

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.

Do ultra-thin layers improve energy storage performance?

However, the energy density of these dielectric films remains a critical limitation due to the inherent negative correlation between their maximum polarization ( $P_{\max}$ ) and breakdown strength ( $E_b$ ). This study demonstrates enhanced energy storage performance in multilayer films featuring an ultra-thin layer structure.

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  $\text{PbZr}_{0.52}\text{Ti}_{0.48}\text{O}_3$  (PZT) ferroelectric films has been significantly enhanced to  $349.6 \text{ J cm}^{-3}$  compared to  $99.7 \text{ J cm}^{-3}$  in the strain (defect) -free state, achieving an increase of 251%.

How to improve energy storage performance of multilayer films?

Current methods for enhancing the energy storage performance of multilayer films are various, including component ratio tuning, interface engineering, diffusion control, stress manipulation, and conduction mechanism modulation.

Do film dielectrics improve energy storage performance?

Film dielectrics possess larger breakdown strength and higher energy density than their bulk counterparts, holding great promise for compact and efficient power systems. In this article, we review the very recent advances in dielectric films, in the framework of engineering at multiple scales to improve energy storage performance.

Does ultra-thin  $\text{Nb}_2\text{O}_5$  film improve energy storage performance?

Ultimately, in the ultra-thin  $\text{Nb}_2\text{O}_5$  film, with each layer having a thickness of 6.7 nm, we achieved a remarkable enhancement of energy storage performance, with  $W_{\text{rec}}$  reaching  $65.8 \text{ J cm}^{-3}$  and efficiency reaching 72.3%.

## 2. Experimental 2.1. Synthesis of $\text{BiFeO}_3$ and $\text{SrTiO}_3$ precursors

As a prototypical perovskite, ferroelectric  $\text{BaTiO}_3$  (BT) has been studied and applied widely in many fields [18]. Zhang et al. prepared the epitaxial  $\text{BaTiO}_3$  thin films with  $\text{LaNiO}_3$  bottom electrodes using a magnetron sputtering technique and investigated the energy storage properties [19]. However, the reports on the energy storage performance of sol-gel grown ...

Dielectric energy storage capacitors as emerging and imperative components require both high energy density and efficiency. Ferroelectric-based dielectric thin films with large polarizability, high breakdown strength, and ...

The 20 mol% La-doped BTT thin film achieved the highest energy storage efficiency of 75.2% and the highest recoverable energy density of 128.3 J/cm<sup>3</sup>. These findings ...

The energy storage density in HZO thin films was optimized through a three-pronged approach: (i) field-driven NC optimization through ferroic phase engineering in ...

Flexible electronics is an emerging and important field, for which flexible energy-storage dielectric films are required. Success for flexible energy-storage films has been proven using modified deposition on flexible substrates, 85,86 which ...

Dielectric capacitors are critical energy storage devices in modern electronics and electrical power systems 1,2,3,4,5,6 pared with ceramics, polymer dielectrics have intrinsic advantages of ...

It can affect the energy storage performance in the thin film preparation experiments. In this section, we simulate 4 layers, 8 layers, 16 layers, and 24 layers PZO-based AFE thin films to investigate the effect of film thickness on domain structure and energy storage performance. The simulation parameters all use a 10-layer substrate to apply ...

In this work, we propose a multiscale structure (including defect, domain, and grain structures) synergetic optimization strategy to optimize the polarization behavior and ...

The recoverable energy storage density of the PZO films with 0.05 mol/L NiO was raised to 19.6 J/cm<sup>3</sup> at 1038 kV/cm, corresponding to an increase of 30% compared with that of the pure PZO thin films under the same electric field. Our study confirmed that adding NiO is an effective method to improve the energy storage performance of PZO thin films.

The maximum energy-storage densities and energy-storage efficiency of BLZT thin films, calculated from the P-E loops measured at the corresponding E<sub>BD</sub> values, are shown in Fig. 7 (c,d). Due to a high 3.8 MV/cm E<sub>BD</sub> value, an ultrahigh U<sub>reco</sub> value of about 72.2 J/cm<sup>3</sup> is achieved in the BL5ZT thin film.

Regarding the satisfactory energy storage density of NNO-0.1BHO thin film, its thermal stability, fatigue resistance and charging-discharging performance were studied further, which is important for practical application. Temperature-dependent P-E hysteresis loops were measured firstly and the values of W<sub>r</sub> and i were extracted, as shown in ...

Thus, an ultrahigh energy density, efficiency, and stability are realized in the DNP structure-designed self-assembled nanocomposite films, providing a promising pathway for thin-film microcapacitors with high ...

Remarkably, our Bi<sub>0.5</sub>Na<sub>0.5</sub>TiO<sub>3</sub>-based high-entropy thin film capacitor not only showcases

industry-leading energy storage properties at room temperature, with a recoverable energy storage density of  $103 \text{ J cm}^{-3}$ , but also extends its stable operating temperature range to an ultra-high level of  $320 \pm 176^\circ\text{C}$ . This innovative method paves the way ...

Here, we mainly investigated the enhanced energy storage properties of LBFO thin films with a La doping concentration exceeding 20 %. Download: Download high-res image (543KB) Download: Download full-size image; Fig. 1. (a) Schematic diagram of a La-doped  $\text{BiFeO}_3$  (LBFO) thin film deposited on a Nb:STO substrate. (b)  $\text{th-2th}$  scans of the LBFO ...

Polymer thin films operable under concurrent electric and thermal extremes represent critical building blocks of capacitive energy storage and electrical isolator for modern power and electronic systems with ever-increasing demands for power density and payload efficiency. ... This work uncovers a new method of achieving exceptional high ...

This work aims to correlate the yttrium concentration with the energy storage properties of YSZ thin films (nominally 100 nm), grown by ALD. The yttrium concentration was controlled throughout the ALD  $\text{ZrO}_2\text{:Y}_2\text{O}_3$  cycle ratio: 2:1, 4:1, 6:1, and 8:1. Optical, structural and chemical characterizations such as ultraviolet-visible spectroscopy (UV-Vis), reflection ...

Antiferroelectric film capacitors have attracted increasing attention due to their excellent energy storage properties. In this work,  $\text{PbZrO}_3$  (PZO) antiferroelectric films have been prepared on the flexible fluorophlogopite (Mica) and rigid  $\text{Pt/Ti/SiO}_2/\text{Si}$  substrates with a seed layer of  $\text{LaNiO}_3$  (LNO) layer by sol-gel process. The microstructure and energy storage ...

Here, by doping equimolar Zr, Hf and Sn into  $\text{Bi}_4\text{Ti}_3\text{O}_{12}$  thin films, a high-entropy stabilized  $\text{Bi}_2\text{Ti}_2\text{O}_7$  pyrochlore phase forms with an energy density of  $182 \text{ J cm}^{-3}$  and 78% efficiency ...

Electrochromic energy storage devices (EESDs) integrating optical modulation and energy storage are gaining attention for smart building applications. The  $\text{WO}_3$  thin films with a ...

Table 3 is a comparison with other dielectric thin film energy storage performance. In contrast, the multi-ion doped medium-entropy amorphous film with  $S = 1.37$  designed by entropy has excellent  $W_{\text{rec}}$ , breakdown field strength and efficiency. Download: Download high-res image (608KB)

Highest Performance Data Exemplars for Dielectric Energy Storage Systems of Different Materials, Including the Bulky BOPP, Perovskite Relaxor Ferroelectric (RFE) and Antiferroelectric (AFE) Thin Films, and Ferroelectric (FE) and AFE ...

Here, large recoverable energy storage density ( $66.8 \text{ J/cm}^3$ ) and high storage efficiency (85.1%) were achieved in the  $\text{BaBi}_4\text{Ti}_4\text{O}_{15}$  thin film via La doped. Such enhanced energy storage performances can attribute to the improvement of crystallization quality with increase of grain size and decrease of leakage

current.

The BCGZT thin film with  $x = 0.0075$  possesses an enhanced energy storage density of  $55.1 \text{ J/cm}^3$  and an acceptable energy storage efficiency of  $67.1 \%$  at the ultra-high breakdown field of  $4300 \text{ kV/cm}$ , which is promising for capacitor applications.

In this work,  $\text{SrTiO}_3/\text{BiFeO}_3/\text{SrTiO}_3$  (ST/nBF,  $n$  represents the different spin-coating number of BF layers) thin films were prepared via the sol-gel method. Nevertheless, the effect of the interface number on energy storage properties is a contentious issue. Some researchers reported that interfaces were beneficial for energy storage [24], while others ...

Thin-film coating has also been implemented in emerging battery technologies such as thin-film solid-state batteries and anode-free batteries, which offer new possibilities for the use of battery technologies in electronics.

High power and extended cycle life at high energy density are key benefits for energy storage, which can be achieved through adopting advanced high-energy electrode materials and novel architectures and manufacturing protocols to transform the current form of Li-ion battery and energy storage technology. Thin film processing is the promising ...

Metallized polymer films as current collectors represent interesting opportunities to increase both gravimetric and volumetric energy density while improving battery safety aspects and saving scarce resources compared to ...

Flexible ferroelectric films with high polarization hold great promise for energy storage and electrocaloric (EC) refrigeration. Herein, we fabricate a lead-free Mn-modified  $0.75 \text{ Bi}(\text{Mg}_{0.5}\text{Ti}_{0.5})\text{O}_3\text{-}0.25 \text{ BaTiO}_3$  (BMT-BTO) thin ...

$\text{PbZrO}_3$ -derived oxide thin film capacitors are promising for high efficiency and low loss dielectric energy storage applications. Topics Antiferroelectricity, Energy storage, Film capacitor, Dielectric properties, ...

Park, M. H. et al. Thin  $\text{Hf}_x\text{Zr}_{1-x}\text{O}_2$  films: a new lead-free system for electrostatic supercapacitors with large energy storage density and robust thermal stability. Adv. Energy Mater. 4 ...

In this work, an exceptional room-temperature energy storage performance with  $W_r \sim 86 \text{ J cm}^{-3}$ ,  $\eta \sim 81\%$  is obtained under a moderate electric field of  $1.7 \text{ MV cm}^{-1}$  in  $0.94(\text{Bi}, \text{Na})\text{TiO}_3\text{-}0.06\text{BaTiO}_3$  (BNBT) thin films composed of super ...

The  $\text{Pb}(\text{Zr}_{0.92}\text{Li}_{0.08})\text{O}_3$  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.

Web: <https://www.eastcoastpower.co.za>

