Electronic Supplementary Material (ESI) for Soft Matter.

Supplementary information:

Micro-dome array triboelectric nanogenerator with nanocomposite dielectric enhancement layer for wearable pressure sensing and gait analysis

Agha Aamir Jan,‡[a] Seungbeom Kim,‡[a] and Seok Kim*[a]

[a] Department of Mechanical Engineering, Pohang University of Science and Technology (POSTECH), Republic of Korea.

‡Authors contributed equally

*Correspondence to: Prof. Seok Kim, Department of Mechanical Engineering, Pohang University of Science and Technology (POSTECH), Pohang 37673, Republic of Korea. E-mail: seok.kim@postech.ac.kr

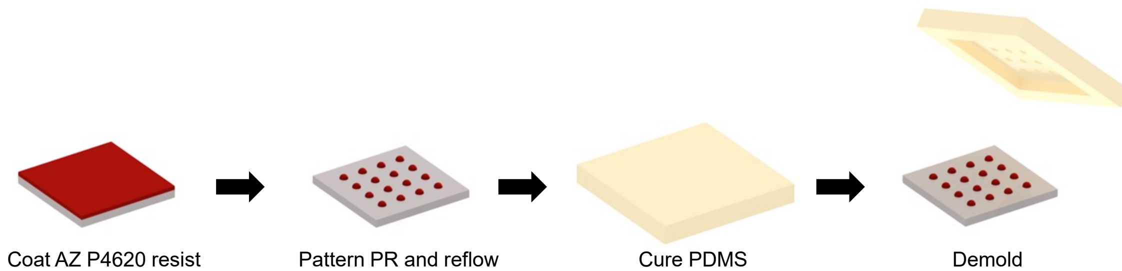

Fig. S1 Lithographic process for the fabrication of micro-dome array master mold.

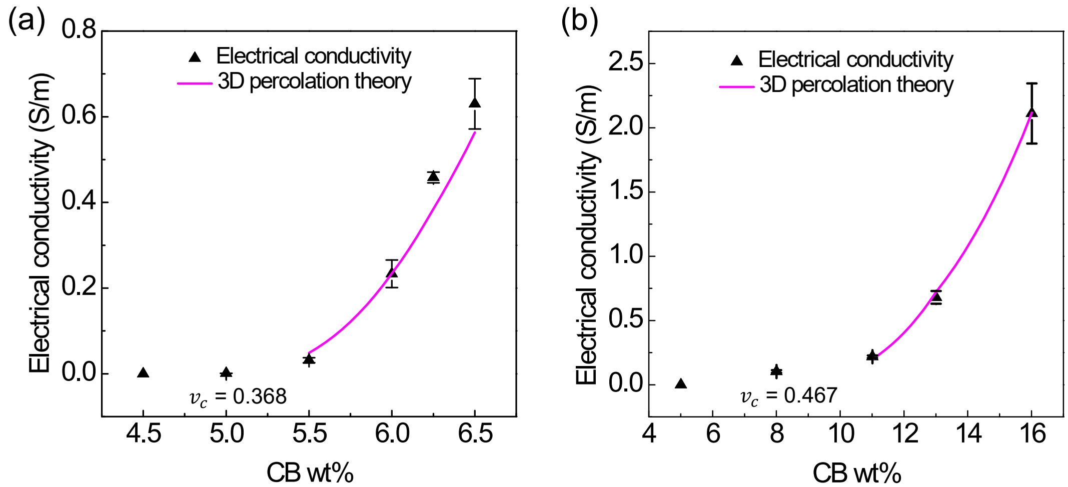

Fig. S2 (a) Electrical percolation of CB/Eco composite dielectric enhancement layer, and (b) CB/PDMS flexible electrode as a function of CB mass fraction. The volumetric fraction of CB at percolation threshold v_c was taken as 0.368 and 0.467 for CB/Eco and CB/PDMS, respectively.

Note1:

The electrical conductivity of polymer composite films can be predicted by power law relationship of 3D percolation theory:[1–3]

$$\sigma = \sigma_0 (v_f - v_c)^t \quad \text{(S1)}$$

where σ is the electrical conductivity of CB/Eco composite film, σ_0 is the conductivity of CB powder, v_f is CB volumetric fraction, v_c is the volumetric fraction at percolation threshold, and *t* is the fitting exponent. v_c was taken as 0.368 at 5.0 wt% of CB/Eco and *t* = 2.35 was obtained by fitting experimental data with the theory.

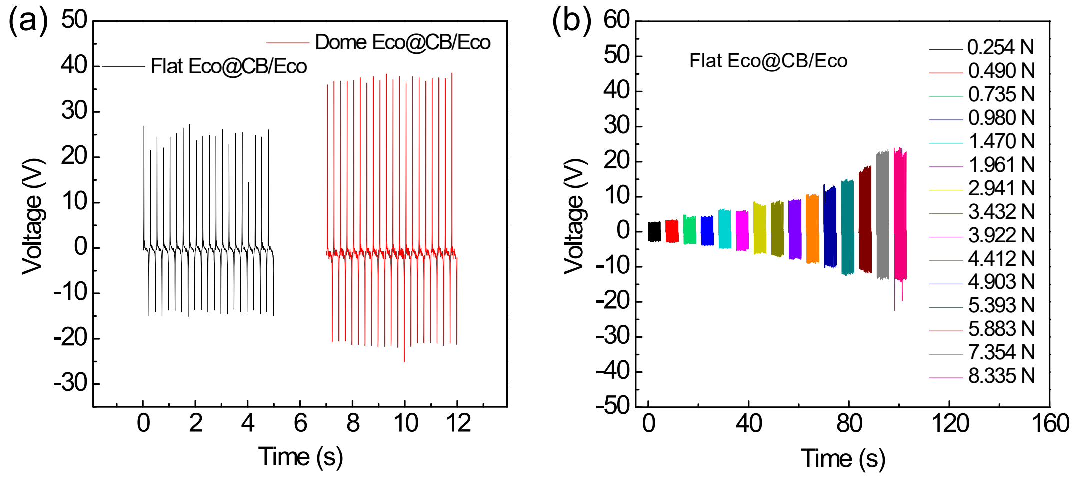

Fig. S3 (a) Comparison of the output voltage of plasma treated- flat Eco@CB/Eco TENG and micro-dome array Eco@CB/Eco TENG, (b) Force-dependent voltage response of plasma treated flat surface Eco@CB/Eco TENG.

Supplementary table 1. Comparison of pressure sensitivity and micro-dome array Eco@CB/Eco TENG with other references.

Structure	Sensitivity	Range	Reference
Hierarchical cone structure	7.989 V/kPa	0.1-60 kPa	[4]
Micro-dome array	2.57 V/kPa 1.70 V/kPa	0.612-8.58 kPa 8.58-20.83 kPa	This work
PDMS dome-conformal electrode (dome size ~1 mm)	0.48 V/kPa 0.25 V/kPa	0-26 kPa 26-130 kPa	[5]
Wrinkled Mxene on prestretched latex substrate	2.35 V/kPa 0.14 V/kPa	0.3-1 kPa 1-50 kPa	[6]
Sandpaper textured	0.367 V/kPa	3-45 kPa	[7]
Stitched fabric structure	0.344 V/kPa 0.018 V/kPa	0-0.25 kPa 0.25-37.5 kPa	[8]
Sandpaper textured	0.293 V/kPa 0.103 V/kPa	0.23-13.12 kPa 13.12-95.95 kPa	[9]
Elliptical cylindrical arrays	0.249 kPa	0-450 kPa	[10]

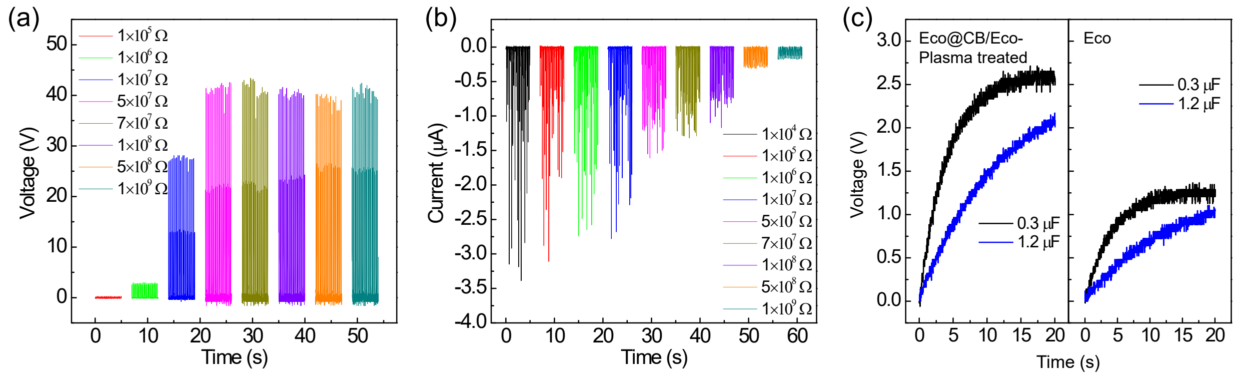

Fig. S4 (a) and (b) Rectified voltage and current as a function of external load resistance from 10 kΩ to 1 GΩ, where 10 kΩ was the short circuit condition, (c) Capacitor charging voltage curves of plasma treated Eco@CB/Eco and Eco only TENGs.

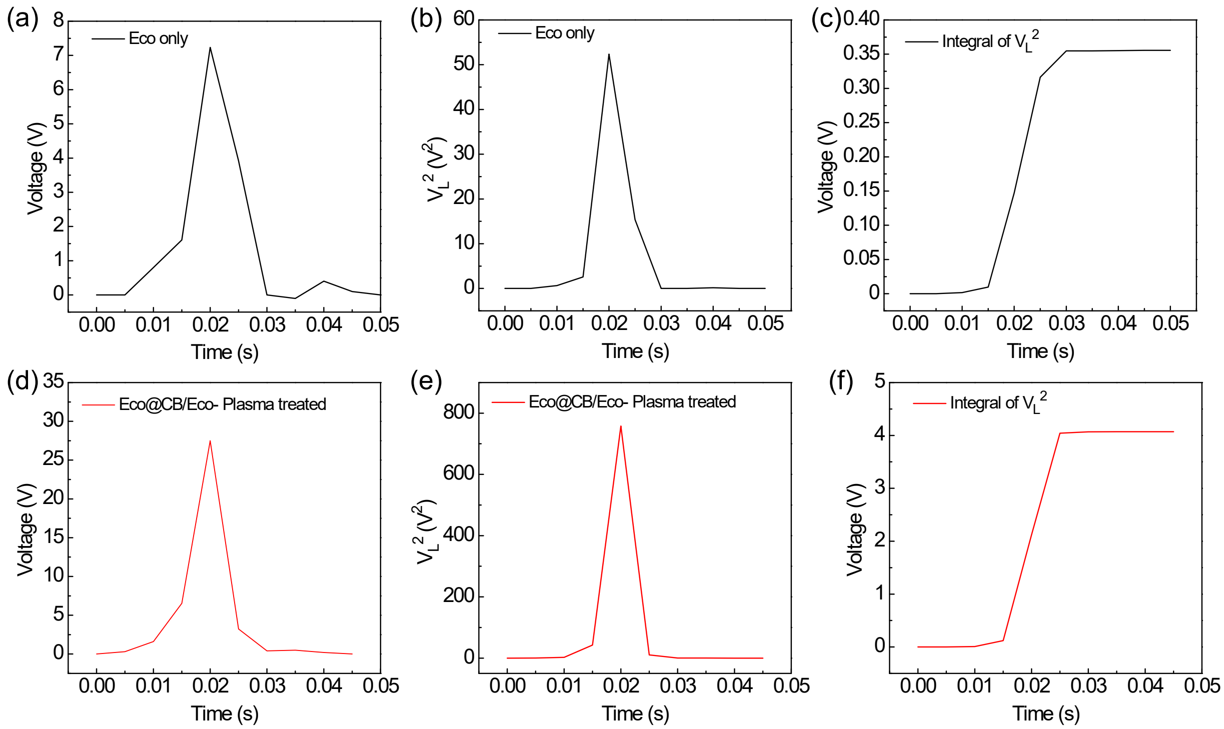

Fig. S5 (a), (b), and (c) Rectified voltage signal, square of the voltage, and integral part of the voltage of Eco only TENG, measured at load resistance of 10 MΩ, the tapping force and frequency were kept at 8.3 N and 4 Hz, (d), (e), and (f) Rectified voltage signal, square of the voltage, and integral part of the voltage of plasma treated Eco@CB/Eco TENG.

Note 2:

The mechanical energy conversion efficiency was calculated by the definition:

$$\eta_{mech} = \frac{E_{electric}}{E_{kinetic}} \times 100\ \% \qquad \text{(S2)}$$

The kinetic energy of aluminum top layer was calculated using equation:

$$E_{kinetic} = \frac{1}{2}mv^2 \qquad \text{(S3)}$$

Al top layer completes the half cycle in 0.125 s at 4 Hz tapping frequency to cover a gap distance of 5 mm. Therefore, the velocity of top layer is 0.04 ms^{-1}. The mass was measured as 0.845 g.

The electrical energy of the Eco only and Eco@CB/Eco TENGs was calculated by using the following equation:[11,12]

$$E_{electric} = Q = \int_{t_1}^{t_2} \frac{{V_L}^2}{R_L} dt \qquad \text{(S4)}$$

Here, V_L is the voltage across the load resistance (R_L=10 MΩ), where the maximum power was attained. Initially, V_L was measured by employing input load resistance and finding the V_L^2 as shown in Fig. S5 a. Then, the integrated value was calculated by using the origin software and the integrated graph is shown in Fig. S5 b.

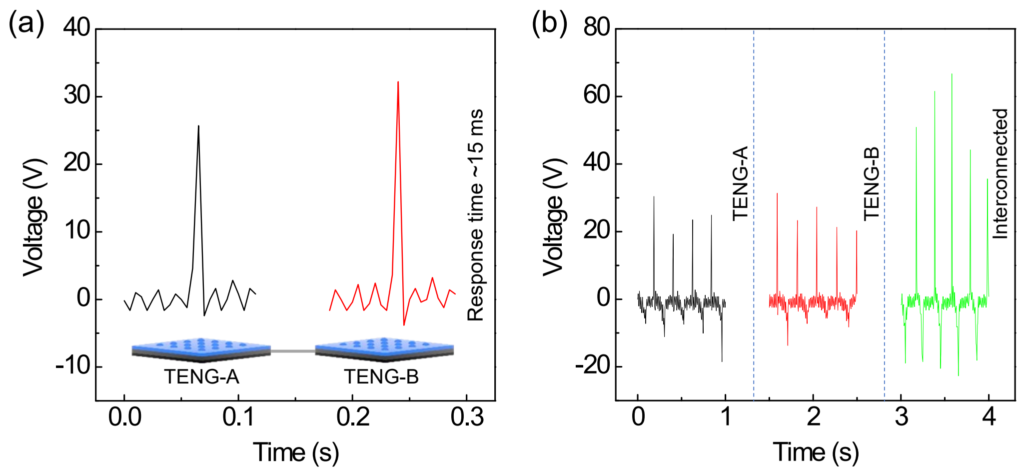

Fig. S6 (a) Finger tapping responses of TENG-A and TENG-B sensors connected in series, (b) Finger tapping responses of individual TENG-A and TENG-B and interconnected TENG sensors.

Notes and references

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