Antiferroelectric materials for energy storage

Can antiferroelectric materials be used for energy storage?

Antiferroelectric materials have shown potential applications in energy storage. However,controlling and improving the energy-storage performance in antiferroelectric remain challenging. Here,a domain structure and energy-storage performance diagram for Pb (Zr 1-x Ti x)O 3 (x <= 0.1) single crystal are investigated via phase-field simulations.

Can antiferroelectric materials store energy in pulsed-power technologies?

The polarization response of antiferroelectrics to electric fields is such that the materials can store large energy densities,which makes them promising candidatesfor energy storage applications in pulsed-power technologies. However,relatively few materials of this kind are known.

Which antiferroelectric ceramic systems are best for energy storage?

In this review, the current state-of-the-art as regards antiferroelectric ceramic systems, including PbZrO 3 -based, AgNbO 3 -based, and (Bi,Na)TiO 3 -based systems, are comprehensively summarized with regards to their energy storage performance.

Are antiferroelectrics a promising material with high energy density?

Continued efforts are being devoted to find materials with high energy density,and antiferroelectrics (AFEs) are promisingbecause of their characteristic polarization-electric field (P - E) double hysteresis loops schematized in Fig. 1a (ref. 4).

Are antiferroelectrics suitable for eco-friendly dielectric energy storage?

Antiferroelectrics are important in emerging energy-storage technologies. Here,the authors present an approach to adjust their local structure and defect chemistry,in order to overcome the current limitations and make them suitable for environmentally-friendly dielectric energy storage.

Can lead-free antiferroelectric ceramics improve energy storage performance?

Meanwhile, recent progress on lead-free antiferroelectric ceramics, represented by AgNbO 3 and NaNbO 3, is highlighted in terms of their crystal structures, phase transitions and potential dielectric energy storage applications. Specifically, the origin of the enhanced energy storage performance is discussed from a scientific point of view.

Lead hafnate (PbHfO3) has attracted a lot of renewed interest due to its potential as antiferroelectric (AFE) material for energy storage. However, its room temperature (RT) energy-storage performance has not been well established and no reports on the energy-storage feature of its high-temperature intermediate phase (IM) are available. In this work, high ...

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To date, several portable, wearable, and even implantable electronics have been incorporated into ultracompact devices as miniaturized energy-autonomous systems (MEASs). Electrostatic supercapacitors could be a promising energy storage component for MEASs due to their high power density and ultrashort charging time. Several dielectric ...

Antiferroelectrics (AFEs) are promising candidates in energy-storage capacitors, electrocaloric solid-cooling, and displacement transducers. As an actively studied lead-free antiferroelectric (AFE ...

Among various kinds of dielectric materials, antiferroelectrics show promising features of high energy-storage density and efficiency. In this study, epitaxial antiferroelectric $PbHfO_3$ films with different orientations are fabricated, in which remarkable anisotropies of polarization and energy storage properties are discovered.

Among the dielectric materials, antiferroelectric (AFE) materials are recognized as their high energy storage performance owing to the large P_{max} and small P_r. 6,7 An essential feature of AFE materials is the electric field-induced reversible AFE to ...

Energy storage materials and their applications have long been areas of intense research interest for both the academic and industry communities. ... extensive efforts have been devoted to the development of high performance, antiferroelectric, energy storage ceramics and much progress has been achieved. In this review, the current state-of-the ...

$AgNbO_3$ lead-free antiferroelectric (AFE) ceramics are attractive candidates for 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. The prepared ceramic ...

Energy density as a function of composition (Fig. 1e) shows a peak in volumetric energy storage (115 J cm^{-3}) at 80% Zr content, which corresponds to the squeezed antiferroelectric state from C ...

Among the dielectric materials, antiferroelectric (AFE) materials are recognized as their high energy storage performance owing to the large P_{max} and small P_r. 6,7 An essential feature of AFE materials is the electric ...

Consequently, extensive research has been conducted on the energy storage capabilities of capacitors utilizing ferroelectric 7-10 and antiferroelectric materials. 11,12 Due to their double hysteresis loops induced by phase transitions under electric fields, antiferroelectric (AFE) capacitors exhibit high energy storage densities and efficiency.

The effect of Ti contents on the microstructure, dielectric, and energy storage properties of prepared $(Pb_{0.97}La_{0.02})(Zr_{0.53}Sn_{0.47})_{1-x}Ti_xO_3$ (PLZST) antiferroelectric ceramics by a traditional solid-state sintering method was systematically studied. The results showed that even though there are trace amounts of impurities in the prepared PLZST ...

Antiferroelectric (AFE) HfO 2 /ZrO 2-based thin films have recently emerged as a potential candidate for high-performance energy storage capacitors in miniaturized power electronics.However, the materials suffer from the issues of the trade-off between energy storage density (ESD) and efficiency, as well as the difficulty in scaling up of the film thickness.

In consideration of environmental protection and energy demand, it is an inevitable trend to explore lead-free dielectric ceramics with high energy storage performance. The lead-free antiferroelectric ceramics based on silver niobate (AgNbO3) with double hysteresis loops have been proved to be a potential energy storage material. AgNbO3-based ...

The capacitors are in rising demand for cryogenic applications. As for now, it still remains an ongoing challenge for simultaneously achieving high energy storage density and cryogenic temperature stability. Herein, the strategy of stable backward phase transition was demonstrated in the antiferroelectric composition of (Pb0.9175La0.055)(Zr0.975Ti0.025)O3. ...

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 ...

(a) The polarization hysteresis loop for a ferroelectric material; (b) polarization hysteresis loop for an antiferroelectric material, where the storage energy density and dissipated energy density are given; (c) Expected polarization hysteresis loop for an antiferroelectric solid solution with a relaxor end member.

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