Amorphous ferroelectric thin film energy storage

How can flexible ferroelectric thin films improve energy storage properties?
Moreover,the energy storage properties of flexible ferroelectric thin films can be further fine-tuned by adjusting bending angles and defect dipole concentrations,offering a versatile platform for control and performance optimization.

What is the recoverable energy storage density of PZT ferroelectric films?
Through the integration of mechanical bending design and defect dipole engineering,the recoverable energy storage density of freestanding PbZr 0.52 Ti 0.48 O 3 (PZT) ferroelectric films has been significantly enhanced to 349.6 J cm -3compared to 99.7 J cm -3 in the strain (defect) -free state,achieving an increase of ?251%.

Which ferroelectric materials improve the energy storage density?
Taking PZT,which exhibits the most significant improvement among the four ferroelectric materials,as an example,the recoverable energy storage density has a remarkable enhancement with the gradual increase in defect dipole density and the strengthening of in-plane bending strain.

Are ferroelectric thin-film capacitors flexible?
Advances in flexible electronics are driving the development of ferroelectric thin-film capacitors toward flexibility and high energy storage performance.

What are the characteristics of ferroelectric thin films?
Ferroelectric thin films exhibit tensile strain,strain gradient,and defect dipole states. b) The double-well potential of Landau free energy with the strain (defect)-free state (blue curve) and with strain and strain gradient engineering as well as defect engineering (red curve).

What is a freestanding ferroelectric film?
Freestanding ferroelectric films, such as BaTiO 3 (BTO) and BiFeO 3 (BFO), obtained through methods like wet etching or laser lift-off, can be folded nearly 180° without damage and exhibit remarkable piezoelectric, flexoelectric, and flexo-photovoltaic effects.

The trade-off relationship of the polarization and the breakdown strength severely limits the enhancement of energy-storage properties of dielectric materials. In this work, Pb-free 0.92BaTiO3-0.08Bi(Mg1/2Zr1/2)O3 ...

This limits the piezoelectric and dielectric performance parameters of actuators, sensors, energy storage, and further functional devices. Therefore, approaches for improving the electric dipolar order in ferroelectric polymer ...

Figure 4b compares the energy storage performance of our films with those of state-of-the-art dielectrics, for

example, the lead-based Pb(Mg 1/3 Nb 2/3)O 3 -PbTiO 3 film with U e of 133 J cm - ...

The energy storage density of ferroelectric capacitors is mainly determined by their polarization and breakdown strength. In this work, the energy storage performance of BNT thin films was enhanced by introducing an amorphous alumina to construct Al 2 O 3-Bi 0.5 Na 0.5 TiO 3 (AO-BNT) heterojunctions by sol-gel process. The results reveal that the Bi 0.5 Na 0.5 TiO 3 ...

In previous studies, despite the excellent energy storage performance of lead-based ferroelectric thin films, lead-free materials were given wide attention because of environmental considerations regarding sustainable social development [8].Barium zirconate titanate (BZT), as a quintessential lead-free ferroelectric material, has several advantages, ...

Ferroelectric thin film capacitors have attracted increasing attention because of their high energy storage density and fast charge-discharge speed, but less attention has been paid to the realization of flexible capacitors ...

Compared to other dielectric materials like polymers, oxide-based ferroelectric materials typically exhibit higher P max and P r due to their larger spontaneous polarization, promising for energy storage [2], [6], [7]. A classic approach to promote energy storage performance involves combining ferroelectrics with materials of a different structure to reduce ...

The results show that the energy storage density of amorphous thin film is much higher than of that of polycrystalline structure. ... The ferroelectric P-E loops and leakage current were determinated by a Radiant precision workstation. The energy storage properties were obtained on the basis of the P-E loops. 3.

Another effective way by microstructural control to tailor the ESPFs is to form partially amorphous region in a ferroelectric matrix [[17], [18], [19], [20]].Generally, the amorphous phase exhibits extremely high breakdown strength but low dielectric polarization, which significantly hinders the enhancement of energy storage performances [21].On the contrary, ...

The recoverable energy density (W rec) and energy storage efficiency (i) are key indicators for evaluating the performance of thin film energy storage devices.The energy storage mechanism of dielectric thin films is illustrated in Fig. S1, where W rec and i can be expressed as [1, 6]: (1) W rec = ? P r P max E d P (2) i = W rec / (W rec + W loss) here P max, P r, P, and ...

Recently, hybrid amorphous/crystalline structures have been extensively studied, in which the amorphous phase enhances the breakdown strength and the crystalline phase maintains the polarization, and as a result, the energy-storage properties of dielectric films can be effectively improved [[24], [25], [26]] the study by Xie et al., an ultra-high U r of 126 J/cm 3 ...

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Thin film capacitors with large energy storage density and high breakdown strength are widely used in modern electronic fields. To solve the problems of interface effect and different polarization mechanism between matrix and fillers in conventional heterogeneous structure composite thin film capacitors, a new-type inorganic microcrystal-amorphous composite film of ...

Here, by structure evolution between fluorite HfO 2 and perovskite hafnate, we create an amorphous hafnium-based oxide that exhibits the energy density of ~155 J/cm 3 ...

Antiferroelectric PbZrO 3 (AFE PZO) films have great potential to be used as the energy storage dielectrics due to the unique electric field (E)-induced phase transition character.However, the phase transition process always accompanies a polarization (P) hysteresis effect that induces the large energy loss (W loss) and lowers the breakdown strength (E BDS), leading to the inferior ...

Finally, the optimized energy-storage performance is achieved in 0.92BT-0.08BMZ thin films annealed at 600 °C, with a large energy density of 55.2 J/cm 3 and a high energy efficiency of 83.6%, demonstrating the great ...

The energy storage density of ferroelectric capacitors is mainly determined by their polarization and breakdown strength. In this work, the energy storage performance of BNT thin ...

Contrary to the negative impact of ion bombardment on the properties of ferroelectric films, in which reduced polarization together with a larger coercive field were achieved after ion-beam etching due to the formation of defects (as oxygen vacancies) induced by the ion bombardment [24], [25], [26], Kim et al. found that improved energy density and ...

The ferroelectric and energy storage properties of BZT film capacitors are shown in Fig. 3. The P-E hysteresis loops of the BZT films are slim, as seen in Fig. 3 a-c. Leakage current is an important factor in evaluating the quality of films, and it will affect the breakdown field strength of the film.

Dielectric thin film capacitors meet the requirements of self-charging micro-energy storage, and thus are particularly suitable for powering pulsed-power devices due to their higher power density than microsupercapacitors and microbatteries [10, 11].BaTiO 3-based ferroelectric film capacitors have been extensively exploited as promising energy storage owing to their ...

STO, SrTi 1-x Mn x O 3 (STM x, x = 0.01 and 0.04) and Sr 1-y La y TiMn 0.01 O 3 (SL y TM 0.01, y = 0.01, 0.02, 0.03 and 0.04) thin films are synthesized by the sol-gel method and thoroughly investigated on the effects of A-site (La) and B-site (Mn) co-doping effects on the crystalline phase, morphology, dielectric, ferroelectric and energy ...

Notably, among the four ferroelectric materials, KNN exhibits the highest enhancement ratio in recoverable

energy storage density, reaching up to 165% Therefore, the introduction of defect dipoles proves to be an effective ...

The energy storage density of ferroelectric thin film capacitors is mainly limited by the breakdown strength. Here we demonstrate that the high breakdown strength and high ...

The energy storage density of ferroelectric thin film capacitors is mainly limited by the breakdown strength. Here we demonstrate that the high breakdown strength and high energy storage density ...

Dielectric polarization and breakdown strength of dielectrics generally show directly and inversely dependent upon their crystallization, respectively. Therefore, achieving the maximum energy storage density should be expected by controlling the crystallization. A serial of ferroelectric (Ba 0.95, Sr 0.05)(Zr 0.2, Ti 0.8)O 3 (BSZT) thin films were prepared by the sol ...

Herein, we reinforce the performance by adding B 2 O 3 with high breakdown strength in the BaTiO 3-base film.The introduction of B 2 O 3 significantly improves the breakdown strength and reduces the remnant polarization, which is beneficial to achieve high energy storage density and energy storage efficiency. In this work, the BaTiO 3 as the matrix, ...

The ZrO 2 film can be uniformly deposited by spray pyrolysis and the standard photolithographic method can be used for pattering [32], [40], [41].There are several applications of hafnium and zirconium oxide-based ferroelectric thin film transistors (FE-TFTs). The FE-TFT is a promising candidate for next-generation non-volatile memory devices because it offers the ...

Here we demonstrate that the high breakdown strength and high energy storage density can be achieved by constructing BiFeO3/Al2O3 ferroelectricity-insulators ...

The Pb(Zr 0.92 Li 0.08)O 3 ferroelectric films have excellent performance in breakdown electric field strength and energy storage density, but their energy storage efficiency is low. Reduced polarization loss and enhanced energy storage efficiency can be achieved by adjusting the degree of crystallization by annealing at a lower temperature.

Very recently Li et al 114 reported barium titanate [BaTiO 3 -BTO] and bismuth magnesium zirconate [Bi(Mg 1/2 Zr 1/2)O 3 -BMZ] based phase coexisting amorphous and ferroelectric thin films for ...

For the sake of solving the issue of low BDS of barium zirconate titanate films, researchers have carried out a lot of research. Minh D. Nguyen et al. [25] introduced La into BaZr 0.25 Ti 0.75 O 3 films through doping modification, which increased the relaxation of the films, thus significantly improving the BDS and energy storage performances. Other modification ...

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Nano-submicron structure enables the film to maximize the ferroelectric material component and obtain improved dielectric performance without sacrificing breakdown strength ...

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