†Electronic Supporting Information (ESI)

Electrospun Polarity Controlled Molecular Orientation for Synergistic Performance of Artifact Free Piezoelectric Anisotropic Sensor†

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Discussion D1: Estimating the value of dichroic ratio (R), minimum fraction of completely oriented dipoles (f_m) and range of angle δ formed by their long axis with transition dipole moment vector.[1,2]

$$R = \frac{\Delta A_{parallel}}{\Delta A_{perpendicular}} \quad (1)$$

$$if\ R > 1{:}0\ \cot^{-1}\left(\sqrt{R}/2\right); f_m = \frac{R-1}{R+2} \quad (2)$$

$$if\ R < 1{:}\cot^{-1}\left(\frac{\sqrt{R}}{2}\right) \le \delta \le 90°; f_m = \frac{2(1-R)}{R+2} \quad (3)$$

Table S1. Variation of the dichroic ratio (R), the minimum fraction of completely oriented dipoles (f_m) and range of angle δ formed by their long axis with transition dipole moment vector for corresponding vibrational modes attached to the wavenumber in positive and negative electrospinning aligned and random fibers of P(VDF-CTFE).[3]

Fiber	υ (cm^{-1})	approximate normal mode assignment	R	f_m	Estimated α interval
PACF	1430	δ (CH_2) – w (CH_2)	0.45	0.447	71.43° < α < 90°
PACF	1402	w (CH_2) + ν_s (CC)	2.24	0.292	0° < α < 53.18°
PACF	1280	ν_s (CF_2) + ν_s (CC) + δ (CCC)	0.64	0.270	68.16° < α < 90°
PACF	1182	ν_{as} (CF_2) + ρ (CF_2) + ρ (CH_2)	1.02	0.008	0° < α < 63.16°
PACF	1073	ν_{as} (CC) + w (CF_2) + w (CH_2)	2.09	0.267	0° < α < 54.11°
PACF	883	ρ (CH_2) + ν_{as} (CF_2) + ρ (CF_2)	0.91	0.061	64.48° < α < 90°
PACF	841	ν_s (CF_2) + ν_s (CC)	0.78	0.157	66.15° < α < 90°
PRCF	1430	δ (CH_2) – w (CH_2)	0.98	0.010	63.61° < α < 90°
PRCF	1402	w (CH_2) + ν_s (CC)	1.01	0.003	0° < α < 63.30°
PRCF	1280	ν_s (CF_2) + ν_s (CC) + δ (CCC)	0.95	0.033	64.01° < α < 90°
PRCF	1182	ν_{as} (CF_2) + ρ (CF_2) + ρ (CH_2)	0.97	0.018	63.75° < α < 90°
PRCF	1073	ν_{as} (CC) + w (CF_2) + w (CH_2)	0.99	0.002	63.45° < α < 90°
PRCF	883	ρ (CH_2) + ν_{as} (CF_2) + ρ (CF_2)	0.95	0.027	63.90° < α < 90°
PRCF	841	ν_s (CF_2) + ν_s (CC)	0.96	0.021	63.61° < α < 90°
NACF	1430	δ (CH_2) – w (CH_2)	0.24	0.679	76.24° < α < 90°
NACF	1402	w (CH_2) + ν_s (CC)	2.33	0.307	0° < α < 52.63°
NACF	1280	ν_s (CF_2) + ν_s (CC) + δ (CCC)	0.75	0.178	66.51° < α < 90°
NACF	1182	ν_{as} (CF_2) + ρ (CF_2) + ρ (CH_2)	1.04	0.013	0° < α < 62.99°
NACF	1073	ν_{as} (CC) + w (CF_2) + w (CH_2)	2.01	0.252	0° < α < 54.63°
NACF	883	ρ (CH_2) + ν_{as} (CF_2) + ρ (CF_2)	0.92	0.052	64.34° < α < 90°
NACF	841	ν_s (CF_2) + ν_s (CC)	0.93	0.049	63.57° < α < 90°
NRCF	1430	δ (CH_2) – w (CH_2)	0.98	0.008	64.28° < α < 90°
NRCF	1402	w (CH_2) + ν_s (CC)	0.92	0.056	64.40° < α < 90°
NRCF	1280	ν_s (CF_2) + ν_s (CC) + δ (CCC)	1.02	0.007	0° < α < 63.52°
NRCF	1182	ν_{as} (CF_2) + ρ (CF_2) + ρ (CH_2)	0.99	0.005	63.43° < α < 90°
NRCF	1073	ν_{as} (CC) + w (CF_2) + w (CH_2)	0.91	0.058	63.35° < α < 90°
NRCF	883	ρ (CH_2) + ν_{as} (CF_2) + ρ (CF_2)	1.01	0.002	0° < α < 63.55°
NRCF	841	ν_s (CF_2) + ν_s (CC)	0.98	0.007	63.57° < α < 90°

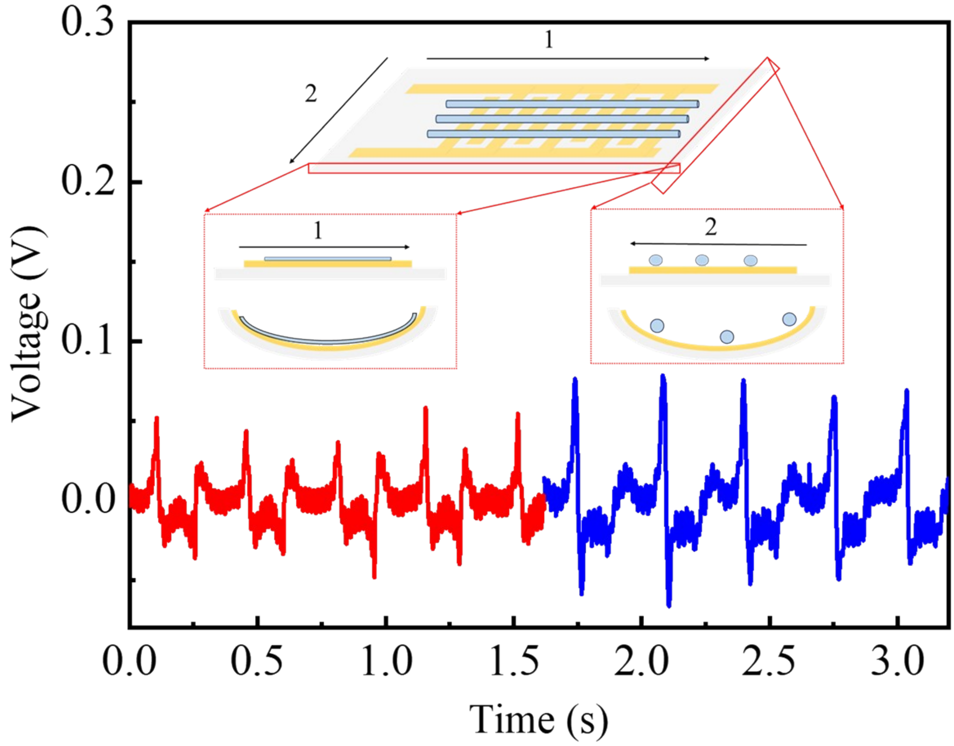

Figure S1. Voltage vs time response under different bending modes (bending angle 60o) to investigate the lateral anisotropy with insets describing the corresponding bending along 1 and 2 axes.

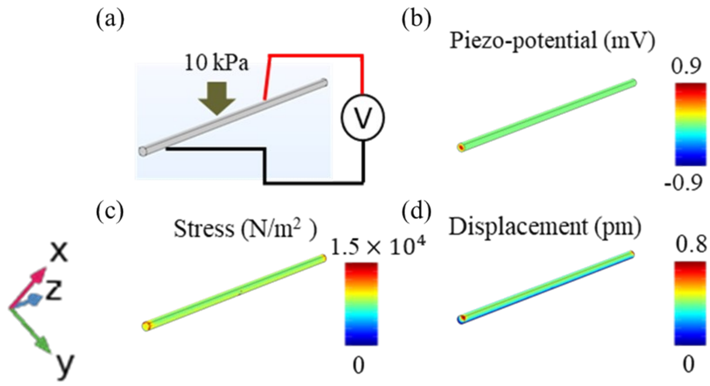

Figure S2. Finite element analysis (a) describing d_{32} mode fiber under stress with corresponding (b) piezo-potential, (c) distribution of stress and (d) displacement generated in the fiber.

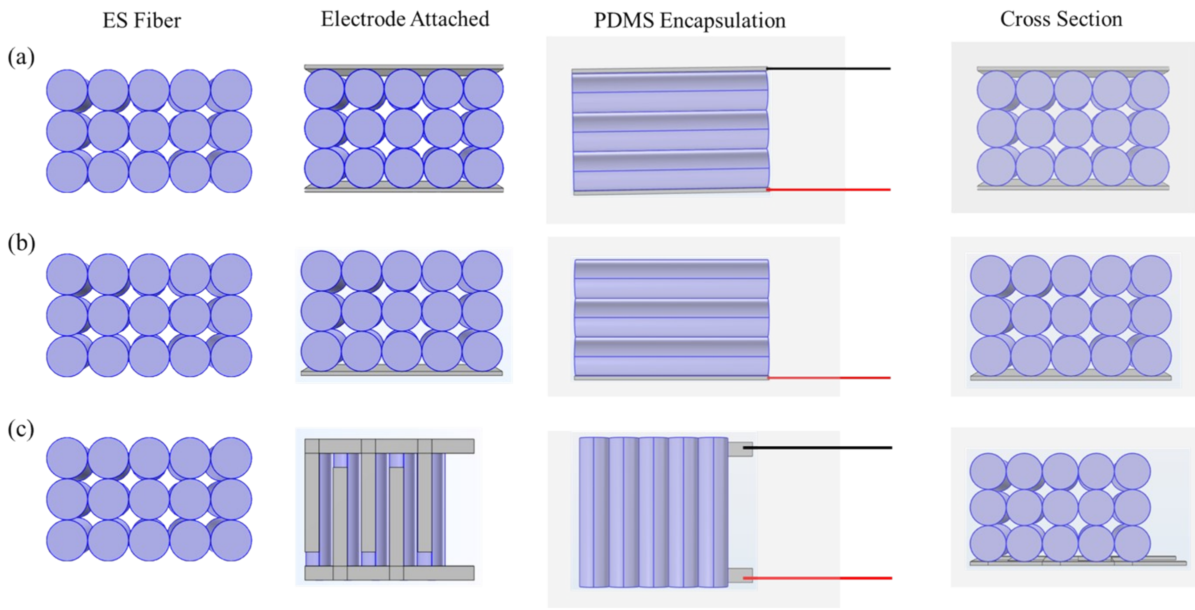

Figure S3. Schematic of the step-wise device fabrication for (a) ferroelectret, (b) triboelectric and (c) piezoelectric signal measurement. In particular, three principal steps of fabrication, viz., ES fiber arrangement, electrode attachment and PDMS encapsulation are shown. In each, the cross-section views are also illustrated to demonstrate three different types of devices, viz., ferroelectret, triboelectric and piezoelectric sensors.

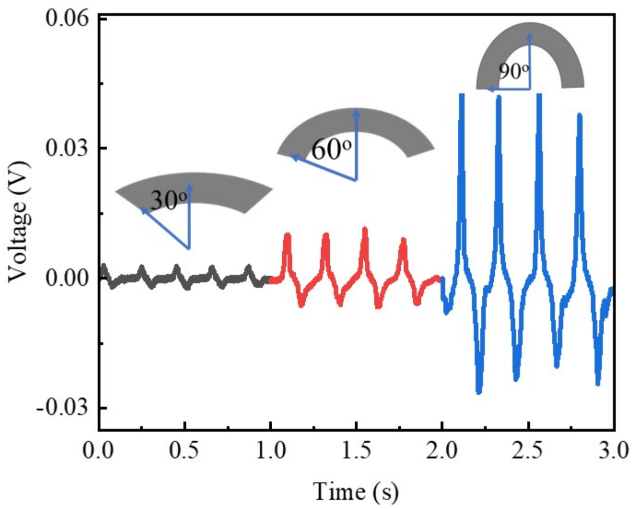

Figure S4. PENG response under different bending angles of 30°, 60° and 90°. The schematics of corresponding bending angles are shown in the inset.

References:

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3. Wang, Z.; Sun, B.; Lu, X.; Wang, C.; Su, Z., Molecular orientation in individualelectrospun nanofibers studied by polarized AFM–IR. *Macromolecules* **2019**, *52*, 9639 9645.