

Supporting Information

Robust Mechanical-to-electrical Energy Conversion from Short-distance Electrospun Poly(vinylidene fluoride) Fiber Webs

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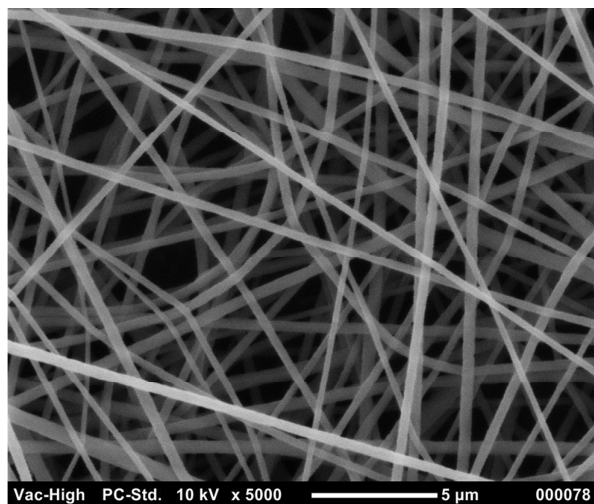


Figure S1. SEM image of separated fibers prepared by a conventional electrospinning (spinning distance 15 cm, applied voltage 15 kV).

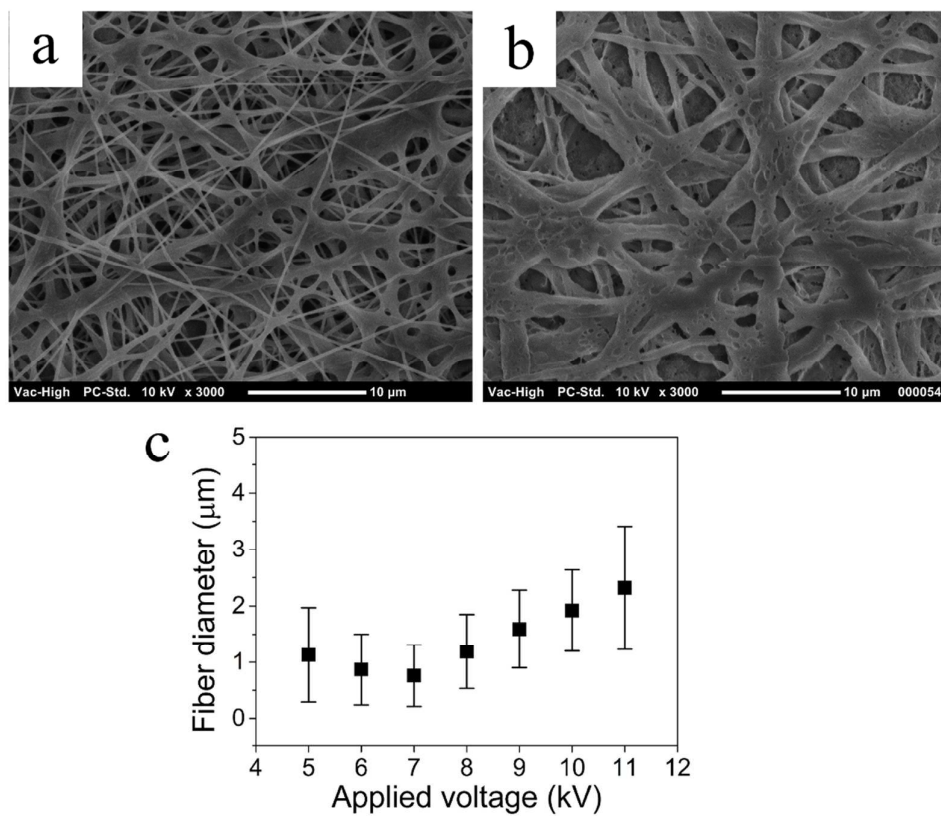


Figure S2. SEM images of PVDF interconnected fibers obtained from (a) 7 kV and (b) 9 kV. (c) Effect of applied voltage on fiber diameter (spinning distance 2 cm).

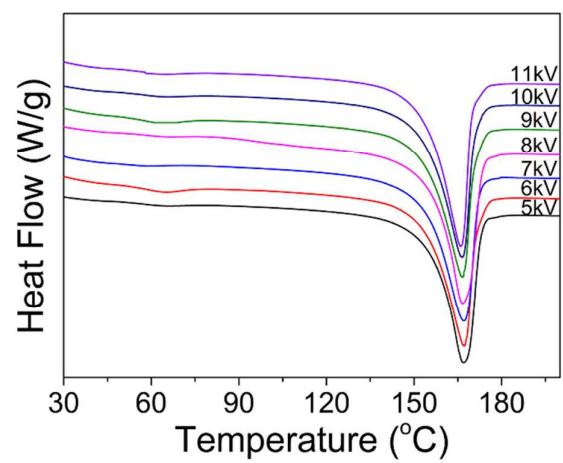


Figure S3. DSC results of PVDF webs prepared from at different applied voltages (spinning distance 2 cm).

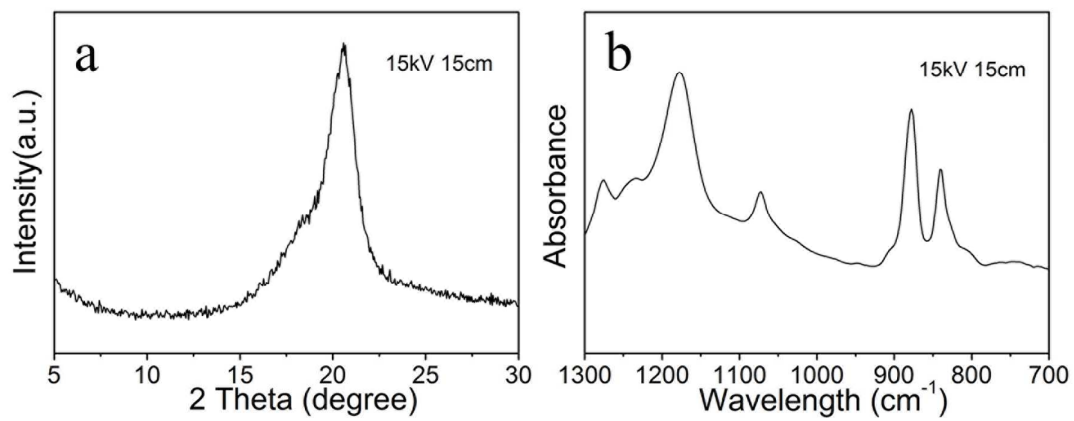


Figure S4. (a) XRD and (b) FTIR results of separated fibers (spinning distance 15 cm, applied voltage 15 kV).

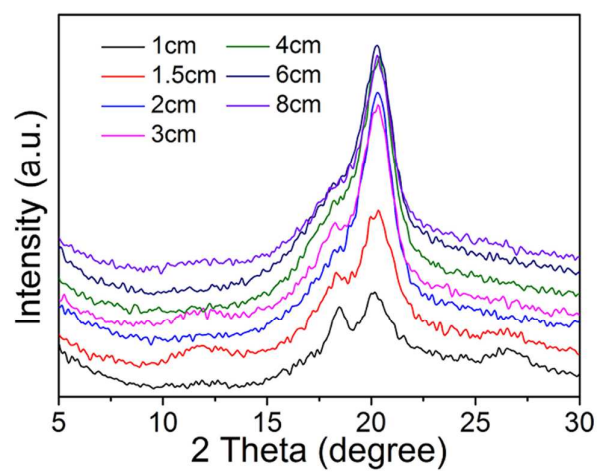


Figure S5. XRD pattern of PVDF webs prepared at different spinning distances (applied voltage 7 kV).

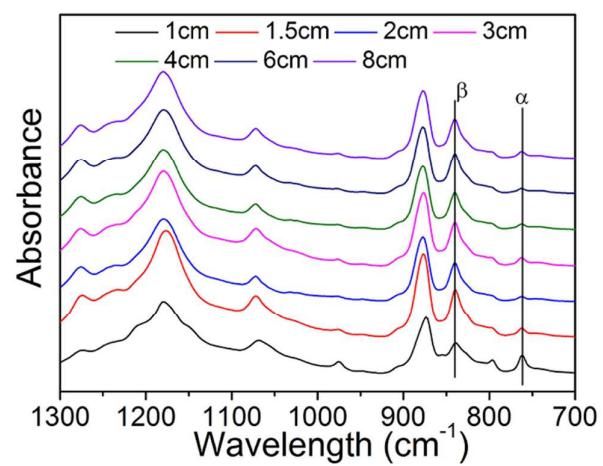


Figure S6. FTIR results of PVDF webs prepared at different spinning distances (applied voltage 7 kV).

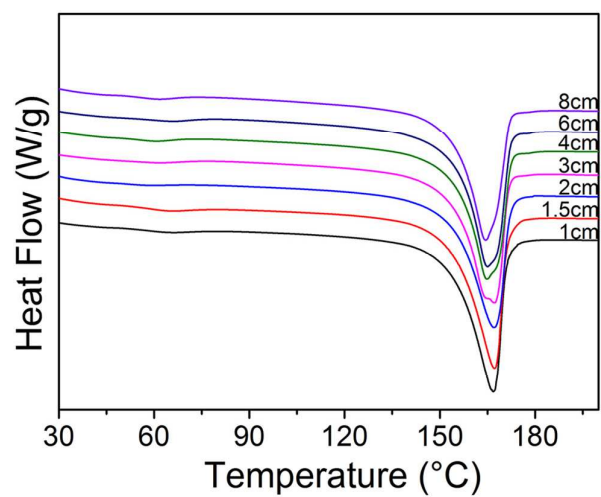


Figure S7. DSC results of PVDF films prepared at different spinning distances (applied voltage 7 kV).

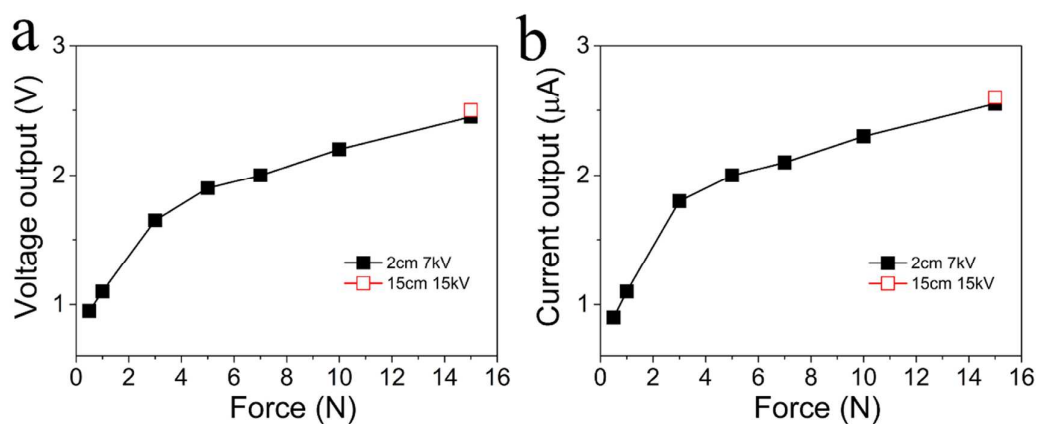


Figure S8. The dependence of (a) voltage and (b) current outputs on the compressive forces. (Web thickness 100 μm , working area 4 cm^2)

Under compression, the PVDF fiber webs underwent two types of deformation, compression of web and elastic deformation of compressed fiber web. When the compressive force was less than 4.0 N, the electric outputs went up rapidly with increasing compressive force, which was contributable to the compression of fibrous structure. Once the web structure is fully compressed, further increasing the compressive force led to elastic deformation of the compressed fiber web.

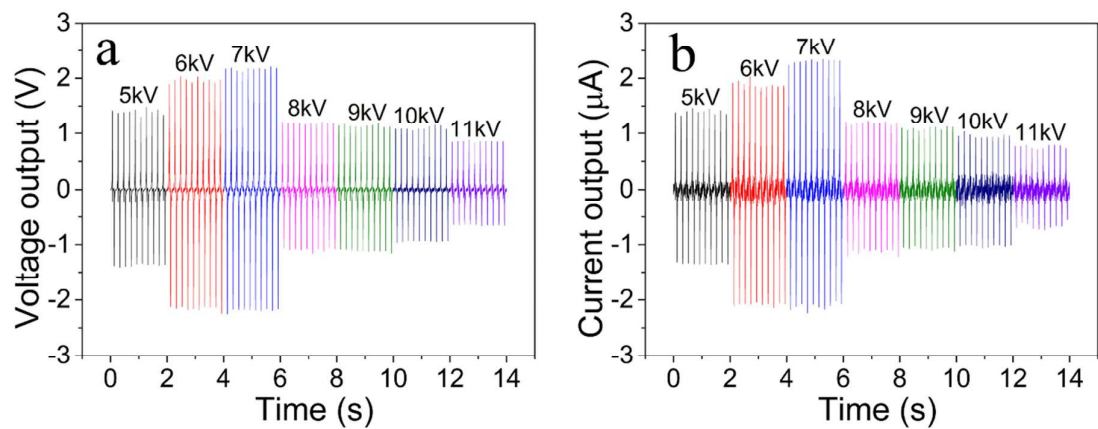


Figure S9. (a) Voltage and (b) current outputs of short-distance electrospun PVDF webs prepared at different applied voltages (spinning distance 2 cm). (Web thickness 100 μm , working area 4 cm^2)

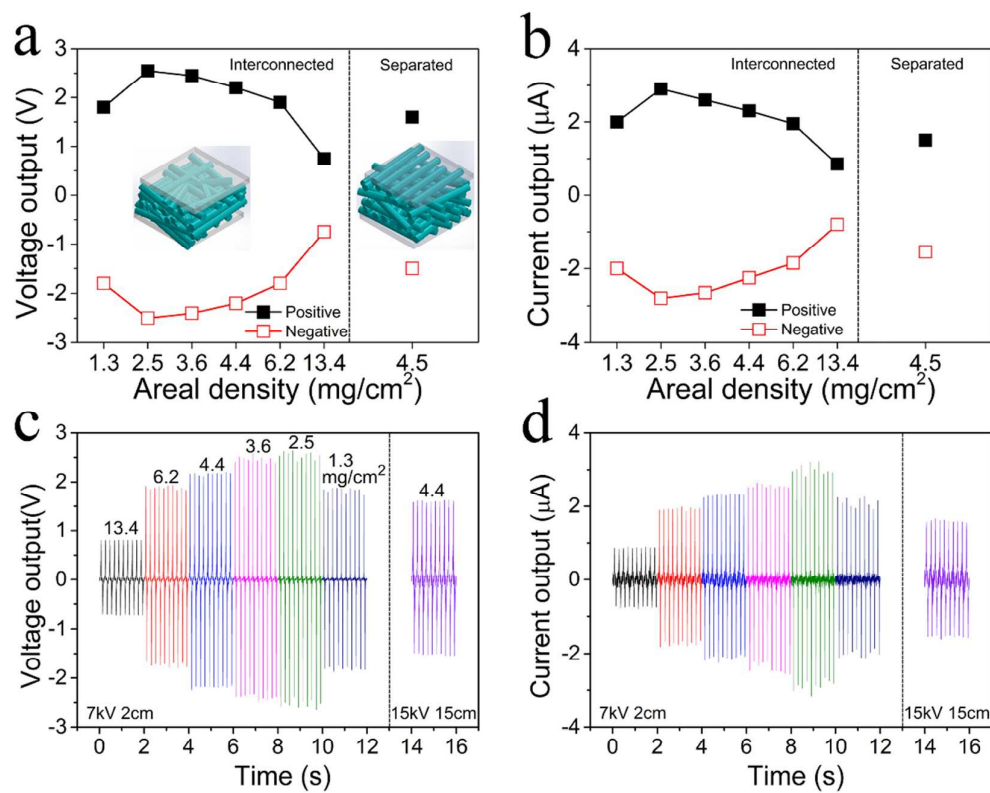


Figure S10. (a) Voltage and (b) current outputs of PVDF webs with different areal densities, (c) voltage and (d) current output signals with different areal densities. (Working area 4 cm²)

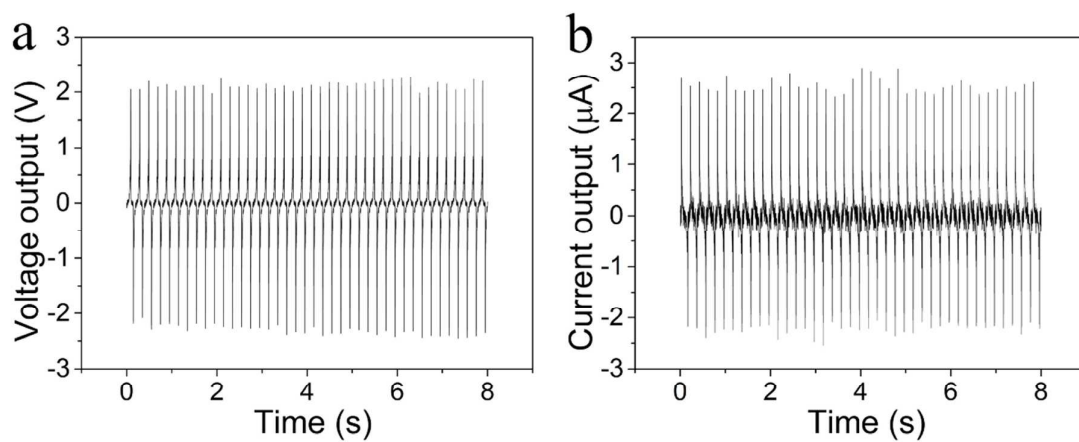


Figure S11. (a) Voltage and (b) current output of PVDF nanofibre web prepared from conventional electrospinning (applied voltage 15 kV, spinning distance 15 cm). (Web thickness 100 μm , working area 4 cm^2)

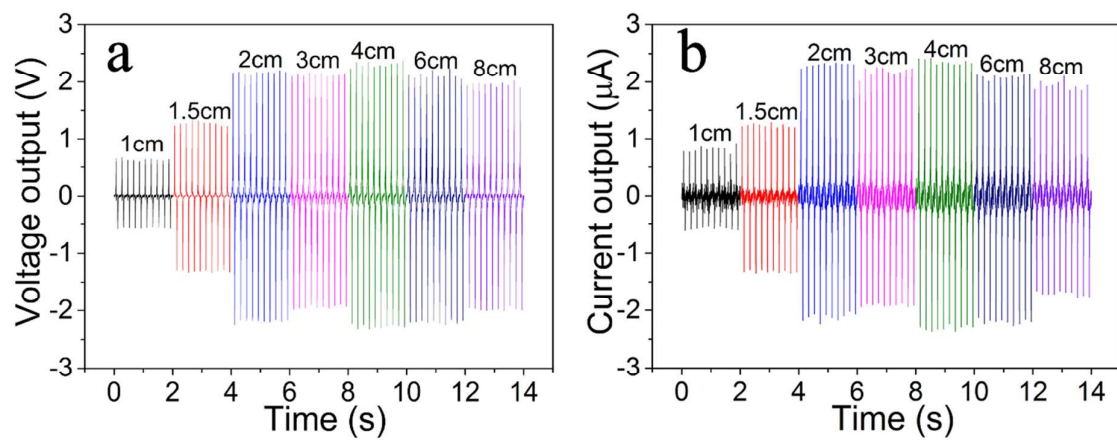


Figure S12. (a) Voltage and (b) current outputs of short distance electrospun PVDF webs prepared at different spinning distances (applied voltage 7 kV). (Web thickness 100 μm , working area is 4 cm^2)

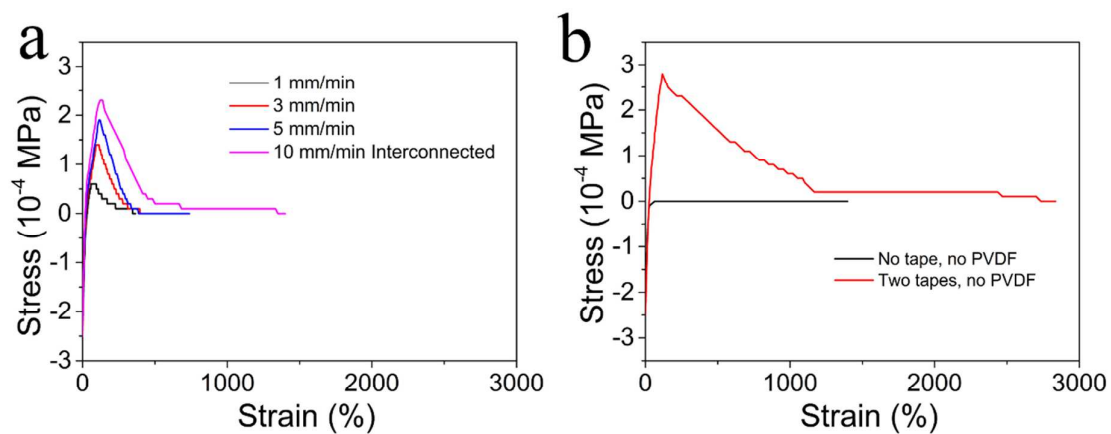


Figure S13. Delamination resistance of (a) the PVDF interconnected webs and (b) two layer double-side stick tapes and direct contact between top and bottom load without any tape or PVDF web in between.

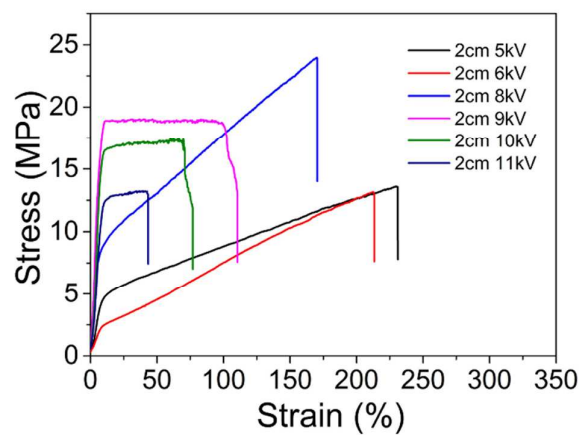


Figure S14. Stress-strain curves of short-distance electrospun PVDF webs prepared at different applied voltages (spinning distance 2 cm).

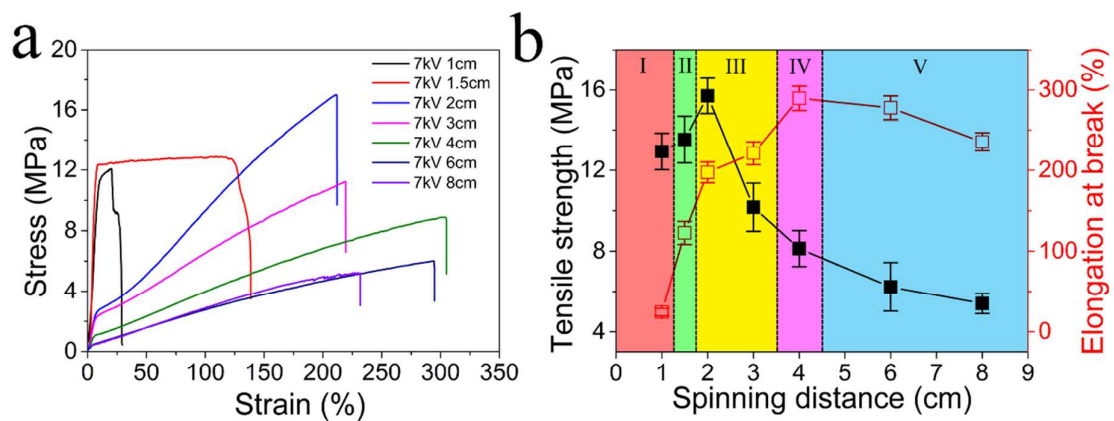


Figure S15. (a) Stress-strain curves of short-distance electrospun PVDF webs prepared at different spinning distances and (b) effect of spinning distance on tensile properties (applied voltage 7 kV).

Calculation of β phase content and crystallinity:

The amount of β phase in these samples was calculated according to

$$F(\beta) = X_{\beta} / (X_{\alpha} + X_{\beta}) = A_{\beta} / [(K_{\beta} / K_{\alpha}) A_{\alpha} + A_{\beta}] \quad (1)$$

Here, $F(\beta)$ means the β phase content while A_{α} and A_{β} represent the absorbance at 761 and 840 cm^{-1} , respectively. K_{α} and K_{β} are the absorption coefficients at the respective wavenumber which are 6.1×10^4 and $7.7 \times 10^4 \text{ cm}^2/\text{mol}$ in values¹⁻³.

The degree of crystallinity (ΔX_c) of each sample was calculated by using the equation^{1,4}:

$$\Delta X_c = \Delta X_m / \Delta X_{100} \quad (2)$$

Here, ΔX_m is the melting enthalpy of the sample and ΔX_{100} represents the melting enthalpy of a 100% crystalline sample. For the samples which contain α and β phase PVDF, equation can be written in the following way:

$$\Delta X_c = \Delta X_m / (x \Delta X_{\alpha} + y \Delta X_{\beta}) \quad (3)$$

The coefficient of x and y indicate the α and β phase content while ΔX_{α} and ΔX_{β} are the melting enthalpy of a 100% crystalline sample in the α and β phase. The value of ΔX_{α} is 93.07 J/g while ΔX_{β} is 103.4 J/g, respectively.

References

- (S1) Lanceros-Mendez, S.; Mano, J.; Costa, A.; Schmidt, V. FTIR and DSC Studies of Mechanically Deformed β -PVDF Films. *J. Macromol. Sci., Phys.* **2001**, *40*, 517-527.
- (S2) Benz, M.; Euler, W. B. Determination of the Crystalline Phases of Poly (vinylidene fluoride) Under Different Preparation Conditions Using Differential Scanning Calorimetry and Infrared Spectroscopy. *J. Appl. Polym. Sci.* **2003**, *89*, 1093-1100.
- (S3) Branciforti, M. C.; Sencadas, V.; Lanceros - Mendez, S.; Gregorio, R. New Technique of Processing Highly Oriented Poly (vinylidene fluoride) Films Exclusively in the β Phase. *J. Polym. Sci., Part B: Polym. Phys.* **2007**, *45*, 2793-2801.
- (S4) Garcia, I. T.; Samios, D. Thermomechanical Behaviour of Semicrystalline Polymers Submitted to Plane-Strain Compression. *Polymer* **1998**, *39*, 2563-2569.

Video S1: Decompression process of interconnected fiber web (spinning distance 2 cm, applied voltage 7 kV).

Video S2: Decompression process of separated fiber web (spinning distance 15 cm, applied voltage 15 kV).