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

Enhanced Electric Displacement Induce Large Energy Density in Polymer Nanocomposite Containing Core-Shell Structured $BaTiO_3$@TiO_2 Nanofibers

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Electronic supplementary information

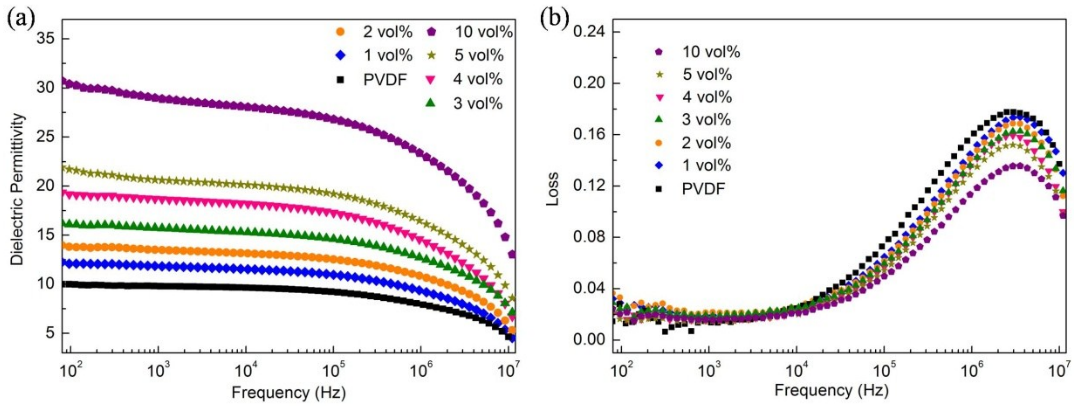

Fig. S1 Frequency-dependent dielectric (a) permittivities and (b) losses of BTO@TO-nf/PVDF nanocomposite films with different volume fraction of nanofillers.

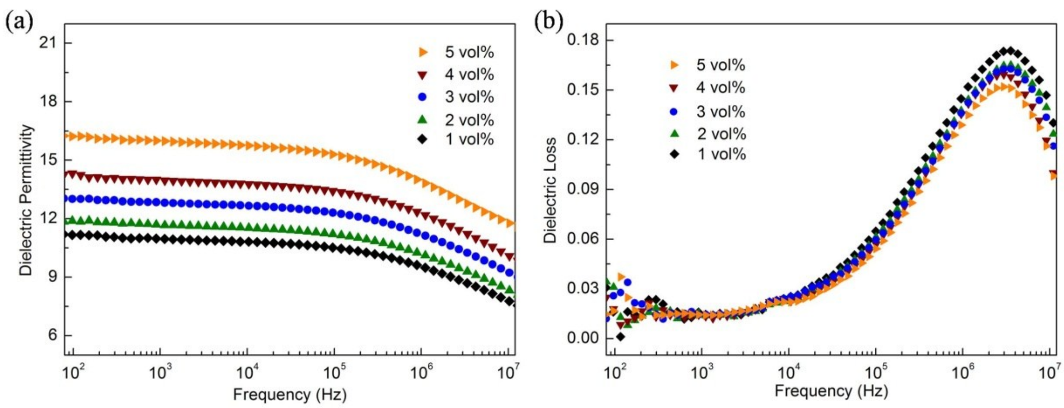

Fig. S2 Frequency-dependent dielectric (a) permittivities and (b) losses of BTO-nf/PVDF nanocomposite films with different volume fraction of nanofillers.

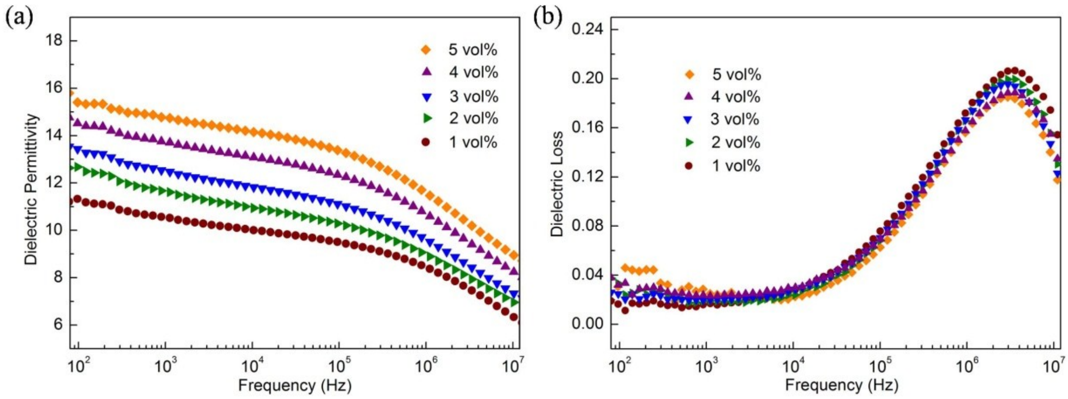

Fig. S3 Frequency-dependent dielectric (a) permittivities and (b) losses of TO-nf/PVDF nanocomposite films with different volume fraction of nanofillers.

Fig. S1~S3 show the frequency-dependent dielectric permittivities and the dielectric losses of the BTO@TO-nf/PVDF, BTO-nf/PVDF and TO-nf/PVDF nanocomposite films, respectively. The dielectric permittivity of the nanocomposites is increased with the loading of the nanofibers rising, and the decrease of the dielectric permittivities of the nanocomposites with increasing frequency is attributed to the reduction of the dipolar contribution at high frequency. The dielectric loss of the nanocomposites remains low at low frequency and shows a wide peak at high frequency as a result of the dielectric relaxation of the polymer matrix. The values of dielectric permittivities and losses at 1 kHz are comparatively exhibited in Fig 4a in the text.

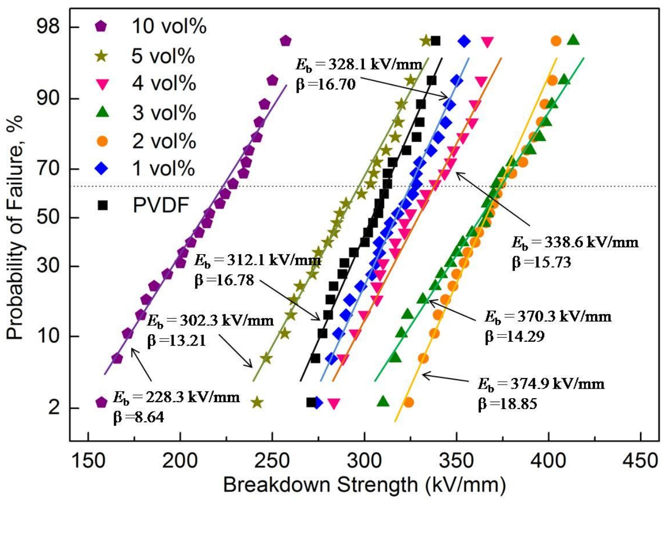

Fig. S4 Failure probability of dielectric breakdown of BTO@TO-nf/PVDF nanocomposite films with different volume fraction of nanofillers deduced from Weibull distribution.

As shown in Fig. S4, the electric breakdown strengths of the nanocomposite films were analyzed according to a two parameter Weibull distribution function[1,2]:

$$P(E) = 1 - \exp(-(E / E_b)\beta)$$

where $P(E)$ is the cumulative probability of electric failure, E is experimental breakdown electric field, E_b is a scale parameter refers to the breakdown strength at the cumulative failure probability of 63.2% which is regarded as the breakdown strength of the measured sample, and β is the Weibull modulus associated with the linear regressive fit of the distribution.

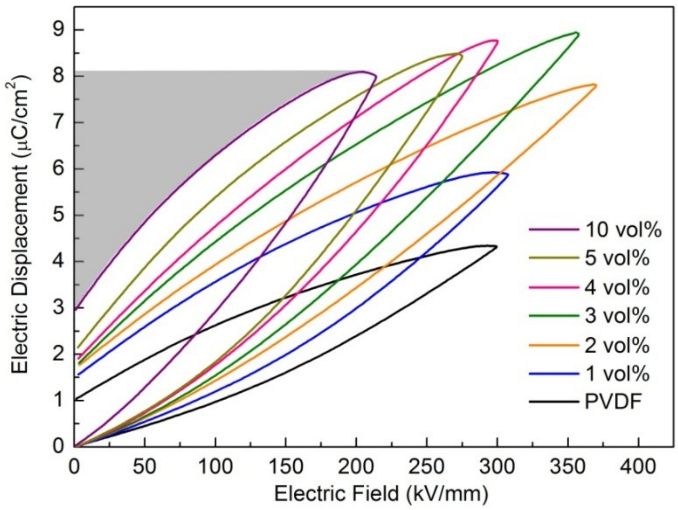

Fig. S5 Unipolar *D-E* loops of BTO@TO-nf/PVDF nanocomposite films with different volume fraction of nanofillers.

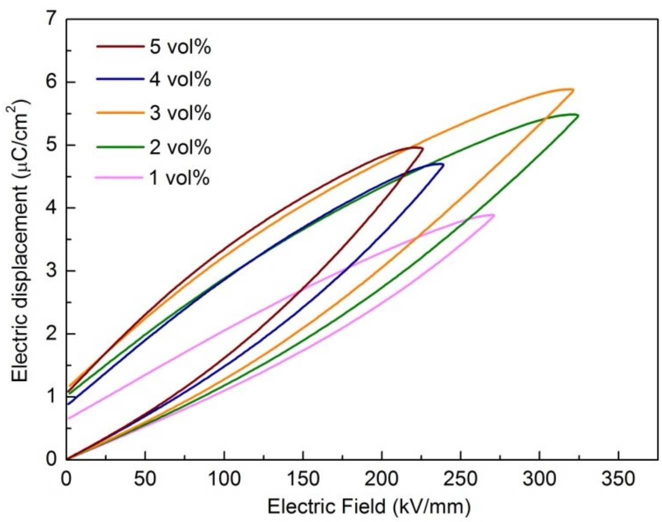

Fig. S6 Unipolar *D-E* loops of BTO-nf/PVDF nanocomposite films with different volume fraction of nanofillers.

Fig. S5 and S6 represent the unipolar dielectric displacement-electric field loops of BTO@TO-nf/PVDF and BTO-nf/PVDF nanocomposite films, respectively, where the shaded area in Fig. S5 enclosed by the curve and the *y* axis reveals the discharged energy density of the sample. Listed in Table S1 are the values of the dielectric permittivity at 1 kHz, the electric displacement measured at 200 kV·mm^{-1}, the breakdown strength and the discharged energy density calculated from the *D*-*E* loops shown in Fig. S5.

Table S1 Dielectric permittivity, electric displacement, breakdown strength and discharged energy density of BTO@TO-nf/PVDF nanocomposite films with different BTO@TO-nf loadings.

Content	ε [a)]	D [b)] (μC·cm^{-2})	E_b (kV·mm^{-1})	Discharged U_e (J·cm^{-3})	Energy efficiency (%)
PVDF	9.8	2.39	312.1	4.31	0.50766
1 vol%	11.8	2.99	328.1	5.18	0.47874
2 vol%	13.5	3.43	374.9	9.51	0.57812
3 vol%	15.7	3.95	370.3	10.94	0.58976
4 vol%	18.9	4.68	338.6	8.91	0.56392
5 vol%	20.6	5.13	302.3	6.82	0.4868
10 vol%	28.9	7.19	228.3	3.95	0.40306

a) the values are at 1 kHz; b) the values are measured at 200 kV mm^{-1}

Reference

1 V. Tomer, E. Manias, C. A. Randall, *J. Appl. Phys.* **2011**, *110*, 044107.

2 S. P. Fillery, H. Koerner, L. Drummy, E. Dunkerley, M. F. Durstock, D. F. Schmidt, R. A. Vaia, *ACS Appl. Mater. Interfaces* **2012**, *4*, 1388.