Lead-free antiferroelectric ceramic energy storage materials

Are lead-free antiferroelectric ceramics suitable for energy storage applications?
Lead-free dielectric ceramics with high recoverable energy density are highly desired to sustainably meet the future energy demand. AgNbO 3 -based lead-free antiferroelectric ceramics with double ferroelectric hysteresis loops have been proved to be potential candidates for energy storage applications.

Are antiferroelectric materials suitable for energy storage applications?
Antiferroelectric materials are attractive for energy storage applicationsand are becoming increasingly important for power electronics. Lead-free silver niobate (AgNbO 3) and sodium niobate (NaNbO 3) antiferroelectric ceramics have attracted intensive interest as promising candidates for environmentally friendly energy storage products.

Why are lead-free antiferroelectric ceramics becoming a research hotspot?
Lead-free antiferroelectric ceramics are becoming a research hotspot in the field of energy storage as current energy storage devices grow, in order to fulfill the high demands for energy storage performance of dielectric ceramic materials while also protecting the environment.

How can lead-free dielectric energy storage ceramic materials improve energy storage properties?
It is necessary to design and prepare lead-free dielectric energy storage ceramic materials with high energy storage properties by optimizing the structure of AgNbO 3 materials, compounding multiple components, or exploring new rationalized sintering mechanisms.

Are agnbo 3 lead-free antiferroelectric ceramics suitable for energy storage?
AgNbO 3 lead-free antiferroelectric (AFE) ceramics are attractive candidatesfor energy storage applications and power electronic systems. In this study,AgNbO 3 ceramics are synthesized by single-step sintering (SSS) and two-step sintering (TSS) processes under oxygen-free atmosphere,and their energy storage performance is compared.

Are lead-free materials the future of energy storage?
Lead-free materials with high energy storage density and efficiency are becoming increasingly relevant in today's energy crisis. Pure silver niobate materials have been discovered to contain double electric hysteresis loops and strong saturation polarization in recent experiments.

Many studies on lead lanthanum zirconate titanate, lead lanthanum zirconate titanate, and lead titanate magnesium niobate-lead titanate-based materials are now underway, for example, PbZrO 3-based antiferroelectric ceramics have recoverable energy density as high as 10.4 J/cm 3, their energy storage density is higher than other dielectric ...

These results not only reveal the high potential of La-modified AgNbO 3 ceramics for energy storage

applications but also open up a feasible approach of domain engineering to ...

AgNbO3 lead-free antiferroelectric ceramic is reported to be a promising candidate for energy storage applications. A great breakthrough with high recoverable energy density up to 4.2 J cm-3 and good...

In comparison, AN has energy storage density in the range of 1.6 J/cm 3 at electric field of 14 kV/mm [54] and with compositional modifications AN-based materials can exhibit energy storage density even close to 6.5 J/cm 3 at 37 kV/mm [55]. However, all reports on the AN-based energy storage materials were made on bulk ceramics.

The primary AFE materials for energy storage applications have been the La-doped Pb-based ceramics [7, [9], [10], [11]], in which a W rec up to 12.8 J/cm 3 has been obtained [11].However, the high toxicity of Pb-containing compounds continuously raises severe problems [12].Thus, the intensive researches have been performed on lead-free counterparts [13, 14].

Lead-free antiferroelectric (AFE) ceramic materials have attached increasing attention in application of high-power capacitors for the past few years, due to their high energy storage density and environmental protection. However, the related applications are seriously restricted because of the limited number of environment friendly AFE ...

These results not only suggest that the NaNbO 3-based relaxor antiferroelectric ceramics are promising candidates for advanced energy storage capacitors, but also provide ...

Enhanced Energy Density and Efficiency in Lead-Free Sodium Niobate-Based Relaxor Antiferroelectric Ceramics for Electrostatic Energy Storage Application. Advanced Electronic Materials 2022, 8 (12) ...

Therefore, developing novel lead-free antiferroelectric ceramics with superior energy storage properties are essential and vital. NaNbO 3 (NN) is another well-documented lead-free antiferroelectric compound, which is attributed to the antiparallel displacements of the Nb 5+ ions in successive pairs of oxygen layers [15, 16].

In this work, we systematically investigated the effects of single-step and two-step sintering methods on the structural, dielectric and energy storage properties of pure AgNbO3 lead-free antiferroelectric ceramics. Compared with the single-step sintered ceramic, the ceramic prepared by two-step sintering method has smaller grain size, dense and homogeneous ...

Dielectric ceramic capacitors are critical components in pulse power systems due to their ultrafast discharge capabilities and high power density [1], [2], [3].A key factor limiting the broader application of these capacitors is energy storage density [4] nsequently, significant efforts have been directed toward enhancing energy density while considering cost-effectiveness and ...

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NaNbO 3-based ceramic materials, as representatives of the lead-free antiferroelectric system, show very great potential for energy storage due to their wide bandgap (~3.45 eV), high polarization ...

Environmentally benign lead-free bulk ceramics with high recoverable energy density (W rec) are very attractive in advanced pulsed power capacitors this work, composition engineering was adopted by La 3+ ...

Dielectric materials have drawn increasing attention due to their high power density and fast charge-discharge speed. Although satisfactory energy storage performance has been achieved in lead-based ceramics, the exploration of suitable lead-free substitutions is highly desired since the rising environmental concerns caused by lead-based compounds.

Lead-free dielectric capacitors with high energy storage density and temperature-insensitive performance are pivotal to pulsed power systems. In this work, a pronounced recoverable energy storage density (W rec) was ...

It is necessary to design and prepare lead-free dielectric energy storage ceramic materials with high energy storage properties by optimizing the structure of AgNbO 3 ...

Dielectric capacitors have drawn growing attention for their wide application in future high power and/or pulsed power electronic systems. However, the recoverable energy storage density (W rec) for dielectric ceramics is relatively low up to now, which largely restricts their actual application. Herein, the domain engineering is employed to construct relaxor ...

Furthermore, the newly developed composites exhibit better energy storage characteristics at 120 °C, with a high W rec of 3.5 J cm -3 as well as a high i of 91%. This study demonstrates that the design of a relaxor/antiferroelectric composite provides a highly effective method to improve the energy storage performance of lead-free ceramics.

With the rapid development of economic and information technology, the challenges related to energy consumption and environmental pollution have recen...

AgNbO3 lead-free antiferroelectric (AFE) ceramics are attractive candidates for energy storage applications and power electronic systems. In this study, AgNbO3 ceramics ...

Various Pb-based antiferroelectric materials exhibit a typical double hysteresis loop and subsequently high discharge energy density. Ba 2+ is considered as the perfect substitute of Pb 2+ for energy storage applications. The benefit of Ba 2+ over Pb 2+ is that it changes the polar ordering and can consequently decrease the antiferroelectric to ferroelectric transition ...

However, the utilization of lead has caused environmental issues, thus motivating the invention of lead-free energy storage materials [19]. Lead-free antiferroelectric materials, which show double hysteresis loops, are

becoming increasingly popular due to their superior energy storage capacity.

Dielectric energy storage materials have attracted much attention from both academia and industry due to the larger power density than chemical batteries arising from the fast charge-discharge speed ... Silver niobate Lead-free antiferroelectric ceramics: enhancing energy storage density by B-Site doping. ACS Appl. Mater. Inter., 10 (2018), pp ...

Antiferroelectric materials have attracted growing attention for their potential applications in high energy storage capacitors, digital displacement transducers, pyroelectric detectors and sensors, solid-state cooling devices, and explosive energy conversion, and so on, because of their novel field-induced phase transitions between antiferroelectric and ferroelectric.

NaNbO3(NN)-based lead-free eco-friendly antiferroelectric (AFE) ceramics with an extremely high maximum polarization (Pm) are believed to be a promising alternative to traditional lead-based ceramics. Nevertheless, the ...

Ceramic-based dielectric capacitors are the core components to store energy in electronic power devices [1], [2] pared to batteries and electrochemical capacitors, dielectric capacitors possess high power density owing to their fast charge-discharge capability [3], [4].However, the inferior temperature stability of energy storage for the dielectric capacitors ...

Giant energy density and high efficiency achieved in silver niobate-based lead-free antiferroelectric ceramic capacitors via domain engineering,Energy Storage Materials,34,417-426(2021)?

SHI Ruijian, LEI Junwei, ZHANG Yi, XIE Aiwen, ZUO Ruzhong. Linear-like NaNbO 3-based Lead-free Relaxor Antiferroelectric Ceramics with Excellent Energy-storage and Charge-discharge Properties[J]. Journal of Inorganic Materials, 2024, 39(4): 423-431.

The mechanisms underpinning high energy storage density in lead-free Ag 1-3x Nd x Ta y Nb 1-y O 3 antiferroelectric (AFE) ceramics have been investigated. Rietveld refinements of in-situ synchrotron X-ray data reveal that the structure remains quadrupled and orthorhombic under electric field (E) but adopts a non-centrosymmetric space group, Pmc2 1, in which the ...

Lead-free antiferroelectric AgNbO 3 (AN) ceramics have attracted significant attention due to their potential in energy storage applications. However, the presence of the ferrielectric phase and field-induced phase transitions result in substantial remnant polarization (P r) and hysteresis loss, which substantially diminishes their energy storage properties.

Lead-free silver niobate (AgNbO 3) and sodium niobate (NaNbO 3) antiferroelectric ceramics have attracted intensive interest as promising ...

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NaNbO 3-based lead-free energy storage ceramics are essential candidates for next-generation pulsed power capacitors, especially under the background of energy saving and environmental protection.However, the room-temperature antiferroelectric P phase of pure NaNbO 3 ceramics limits its further development in energy storage owing to the irreversible ...

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