设电源侧、电网侧与用户侧百兆瓦时动态可重构电池储能系统示范工程，完成应用验证与综合性能评估。</p> <p>3、研究内容</p> <p>围绕“本质消除电池储能系统短板效应的能量信息化处理机制”与“动态可重构电池储能系统本质属性与运行特性的耦合规律”两个科学问题，突破大规模动态可重构电池储能系统关键技术：1)大规模动态可重构电池系统理论与创新模组设计；2)基于动态可重构电池系统的本质安全控制和能量控制；3)百兆瓦级动态可重构电池储能系统高效集成与协同运行；4)百兆瓦时动态可重构电池储能系统寿命提升与智能运维；5)百兆瓦时动态可重构电池储能系统示范验证与综合评估。</p> <p>4、技术路线</p> <p>采用理论研究、技术攻关、装备研制、工程验证相结合的技术路线，基于能量信息化的动态可重构电池储能系统技术，以构建高安全、长寿命、低成本的动态可重构电池储能系统为目标，依次开展规模化动态可重构电池储能系统本质安全控制与能量控制、高效集成与协同运行、快速寿命评估与智能运维等方面研究，研</p>			



十、项目参加人员基本情况表

填表说明： 1. 专业技术职称：A、正高级 B、副高级 C、中级 D、初级 E、其他；
 2. 投入本项目的全时工作时间（人月）是指在项目实施期间该人总共为项目工作的满月度工作量；累计是指项目组所有人员投入人月之和；
 3. 项目固定研究人员需填写人员明细；
 4. 是否有工资性收入：Y、是 N、否；
 5. 人员分类代码：A、项目负责人 B、课题负责人 C、项目/课题骨干 D、其他研究人员；
 6. 工作单位：填写单位全称，其中高校要具体填写到所在院系。

序号	姓名	性别	出生日期	证件类型	证件号码	专业技术职称	职务	最高学位	专业	投入本项目的全时工作时间（人月）	人员分类代码	所属课题	是否有工资性收入	工作单位	参加人员签字
1	慈松	男	1970-08-26	身份证	37010219700826331X	正高级	信息能源教育部-中国移动联合实验室（筹）主任	博士	电气工程	18	项目负责人	大规模动态可重构电池系统理论与创新模组设计	是	清华大学电机系	
2	孙玉树	男	1987-03-14	身份证	152122198703143652	副高级	无	博士	电力系统及其自动化	18	任务（课题）负责人	基于动态可重构电池系统的本质安全控制和能量控制	是	中国科学院电工研究所	
3	王金玉	男	1988-03-30	身份证	370724198803305158	正高级	无	博士	电气工程	18	任务（课题）负责人	百兆瓦级动态可重构电池储能系统高效集成与	是	西安交通大学电气工程学院	



71	李正军	男	1966-05-17	身份证	370111196605172039	中级	研发工程师	学士	计算机科学	20	项目/课题骨干	百兆瓦时动态可重构电池储能系统寿命提升与智能运维	是	云储新能源科技有限公司
72	王运方	男	1983-11-30	身份证	110105198311307712	副高级	总监	硕士	仪器仪表工程/工业工程管理	20	项目/课题骨干	百兆瓦时动态可重构电池储能系统寿命提升与智能运维	否	云储新能源科技有限公司
73	罗冲	男	1990-07-18	身份证	210703199007182431	副高级	无	博士	材料科学与工程	18	项目/课题骨干	百兆瓦时动态可重构电池储能系统寿命提升与智能运维	是	北京理工大学材料学院
74	郭永水	男	1977-10-25	身份证	372428197710256314	副高级	无	硕士	计算机体系结构	18	项目/课题骨干	百兆瓦时动态可重构电池储能系统寿命提升与智能运维	是	清华大学电机系
75	叶小晖	男	1985-02-12	身份证	370683198502129212	副高级	无	博士	电机工程	18	项目/课题骨干	百兆瓦时动态可重构电池储能系统寿命提升与智能运维	是	清华大学电机系
76	郑威	男	1977-12-20	身份证	330522197712201059	其他	高级咨询设计师	学士	计算机	14	项目/课题骨干	百兆瓦时动态可重构电池储能系统	是	中国移动通信集团设计院有限公司



本页无正文，为签章页。

项目依托单位（公章）：清华大学

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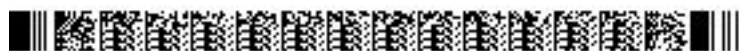
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单位负责人： 罗冲

2023年11月22日

2023年11月17日





Energy Materials and Devices

LETTER OF APPOINTMENT

PRESENTED TO

Chong Luo

This letter of appointment is hereby granted to you for your appointment as the Youth Editorial Board Member of *Energy Materials and Devices* for two years.

Kang Feiyu

Editor-in-Chief Feiyu Kang

on behalf of the *Energy Materials and Devices* editorial team

Tsinghua University Press
January 2024



清华大学出版社
TSINGHUA UNIVERSITY PRESS

**BATTERY
|||·ENERGY**

Open Access

Certificate of Appointment



This certificate is awarded to

Prof. Chong Luo

in recognition of the appointment as

a Young Editorial Board Member of

BATTERY ENERGY

From August 1, 2023 to July 31, 2024

Editor-in-Chief: Yong-Mook Kang

WILEY



聘书

Letter of Appointment

尊敬的 罗冲 老师：

兹聘请您担任《自然科学进展：国际材料》（Progress in Natural Science: Materials International）期刊第一届青年编委，聘期一年，自2023年5月10日至2024年5月10日。

特此聘请。

中国材料研究学会



北京市科学技术协会

BEIJING ASSOCIATION FOR SCIENCE AND TECHNOLOGY

青年人才托举工程

YOUNG ELITE SCIENTIST SPONSORSHIP
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入选证书

CERTIFICATE OF RECOGNITION

罗冲

Luo Chong

No. BYESS2023407





第二届

北京大学生创新创业大赛
The Second Beijing College Students' Innovation and Entrepreneurship Competition

社会服务赛道 三等奖

项目名称： 锌电聚能——智能化响应界面修饰层锌电池

负责人： 刘冰然

团队成员： 刘冰然、张昊妍、杨明芳、鲁琦、董安琪、汪苑妤、王淑清

指导教师： 陈人杰、罗冲、贾琳

推荐单位： 北京理工大学



北京市教育委员会



北京市人力资源和社会保障局



北京市发展和改革委员会

二〇二三年十月





第九届中国国际“互联网+”大学生创新创业大赛
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梁嵩阳

指导老师：陈人杰、罗冲、贾琳、谢勇

推荐学校：北京理工大学

在二〇二三年第九届中国国际“互联网+”大学生创新创业大
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项目名称: 锌电聚能——智能化响应界面修饰层锌电池

推荐单位: 材料学院, 化学与化工学院

团队成员: 刘冰然, 张昊妍, 杨明芳, 鲁琦, 董安琪, 汪芃舒, 王淑清, 梁嵩阳

指导老师: 陈人杰, 罗冲, 贾琳, 谢勇

