



# Key materials for solid-state lithium metal batteries

Solid-state lithium metal batteries (SSLMBs) have gained significant attention in energy storage research due to their high energy density and significantly improved safety. But there are still certain problems with ...

Solid-state lithium metal batteries have been recognized as promising energy storage devices for the near future, but their key materials, such as Li metal anodes, SSEs, and high-energy cathodes, exhibit inferior air stability, which leads to a variety of performance issues and even device failure. Enhancing the air stability of the battery ...

According to the types of cathode materials, lithium metal batteries can be divided into three primary categories: ... lithium salts in non-aqueous electrolytes play a key role in the CEs of lithium anodes. Because of the balanced properties, ...

High-energy-density and safe energy storage devices are an urged need for the continuous development of the economy and society. 1-4 Lithium (Li) metal with the ultrahigh theoretical specific capacity ( $3860 \text{ mAh g}^{-1}$ ) and the lowest electrode potential ( $-3.04 \text{ V}$  vs. standard hydrogen electrode) is considered an excellent candidate to replace ...

The applications of the functional composite solid-state electrolytes in flexible lithium metal batteries are introduced with an emphasis on the relationship between the mechanisms, strategies, and applications for lithium-sulfur batteries, lithium-air batteries, and other lithium metal batteries. Download: [Download full-size image](#)

Solid-state lithium metal batteries (SS-LMBs) have attracted much attention in recent years and are recognized as a next generation battery technology, potentially relieving anxieties about mileage and safety of electric vehicles [[5], [6], [7]]. The effort is driven by the expectation that solid-state electrolytes (SSEs) can ensure the substantially better cyclability, ...

To match the high capacity of metallic anodes, all-solid-state batteries require high energy density, long-lasting composite cathodes such as Ni-Mn-Co (NMC)-based lithium oxides mixed with a solid-state electrolyte (SSE). However in practice, cathode capacity typically fades due to NMC cracking and increasing NMC/SSE interface debonding because of NMC ...

Current lithium-ion batteries (LIBs) based on graphite negative electrodes already could not meet the growing energy demand for poor safety and limited energy density 1,2,3,4,5. Solid state ...

The development of solid-state electrolyte (SSE) materials with high Li<sup>+</sup> ionic conductivity in recent years has turbocharged research on solid-state batteries (SSBs). 1 A major attraction of SSBs is the potential for the use of high-capacity electrodes such as lithium metal anodes. Lithium metal has received substantial research



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focus over the years, and it has been ...

In this regard, solid-state lithium metal batteries (SSLMBs) coupling high-energy electrode materials (e.g., lithium metal (Li<sup>176</sup>), lithium alloys, nickel-rich  $\text{LiNi}_{1-x-y}\text{Co}_x\text{Mn}_y\text{O}_2$  ...

The successes and failings of such all solid-state metal batteries, ... to ethylene oxide (EO) of 0.10 was maintained in the materials by addition of the lithium ... A key finding is that ...

In this review, the main components of solid-state lithium-ion batteries and the variables that could impact the properties of the anode, cathode and electrolytes are discussed ...

As a result, the assembled solid-state battery shows a lifetime of over 2000 cycles with an average Coulombic efficiency of 99.9% and capacity retention of 80%. Our discovery sheds fresh light on the targeted regulation of the reactive residual solvent to extend the cycle life of solid-state batteries.

The research not only describes a new way to make solid state batteries with a lithium metal anode but also offers new understanding into the materials used for these potentially revolutionary batteries. The research is published in Nature Materials. "Lithium metal anode batteries are considered the holy grail of batteries because they have ...

School of Material Science & Engineering, Beijing Key Laboratory of Environmental Science and Engineering, Beijing Institute of Technology, Beijing, 100081 China. Search for more papers by this author. Hao Yan, Corresponding Author. ... All-solid-state lithium metal batteries, consisting of intrinsic-safe solid-state electrolytes and high ...

Solid-state electrolytes (SSEs) have emerged as high-priority materials for safe, energy-dense and reversible storage of electrochemical energy in batteries. In this Review, we assess recent ...

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A: A solid-state lithium-metal battery is a battery that replaces the polymer separator used in conventional lithium-ion batteries with a solid-state separator. The replacement of the separator enables the carbon or silicon anode used in conventional lithium-ion batteries to be replaced with a lithium-metal anode.

The primary goal of this review is to provide a comprehensive overview of the state-of-the-art in solid-state batteries (SSBs), with a focus on recent advancements in solid electrolytes and anodes. The paper begins with a background on the evolution from liquid electrolyte lithium-ion batteries to advanced SSBs, highlighting their enhanced safety and ...



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The highest reported conductivities of LATP and LAGP are  $1.09 \times 10^{-3} \text{ S cm}^{-1}$  [78] and  $6.18 \times 10^{-3} \text{ S cm}^{-1}$  [75], respectively, at room temperature (Fig. 1). In general, the ...

Graphic illustrations of a) a state-of-the-art lithium-ion battery with liquid electrolyte and b) an all-solid-state battery with lithium metal anode. (CC: current collector; LE: liquid electrolyte, SE: solid electrolyte; AAM/CAM: anode and cathode active material, ...

DOI: 10.12028/j.issn.2095-4239.2016.0043 Corpus ID: 217346647; A review of key materials for all-solid-state lithium ion batteries @article{Yang2016ARO, title={A review of key materials for all-solid-state lithium ion batteries}, author={Li Yang and Ding Fei and Sang Lin and Zhong Hai and Liu Xingjiang}, journal={Energy Storage Science and Technology}, year={2016}, volume={5}, ...

Solid electrolytes can protect the Li metal from interacting with electrolytes and pave the way for significantly reduced electrolyte volumes or future "solid-state batteries". Solid-state ...

This review focuses on the research progress of lithium-free anode materials in solid-state batteries, including C, Si, Sn, Bi, Sb, metal hydrides, and lithium titanate ( $\text{Li}_4\text{Ti}_5\text{O}_{12}$ ). The effects of the size and structure of active materials, the use of a binder, the selection of solid electrolytes, and the manufacturing process on the ...

Solid-state batteries are commonly acknowledged as the forthcoming evolution in energy storage technologies. Recent development progress for these rechargeable batteries has notably accelerated their trajectory toward achieving commercial feasibility. In particular, all-solid-state lithium-sulfur batteries (ASSLSBs) that rely on lithium-sulfur reversible redox ...

In solid-state batteries, carbon-based materials are one of the outstanding anode materials used widely [63], [64]. Graphite is one of the exceptional materials employed for solid-state batteries because of the distinctive layered structure capable of integrating the lithium-ions throughout the Lithiation/delithiation processes.

Lithium alloy anodes in the form of dense foils offer significant potential advantages over lithium metal and particulate alloy anodes for solid-state batteries (SSBs). However, the reaction and degradation mechanisms of dense alloy anodes remain largely unexplored. Here, we investigate the electrochemical lithiation/delithiation behavior of 12 ...

BATTERIES Solid-state batteries: The critical role of mechanics Sergiy Kalnaus<sup>1\*</sup>, Nancy J. Dudney<sup>2+</sup>, Andrew S. Westover<sup>2</sup>, Erik Herbert<sup>3</sup>, Steve Hackney<sup>4</sup> Solid-state batteries with lithium metal anodes have the potential for higher energy density, longer lifetime, wider operating temperature, and increased safety .

Solid-state battery literature analysis showing (a) the number of peer-reviewed publications from 2000 to 2020 (keywords: "lithium" and "solid-state batter\*", Web of Science) and (b) a radar plot that compares the level of activities in key technical areas for solid-state batteries based on analysis of 12 recent review articles.



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Our results here pave the way for the future design of solid-state batteries with superior rate performance at high loadings, where constriction of Si and other, more ...

The lithium (Li) metal anode, due to its tenfold larger capacity than commercial graphite anode, is a desired component for solid-state batteries.

Solid-state lithium metal batteries offer superior energy density, longer lifespan, and enhanced safety compared to traditional liquid-electrolyte batteries. Their development has the potential to revolutionize battery technology, including the creation of electric vehicles with extended ranges and smaller more efficient portable devices. The employment of metallic ...

Depending on the selection of materials at the anode and cathode, ASSBs can generally include all-solid-state Li-ion batteries using graphite or  $\text{Li}_4\text{Ti}_5\text{O}_{12}$  as the anode, 11 all-solid-state Li-metal batteries with Li metal as the anode, 2 all-solid-state lithium sulfur batteries utilizing sulfur as the cathode, 12 and all-solid-state silicon ...

Solid-state lithium metal batteries (SSLMBs) have gained significant attention in energy storage research due to their high energy density and significantly improved safety. But there are still certain problems with lithium dendrite growth, interface stability, and room-temperature practicality. Nature continually inspires human development and intricate design ...

Abstract Solid-state lithium metal batteries (SSLMBs) with polymer electrolytes (SPEs) have attracted tremendous attention owing to their superior safety and high energy density. ... State Key Laboratory of Advanced Technology for Materials Synthesis and Processing, School of Materials Science and Engineering, Wuhan University of Technology ...

In 2011, Bollor&#233; of France introduced the first commercialize solid-state batteries for electric vehicles with only approximate 100 Wh/kg energy density. 5 years later, another solid-state electrolyte lithium metal battery was introduced by America Solid Energy Company reached 300 ...

Therefore, researchers paid enormous attention to preparing the dendrite-free or stable Li anode by using solid-state electrolytes that include the composite of ceramic fillers with polymer materials and surface modified Li metal strategies which can considerably boost the electrochemical durability and rate features of the solid-state or even ...

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