

Can topological quantum materials be used for energy conversion and storage?

We describe the open problems and the potential applications of TQMs in water splitting, batteries, supercapacitors and other prospects in energy conversion and storage. Topological quantum materials host protected, high-mobility surface states which can be used for energy conversion and storage.

What are topological quantum materials?

Topological quantum materials (TQMs) host symmetrically protected, high mobility electronic states¹⁻⁶. These features make them attractive for a range of applications - most commonly discussed are their potential for spin-related information storage and processing, but TQMs can also be useful for energy conversion and storage.

Can topological insulator be used in electrochemical energy storage?

Topological insulator has attracted worldwide attention due to its promising application prospects in magnetoresistive devices, optoelectronic devices, spintronic and quantum computing. Nevertheless, its potential in electrochemical energy storage have not been fully explored and utilized.

What is the relationship between topological band structures and energy conversion?

Further study of topological properties is needed from both a chemistry and a physics perspective to uncover the relationship between topological band structures and energy conversion or storage, for the design of high-efficiency heterogeneous catalysts for energy conversion such as water splitting and fuel cells.

Why are topological materials important?

Topological materials have attracted intense research interest due to their nontrivial topology of band structures and their promise in applications ranging from low-power electronics to high-performance optoelectronic devices.

Do topological quantum materials have symmetry-protected band structures?

Nature Reviews Physics 4, 611-624 (2022) Cite this article Topological quantum materials (TQMs) have symmetry-protected band structures with useful electronic properties that have applications in information, sensing, energy and other technologies.

Lithium-ion energy storages have been widely used in portable and electric vehicle energy storage devices due to their high theoretical energy density and electrochemical stability. However, the limited and uneven lithium sources impose significant limitations on their wider applications [1]. Potassium-ion storages are beneficial for low-cost ...

The very first magnetic topological insulator is the (integer and fractional) quantum Hall effect, the discovery and theoretical explanation of which resulted in two Nobel prizes, in 1985 and 1998.

The exploration of topologically nontrivial states in condensed matter systems, along with their novel transport properties, has garnered significant research interest. This review aims to provide a comprehensive overview of representative topological phases, starting from the initial proposal of the quantum Hall insulator. We begin with a concise introduction, followed by ...

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the bulk electronic energy band define different quantum or topological phases of matters, offering an excellent prospect for some unique device applications. Device applications of the quantum materials rely primarily on ... topological materials and their properties is presented. This can provide the necessary information for

Electrostatic capacitors can enable ultrafast energy storage and release, but advances in energy density and efficiency need to be made. ... Huang, H. & Scott, J. F. *Ferroelectric Materials for ...*

Energy Storage Materials. Volume 41, October 2021, Pages 255-263. Exploring sodium storage mechanism of topological insulator Bi₂Te₃ nanosheets encapsulated in conductive polymer. Author links open overlay panel Xiaofeng Liu # a b, Yubing Si # a b, Kai Li a b, Yanan Xu a b, Zhipeng Zhao a b, Chuanqi Li a b, Yongzhu Fu a b, Dan Li a b.

This review presents the recent advances in the search for thermoelectric (TE) materials, mostly among intermetallic compounds and in the enhancement of their TE performance. Herein, contemporary approaches towards improving the efficiency of heat-electricity conversion (e.g., energy harvesting and heat pumping) are discussed through ...

Topological quantum materials (TQMs) have symmetry-protected band structures with useful electronic properties that have applications in information, sensing, energy and other technologies. ... making TQMs an ideal platform for understanding surface reactions and looking for highly efficient materials for energy conversion and storage. In this ...

Abstract | Topological quantum materials (TQMs) have symmetry-protected band structures with useful electronic properties that have applications in information, sensing, energy and other...

Abstract: Topological quantum materials (TQMs) have symmetry protected band structures with useful electronic properties that have applications in information, sensing, energy, and other technologies. In the past 10 years, the applications of TQMs in the field of energy conversion and storage mainly including water splitting, ethanol electro-oxidation, battery, ...

In this work, using machine learning and first-principle calculations, for the first time we have screened 7386

topological quantum materials with low diffusion energy barriers. Especially, topological semimetal Na₄CoO₃ has been identified to exhibit high reversible capacity of 269.5 mAh/g and high energy density of 746.5 Wh/kg.

Nontrivial energy band topology is another burgeoning area of research in the fundamental physics of 2D materials. Graphene is a notable example, with a low energy band structure featuring two cone-shaped energy bands that intersect at two points in the Brillouin zone, commonly referred to as the Dirac points [26] ch band topology is responsible for ...

This Technical Review covers topological band theory and provides a guide to the study of topological materials with first-principles methods. ... B., Jansen, M. & Felser, C. A large-energy-gap ...

Topology, a mathematical concept, has recently become a popular and truly transdisciplinary topic encompassing condensed matter physics, solid state chemistry, and materials science. Since there is a direct connection between real space, namely atoms, valence electrons, bonds, and orbitals, and reciprocal space, namely bands and Fermi surfaces, via ...

1 Topological Quantum Materials for Energy Conversion and Storage Huixia Luo^{1*}, Peifeng Yu¹, Guowei Li^{2,3*}, Kai Yan^{4*} ¹School of Materials Science and Engineering, State Key Laboratory of Optoelectronic Materials and Technologies, Key Lab of Polymer Composite & ...

All these topological quantum materials share one thing in common the intrinsic and robust conducting surface states, which lead to many practical applications ranging from light-harvesting, and photo-electric conversion to energy storage [[36], [37], [38], [39]].

Since the first-generation three-dimensional topological insulators were discovered in classic thermoelectric systems, the exploration of novel topological materials for advanced thermoelectric energy conversion has attracted increasing attention. The rapid developments in the field of topological materials, from topological (crystalline) insulators, Dirac/Weyl semimetals, to ...

This review provides a summary of various energy-related topological materials and topologically engineered materials and explore the unique nontrivial ... ScienceGate; ... synthesis, and applications for energy conversion and storage Journal of Materials Chemistry A . 10.1039/d0ta11072h . 2021 . Author(s): Zhigang ...

The discovery of topological materials has provided new opportunities to exploit advanced materials for heat-to-electricity energy conversion as they share many common characteristics with ...

Next, we summarize the application of COF materials in various energy storage technologies, including lithium-ion batteries, lithium-sulfur batteries, sodium-ion batteries, zinc-air batteries, and supercapacitors. ... Some new topological 3D COFs have been reported since 2008, but still require further efforts to expand the 3D COF inventory.

Enhancing the energy storage performance of dielectric material through the adoption of a novel domain strategy is highly desirable. In this study, Bi_{0.5}Na_{0.5}TiO₃-based thin films are fabricated with topological vortex domains (VDs) by controlling the grain size and investigated the correlation between these VDs and the macroscopic polarization response, ...

With a rapid development of electronic and electric power devices, electronic components such as capacitors are broadly investigated towards high energy storage density and miniaturization, leading to an uninterrupted study and preparation of dielectric composite materials with high permittivity and electric breakdown strength [1,2,3,4,5]. Till date, two frequent ...

Phase diagram, topological structures and energy storage in Na_{0.5}Bi_{0.5}TiO₃ (NBT) ... In conclusion, we reviewed the origin of ferroelectricity and summarized the latest research progress about novel FE materials used for energy harvesting, storage, and conversion. From the typical perovskite oxides, one can see that the polarization ...

Topological quantum materials (TQMs) have symmetry protected band structures with useful electronic properties that have applications in information, sensing, energy, and ...

Progress on Emerging Ferroelectric Materials for Energy Harvesting, Storage and Conversion. May 2022; Advanced Energy Materials 12(24):2201199 ... topological structures and energy storage in Na

Just like Bi₂Te₃, Bi₂Se₃ is also predicted to be a near-ideal topological insulator with a single Dirac cone. Bi₂Se₃ offers the potential for topologically protected behavior in ordinary crystals at room temperature and zero magnetic field. It has a large band gap of 0.3 eV at 360 K, which is promising for spintronic applications. For topological insulators, understanding the ...

1 Introduction. As the enhance consumption of fossil fuels, the quick evolution of clean and renewable power sources accelerates the development of electricity storage configurations with ultrahigh power density, high energy density, and excellent cycling performance for sustainable development. [] Lithium-ion batteries (LIBs) with high energy ...

Topological quantum materials are a class of compounds featuring electronic band structures, which are topologically distinct from common metals and insulators. These materials have emerged as exceptionally fertile ground for materials science research. The topologically nontrivial electronic structures of these materials support many interesting ...

This review provides a summary of various energy-related topological materials and topologically engineered materials that have been developed thus far and explore the ...

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properties that have applications in information, sensing, energy and other technologies. In the past 10 years, applications of TQMs in the fields of energy conversion and storage, including water splitting, ethanol electro-oxidation, batteries, supercapacitors and ...

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Topological quantum materials for energy conversion and storage. 2022, Nature Reviews Physics ... Energy Storage Materials, Volume 9, 2017, pp. 214-220. Ze Yang, ..., Shuo Chen. Cage-like MnSe@PPyC/rGO as superior dual anode materials in Li/Na-ions storage. Journal of Alloys and Compounds, Volume 927, 2022, Article 167002.

Numerous topological states of matter have been reported over the years 1,2, including quantum spin Hall insulators 3,4,5, quantum anomalous Hall insulators 6,7, topological superconductors 8,9 ...

Searching appropriate material systems for energy storage applications is crucial for advanced electronics. Dielectric materials, including ferroelectrics, anti-ferroelectrics, and relaxors, have ...

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