Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supporting information

Novel lead-free and high-performance barium strontium titanate-based thin film capacitor with ultrahigh energy storage density and giant power density

Yuzhu Fan, [a,d] Zhiyong Zhou, [a,*] Ying Chen, [a] Wei Huang, [a] and Xianlin Dong [a,b,c,*]

[a] Key Laboratory of Inorganic Functional Materials and Devices, Shanghai Institute of Ceramics, Chinese Academy of Sciences, Shanghai 200050, People's Republic of China

[b] Center of Materials Science and Optoelectronics Engineering, University of Chinese Academy of Sciences, Beijing 100049, People's Republic of China

[c] The State Key Lab of High Performance Ceramics and Superfine Microstructure Shanghai Institute of Ceramics, Chinese Academy of Sciences, 1295 Dingxi Road, Shanghai 200050, People's Republic of China

[d] University of Chinese Academy of Sciences, Beijing 100049, China

Corresponding Authors

*E-mail: **xldong@mail.sic.ac.cn**

*E-mail: **zyzhou@mail.sic.ac.cn**

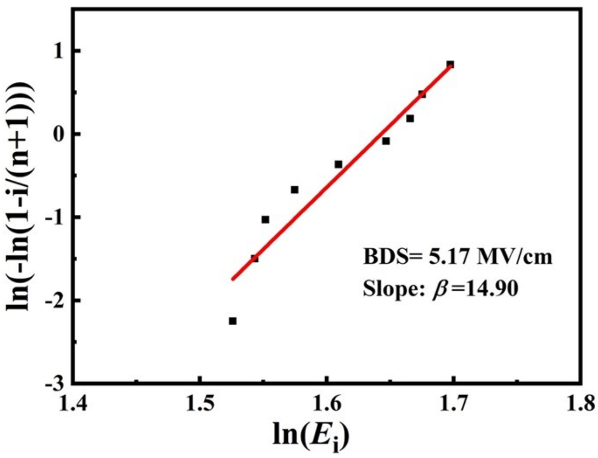

Figure S1. Linear fitting for breakdown strength of Weibull distribution for the BST-BMN thin films.

As shown in Fig. S1, the Weibull distribution function is employed to obtain the value of breakdown strength (BDS). Two key parameters of the Wei-bull distribution X_i and Y_i are calculated from formulas below:

$$X_i = \ln(E_i) \tag{1}$$

$$Y_i = \ln(-\ln(1-i/(1+n))) \tag{2}$$

Where i presents the serial number of different specimens, n denotes the total number of specimens. E_i reflects the specific BDS of each specimen. The order of different samples is determined by the value of its BDS:

$$E_1 \le E_2 \ldots\ldots \le E_i \ldots\ldots \le E_n.$$

As shown in Fig. S1, the linear relationship between X_i and Y_i can be obtained, the calculated E_b and β are 5170 kV cm^{-1} and 14.90, respectively. The fitted value of BDS is superior to many other lead-free thin film systems,[1] which is conducive to the energy storage performances of the BST-BMN thin film capacitors.

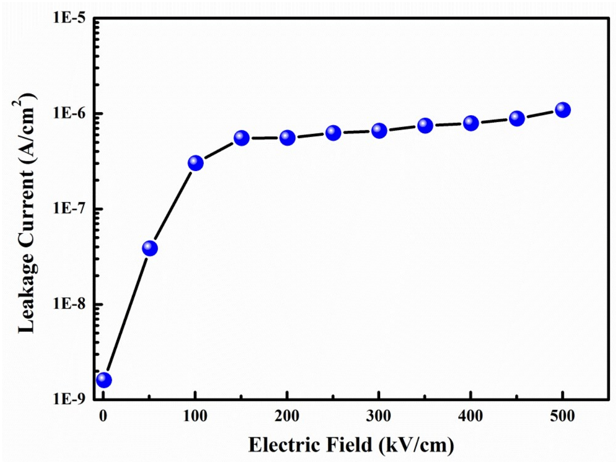

Figure S2. Leakage current density of the BST-BMN films as a function of the electric field.

Fig. S2 shows the leakage current density of the BST-BMN films as a function of the electric field. The leakage current density was determined to be 1.6×10^{-9} A cm^{-2} and 1.0×10^{-6} A cm^{-2} under the electric field of 0 kV cm^{-1} and 500 kV cm^{-1} respectively, which were several orders of magnitude lower than those of undoped BST thin films at the same electric field.[2,3] The suppressed leakage current is conducive to the high BDS in the investigated thin films. [4,5]

References

1. H. Palneedi, M. Peddigari, G.-T. Hwang, D.-Y. Jeong and J. Ryu, *Adv. Funct. Mater.*, 2018, **28**, 1803665.
2. J. Qian, C. H. Yang, Y. J. Han, X. S. Sun and L. X. Chen, *Ceram. Int.*, 2018, **44**, 20808-20813.
3. J. Xie, H. Hao, Z. Yao, L. Zhang, Q. Xu, H. Liu and M. Cao, *Ceram. Int.*, 2018, **44**, 5867-5873.
4. W. Huang, Y. Chen, X. Li, G. Wang, N. Liu, S. Li, M. Zhou and X. Dong, *Appl. Phys. Lett.*, 2018, **113**, 203902.
5. Z. Yao, Z. Song, H. Hao, Z. Yu, M. Cao, S. Zhang, M. T. Lanagan and H. Liu, *Adv. Mater*, 2017, **29**.