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SUPPORTING INFORMATION

Embedded-PVA@Ag Nanofiber Network for Ultra-smooth, High performance Transparent Conducting Electrodes

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SUPPORTING INFORMATION

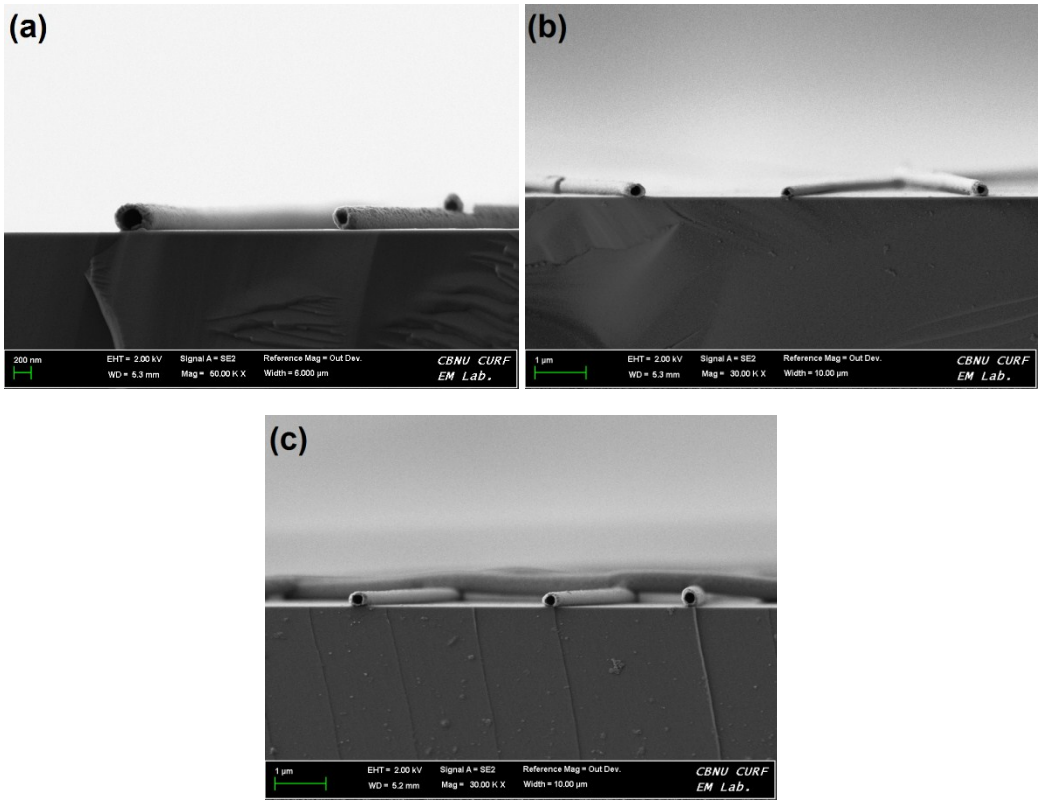

Fig. S1. Cross-sectional FE-SEM images of the PVA@Au NF, (b) PVA@Ag NF and (c) PVA@Cu NF.

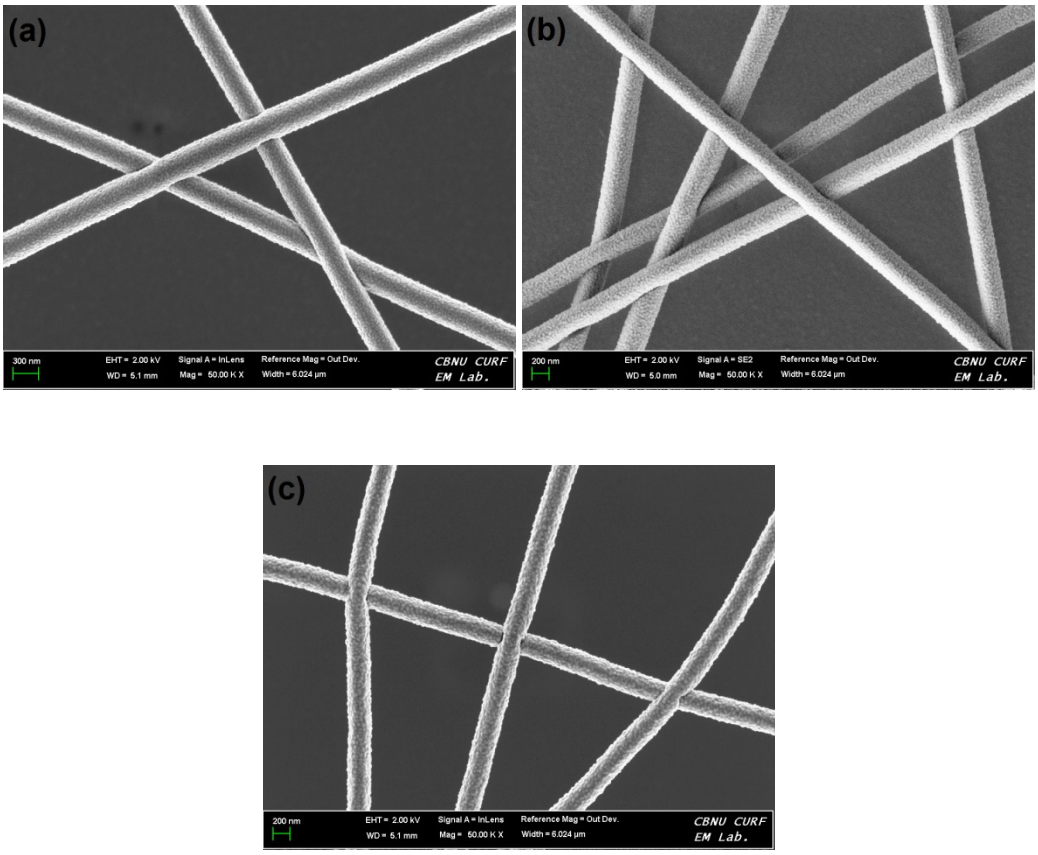

Fig. S2. FE-SEM images of surface and junctions between nanofibers (a) PVA@Au NF, (b) PVA@Ag NF and (c) PVA@Cu NF networks

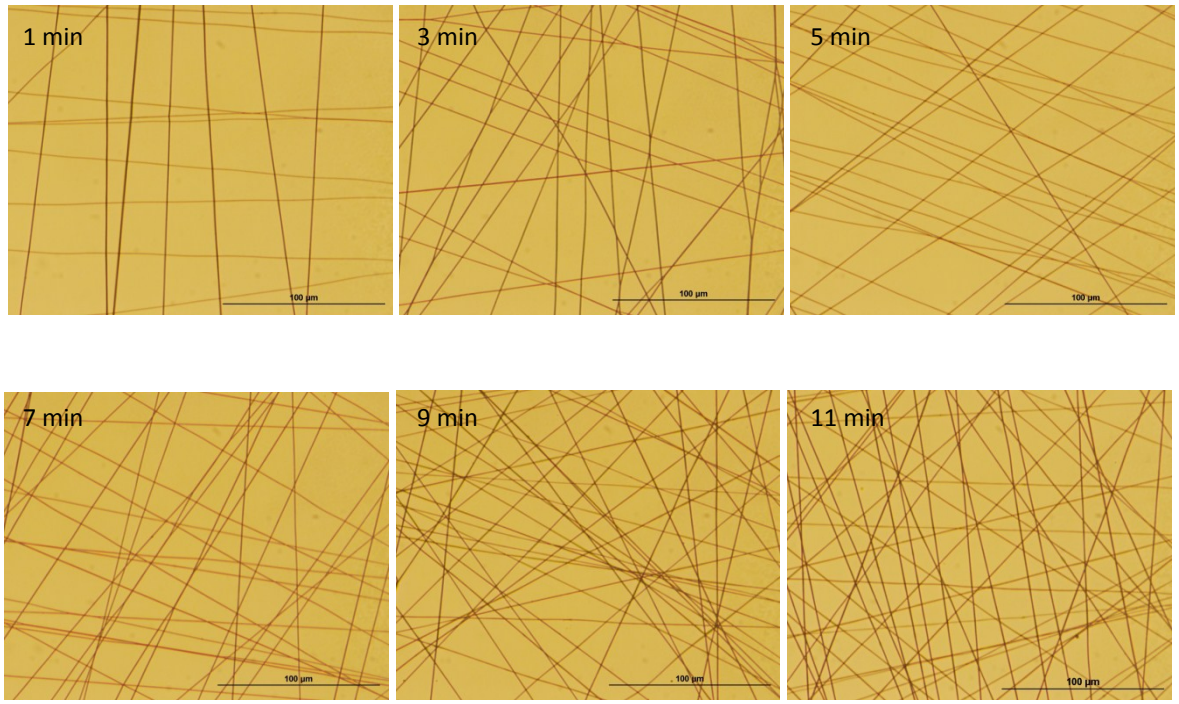

Fig. S3. The digital optical images of the PVA@Ag NF networks on glass substrates at different polymer electrospinning times.

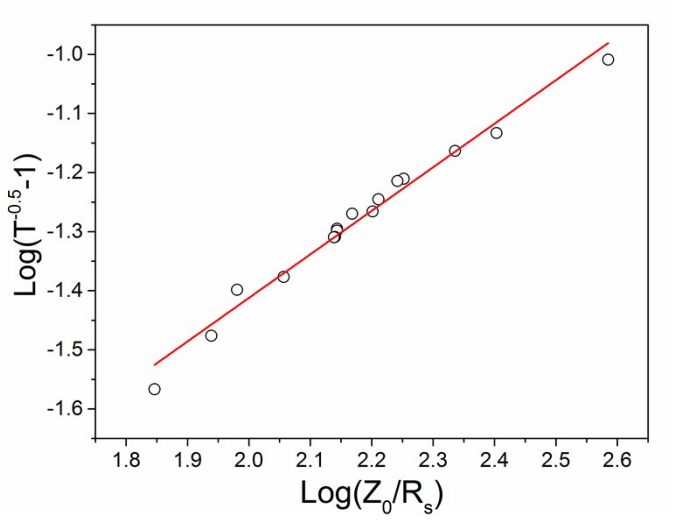

Fig. S4. Log-log plot of ($T^{-0.5}$ -1) vs. Log (Z_0/R_S) for PVA@Ag NF network TCE. (Percolation theory)

The relationship between sheet resistance, R_S, and transmittance, T, in a percolation network is described by[1]

$$T = \left[1 + \frac{1}{\Pi}\left(\frac{Z_0}{R_S}\right)^{1/(n+1)}\right]^{-2} \quad (1)$$

where Z_0 is the impedance of free space (377 Ω), *n* is the percolation exponent, and Π is the percolative figure-of-merit. Π follows the relation

$$\Pi = 2\left[\frac{\sigma_{Op}/\sigma_{DC,B}}{(Z_0 t_{min}\sigma_{Op})^n}\right]^{1/(n+1)} \quad (2)$$

Where σ_{DC} is the *dc* conductivity of the film, σ_{Op} is proportional to the absorption coefficient (σ_{Op}~α/Z_0), and t_{min} is the critical thickness below which the *dc* conductivity becomes thickness dependent. The percolative regime can be identified as a straight line on a log-log plot of ($T^{-1/2}$ -1) versus R_S (equivalent to a graph of *T* vs. R_S).

Figure S4 shows the log-log plot of ($T^{-1/2}$ -1) vs. Z_0/R_S for PVA@Ag NF network TCE. Here, the properties of the PVA@Ag NF network TCE were fitted with equation (1), which confirmed that the performance of the PVA@Ag NF network TCE was limited by percolation theory. The percolation parameters of the PVA@Ag NF network TCEs are summarized in Table 1. It is reported that percolation parameters largely depend on the uniformity of the network.[2] The high Π and low *n* values observed here may be ascribed to the spatially uniform network. This uniformity was a consequence of the evenly distributed polymer nanofiber template achieved by the electrospinning process.

Table S1. Percolation parameters PVA@Ag NF network TCE as compared with literature results**.**

Sample	*n*	Π	Ref.
PVA@Ag NF	0.35	770	Present work
Ag nanotrough	0.10	495	Ref 3
Metal nanowire	0.81	47	Ref 1
Ag nanowire	3.7	26	Ref 2

Table S2. Properties of the PVA@metal NF network electrodes, compared to other flexible, transparent electrodes from previous research results.

Reference	Bending radius	Transparency (550nm)	Sheet resistance (Ω/□)
PVA@Au NF	2 mm	~90%	6.08
PVA@Ag NF	2 mm	~90%	2.56
PVA@Cu NF	2 mm	~90%	3.21
Ref 4	2 mm	90%	2
Ref 3	2.5 mm	92%	100
Ref 5	6 mm	90%	25
Ref 6	4 mm	80%	10
Ref 7	-	85%	20

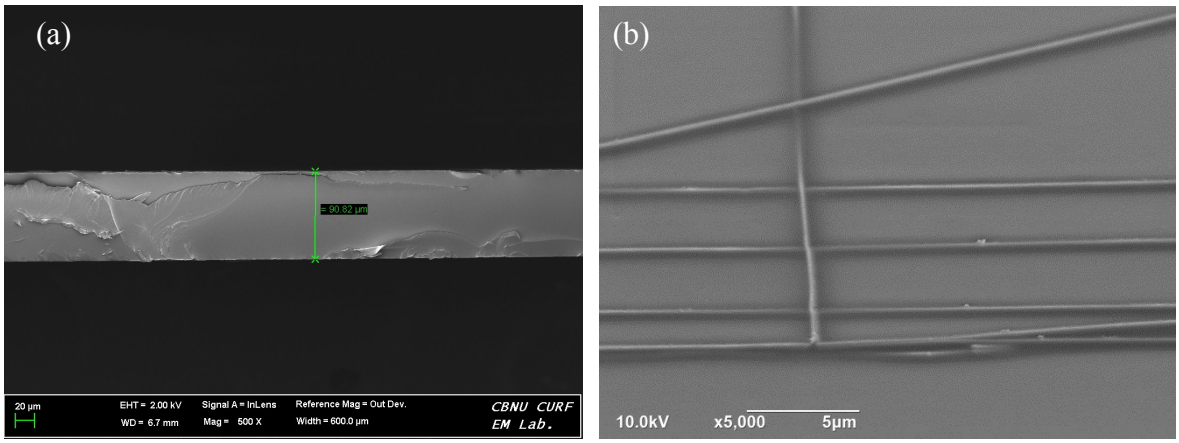

Fig. S5. (a) Thickness of a NOA63 film (b) Side-view FE-SEM images of the embedded PVA@Ag NF network NOA 63 TCE.

Fig.S6. Digital photograph of an experimental set up (infrared thermal imaging camera) for temperature measurement of E-PVA@Ag NF network TCE heater.

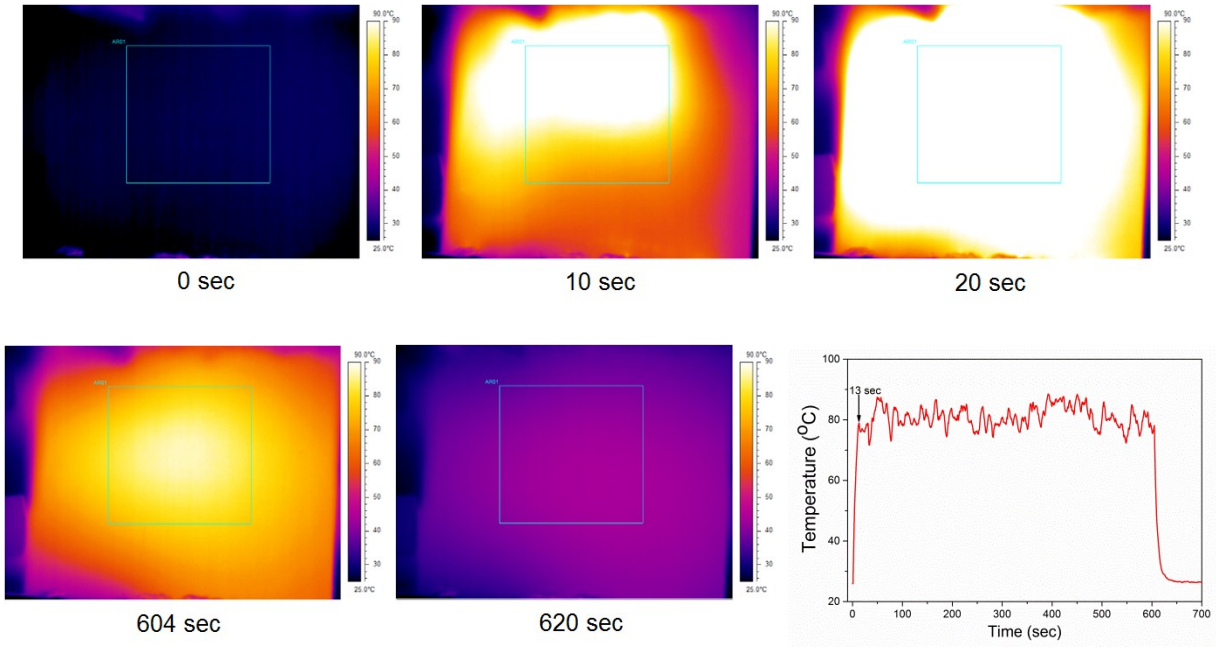

Fig. S7. Infrared thermal imaging photograph of E-PVA@Ag NF network TCE temperature distribution at an applied voltage of 4.0 V with time.

References

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