Electronic Supplementary Information

Ultra-high Discharged Energy Density Capacitor using High Aspect Ratio $Na_{0.5}Bi_{0.5}TiO_3$ Nanofibers

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Electronic supplementary information (ESI) available.

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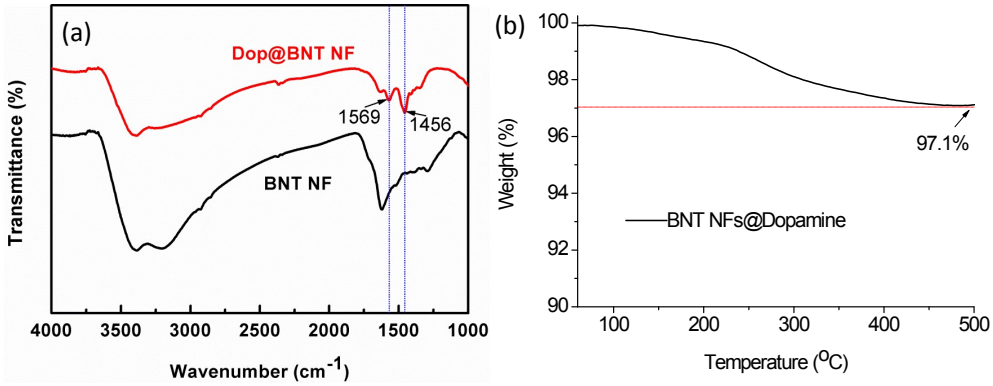

Figure S1 (a) FT-IR spectra of dopamine modified and pristine BNT nanofibres (NFs). It can be seen that two new peaks were formed after the BNT NFs were modified by dopamine; the peaks at 1456 and 1569 cm^{-1} originate from $–NH_3^+$ deformation and amide band, NH bending, respectively.[1] (b) TGA curve of BNT NFs@Dopamine.

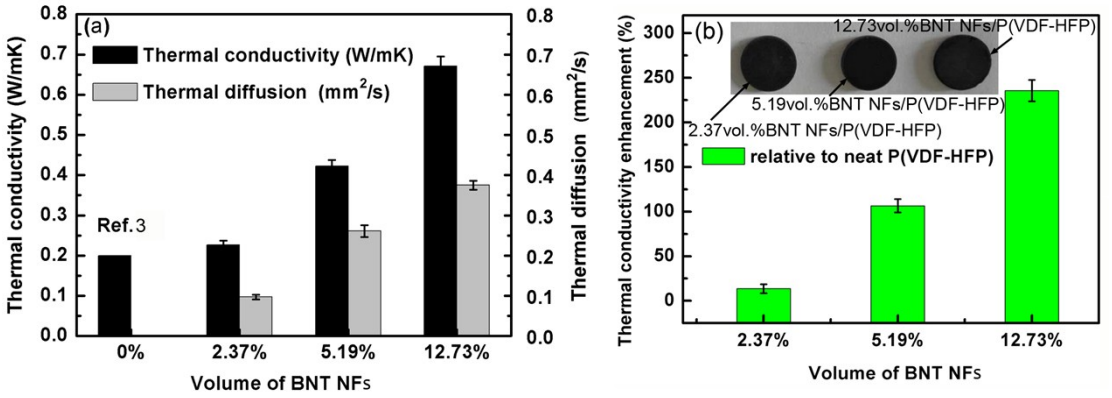

Figure S2 (a) Thermal conductivity and thermal diffusion, and (b) Thermal conductivity enhancement of the BNT nanofiber/P(VDF-HFP) composites with filler loading, a photo of the samples is shown in the insert. The room temperature thermal conductivity of the pure P(VDF-HFP) is approximately 0.2 W m^{-1} K^{-1}, as previously reported.[2] It is clear that the thermal conductivity of the composites depends on the BNT nanofiber loading, which increases with the degree of loading; a similar phenomenon is exhibited with respect to thermal diffusion. For example, the thermal conductivity of the nanocomposite with 12.73 vol% BNT nanofibers increased to 0.67 W m^{-1} K^{-1}, which increased by more than two times compared to the pure P(VDF-HFP) matrix. The enhancement of thermal conductivity is shown in Figure S5b, and the insert shows the test sample of the BNT nanofiber/P(VDF-HFP) composites. The increased thermal conductivity and thermal diffusion is attributed to the high thermal conductivity and thermal diffusion of the BNT nanofiber phase and the homogeneous dispersion of BNT nanofiber

in the polymer matrix as well as the high density achieved via hot pressing.

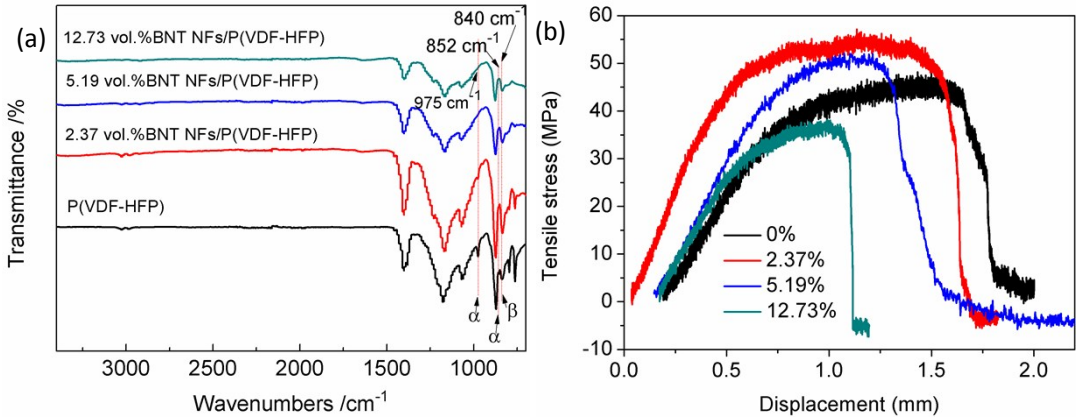

Figure S3 (a) FT-IR spectra of the P(VDF-HFP) nanocomposites with different BNT NFs loadings, (b) The tensile stress-displacement curve of BNT Nanofibers/P(VDF-HFP) nanocomposites with BNT loading level in vol.%.

Table S1 Characteristic breakdown strength and shape factor of the breakdown strength data for the samples

Sample (BNT vol.%)	β	E_0 (kV/mm)
0	8.24	397
2.37	4.30	458
5.19	5.50	337
12.73	5.96	302

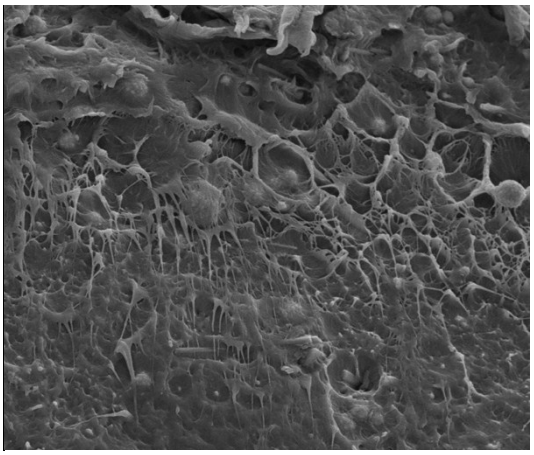

Figure S4 Cross-sectional SEM image of BNT nanofiber/P(VDF-HFP) composites. BNT nanofibres were aligned to the direction of the nanocomposite film, which was perpendicular to the direction of the electric field.

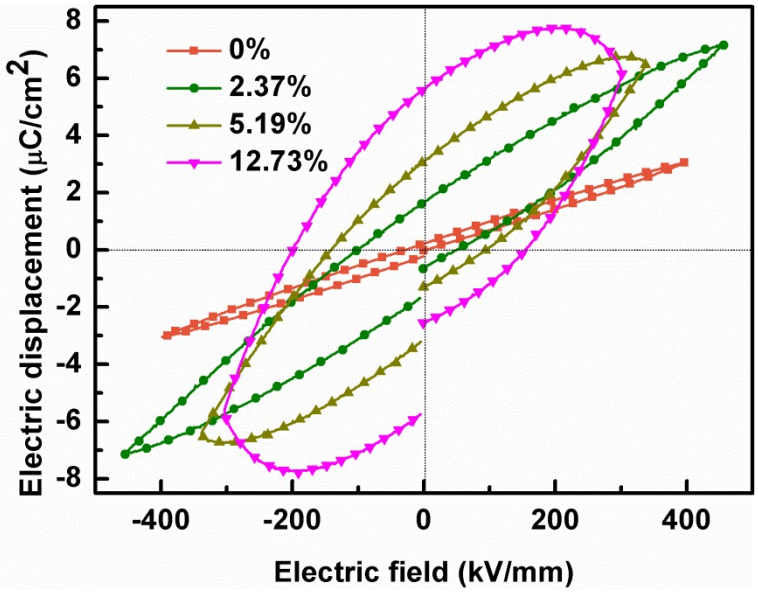

Figure S5 D-E loops of the BNT nanofiber/P(VDF-HFP) nanocomposites with various filler loadings at the maximum electric field. The saturated polarization was continuously increased with the BNT nanofiber content, while the remanent polarization showed a faster increase trend than saturated polarization of the nanocomposite with 12.73 vol% BNT NFs.

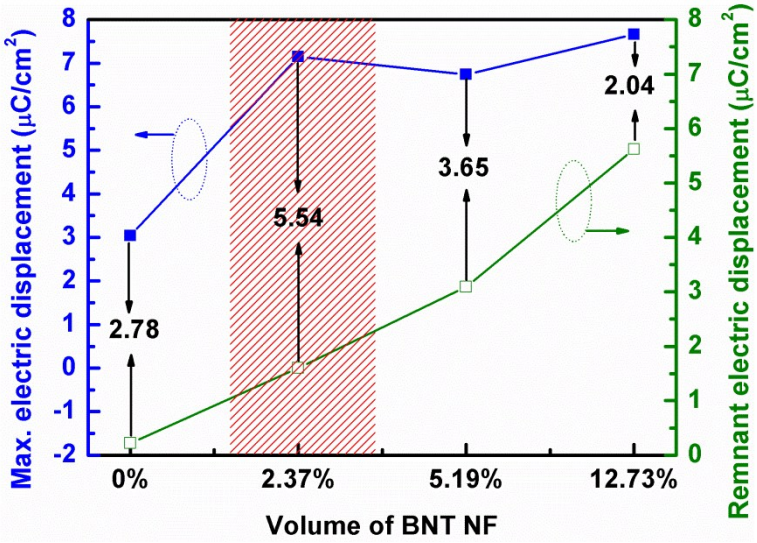

Figure S6 Max. and remnant electric displacement of the BNT nanofiber/P(VDF-HFP) nanocomposites with various filler loadings at the largest electric field.

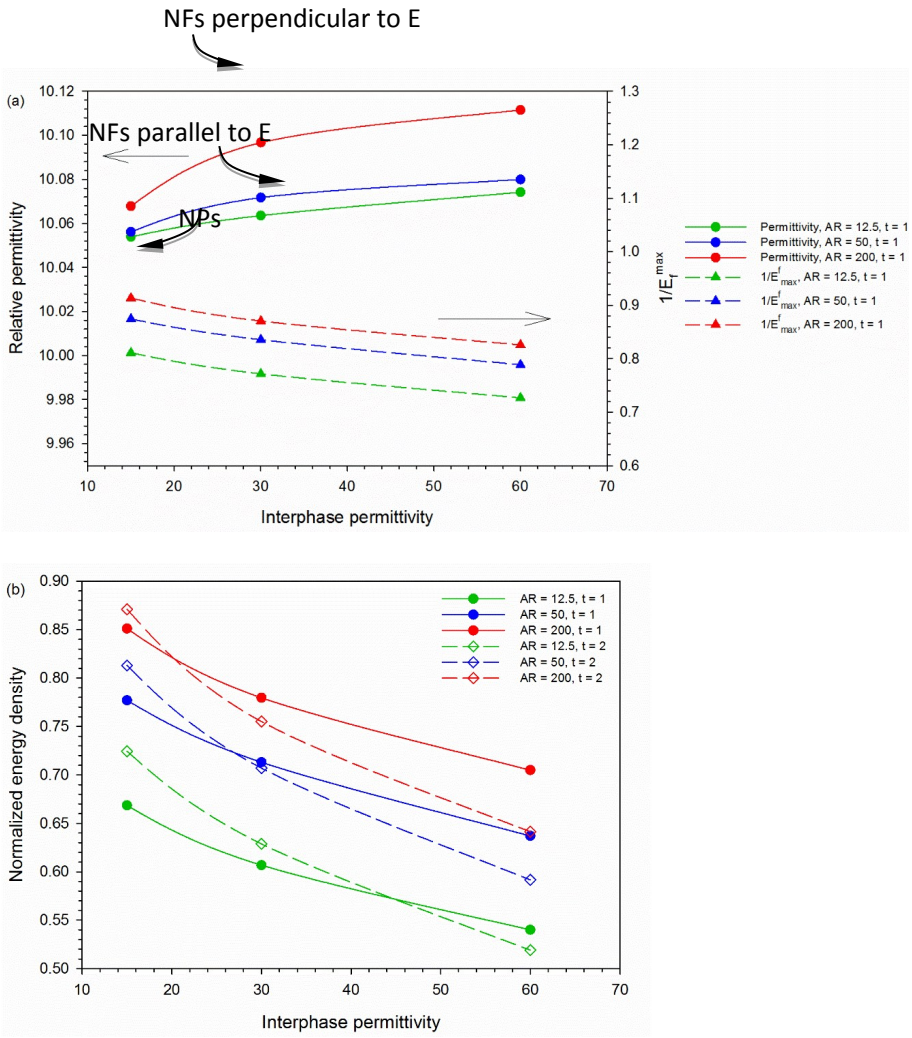

Figure S7 (a) Effect of interphase permittivity (solid line, left axis) and electric field concentration factor, $1/E_f^{max}$ (dashed line, right axis), on relative permittivity of composite for constant interlayer thickness (t = 1), varying aspect ratio (AR =15, 50, 200); (b) effect of interphase permittivity on normalized energy density for interlayer thickness t = 1 (solid lines) and t = 2 (dashed lines) for varying aspect ratio (AR =15, 50, 200) of high permittivity phase. Increasing the permittivity of the interphase past ε_r=15 is detrimental in terms of energy storage properties due to an increase in

electric field concentration.

Reference:

1 V. KumaráThakur, E. JináTan, P. SeeáLee, *RSC Adv.*, 2011, 1, 576

2 Y. Li, X. Huang, Z. Hu, P. Jiang, S. Li and T. Tanaka, *ACS Appl. Mater. Interfaces*, 2011, 3, 4396.

3 X. Huang, T. Iizuka, P. Jiang, Y. Ohki and T. Tanaka, J. Phys. Chem. C, 2012, 116, 13629.