Electronic Supplementary Material (ESI) for Energy & Environmental Science.

Supplementary Information

Sweat-based Wearable Energy Harvesting-Storage Hybrid Textile Devices

Jian Lv, [#,1,2] Itthipon Jeerapan, [#,1] Farshad Tehrani, [#,1] Lu Yin, [#,1] Cristian Silva Lopez[1], Ji-Hyun Jang[1], Davina Joshuia[1], Rushabh Shah[1], Yuyan Liang[1], Linye Xie[1], Fernando Soto[1], Chuanrui Chen[1], Emil Karshalev[1], Chuncai Kong[2], Zhimao Yang[2], Joseph Wang [,1]*

[1]*Department of NanoEngineering, University of California, San Diego, La Jolla, California 92093, United States*

[2]*School of Science, Xi'an Jiaotong University, Xi'an 710049, Shaanxi, China*

**Corresponding author Tel.: +1 8582460128, Fax: +1 8585349553, Email address: josephwang@ucsd.edu*

Supporting Figures

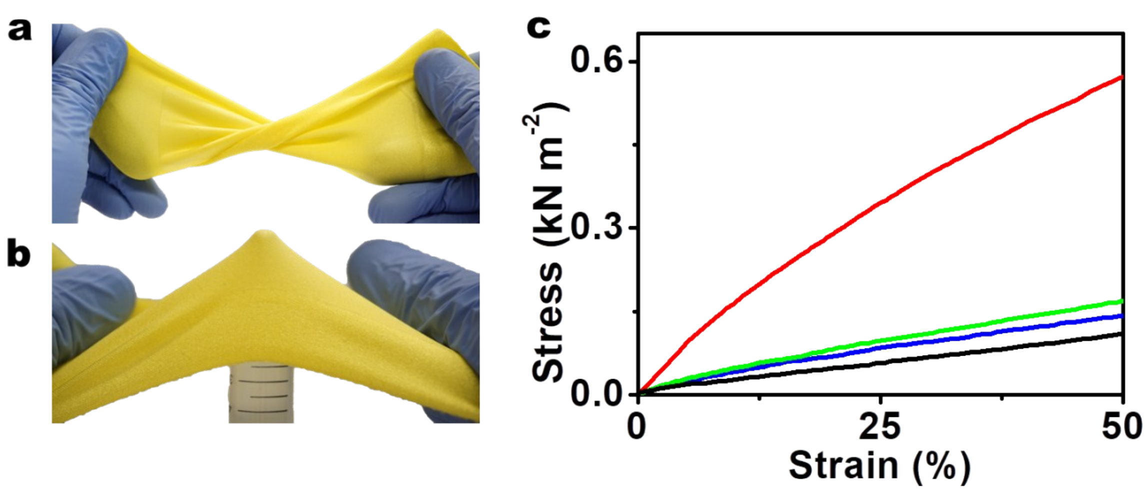

Figure S1. Demonstration of the stretchable textile functionalized with SEBS lining during (a) 180° twisting and (b) doming deformation. (c) The stress-strain curve of several stretchable textiles (Weft direction), including (black plot) the pristine textile used in this work, (green plot) textile with SEBS lining, (blue plot) Dartex Ecoskin PU-laminated textile, and (red plot) Eco-PUL Diaper.

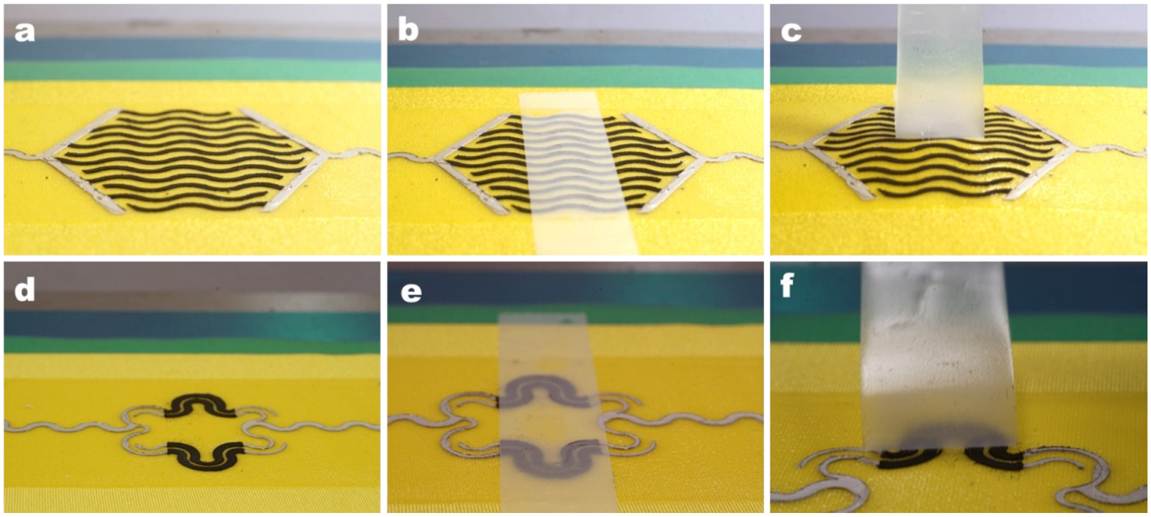

Figure S2. Adhesion test of the printed BFC (a-c) and SC (d-f) composite electrodes using commercial scotch tape. (a and d) Printed electrodes before the tape test. (b and e) Tape applied to electrodes. (c and f) Peeling off the tape.

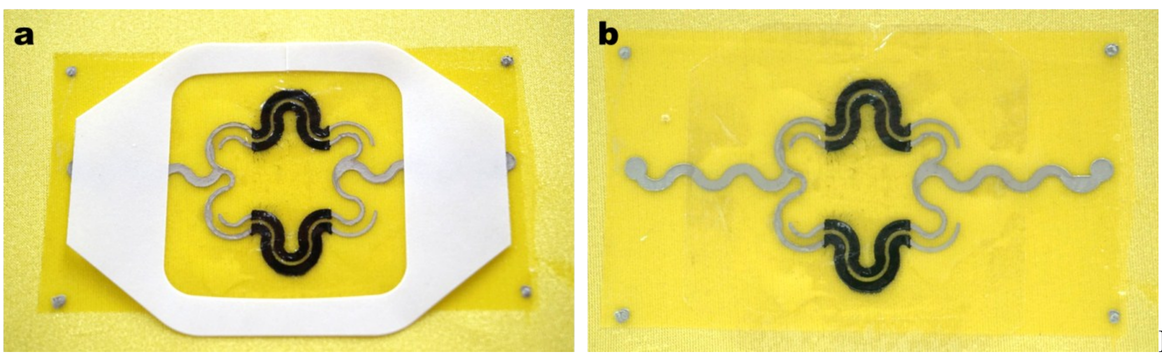

Figure S3. The sealing process for the printed supercapacitor. (a) applying the adhesive Tegaderm film onto the printed SC with coated electrolyte on the active electrode site. (b) After application of the Tegaderm film with the electrolyte being sealed within the adhesive sealing film.

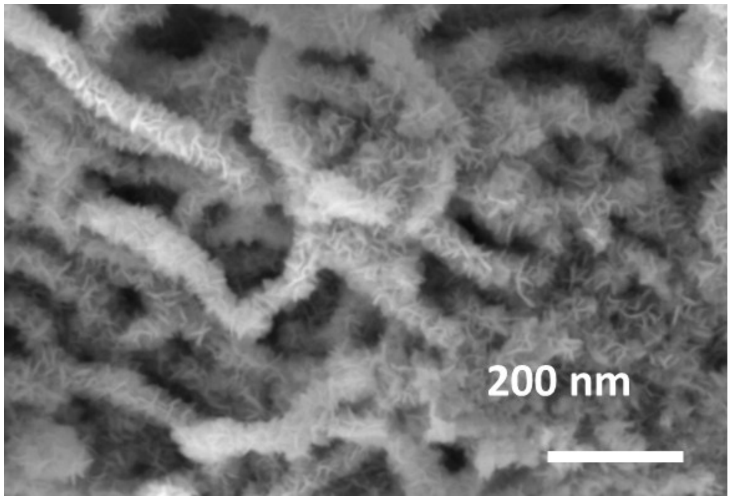

Figure S4. SEM image of the MnO_2/CNT nanowires.

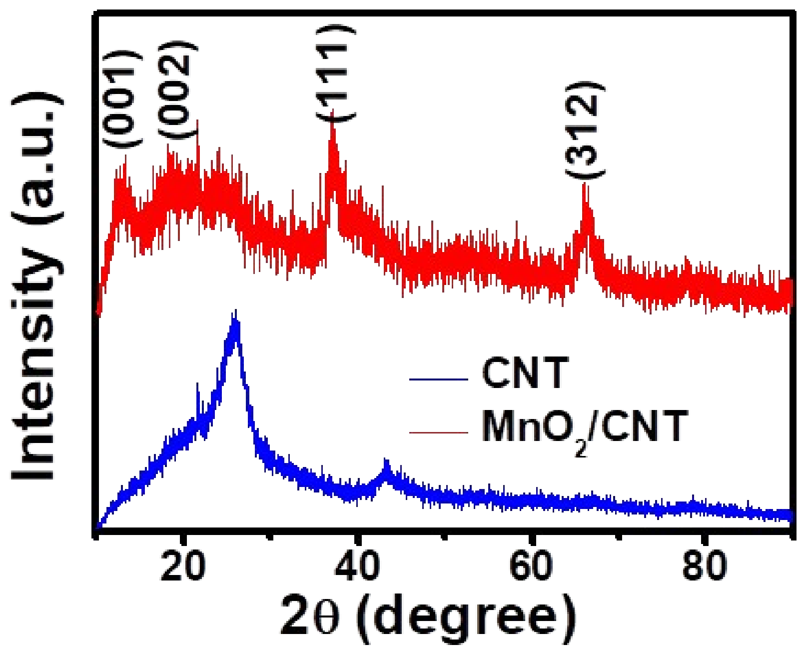

Figure S5. XRD of the prepared MnO_2/CNT nanowires.

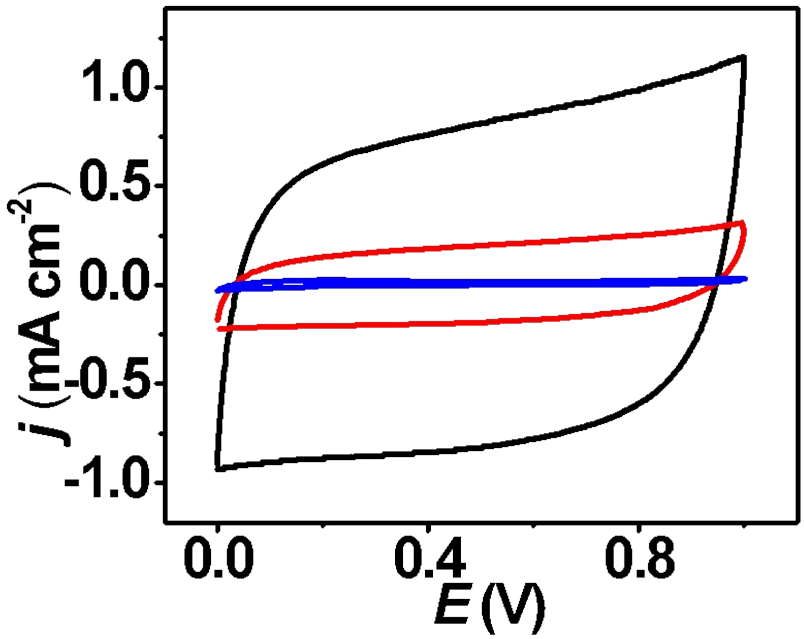

Figure S6. CVs of the screen printed (black line) COOH-CNTs/MnO_2-CNTs/PEDOT: PSS, (red line) COOH-CNTs/MnO_2-CNTs, and (blue line) COOH-CNTs based supercapacitors.

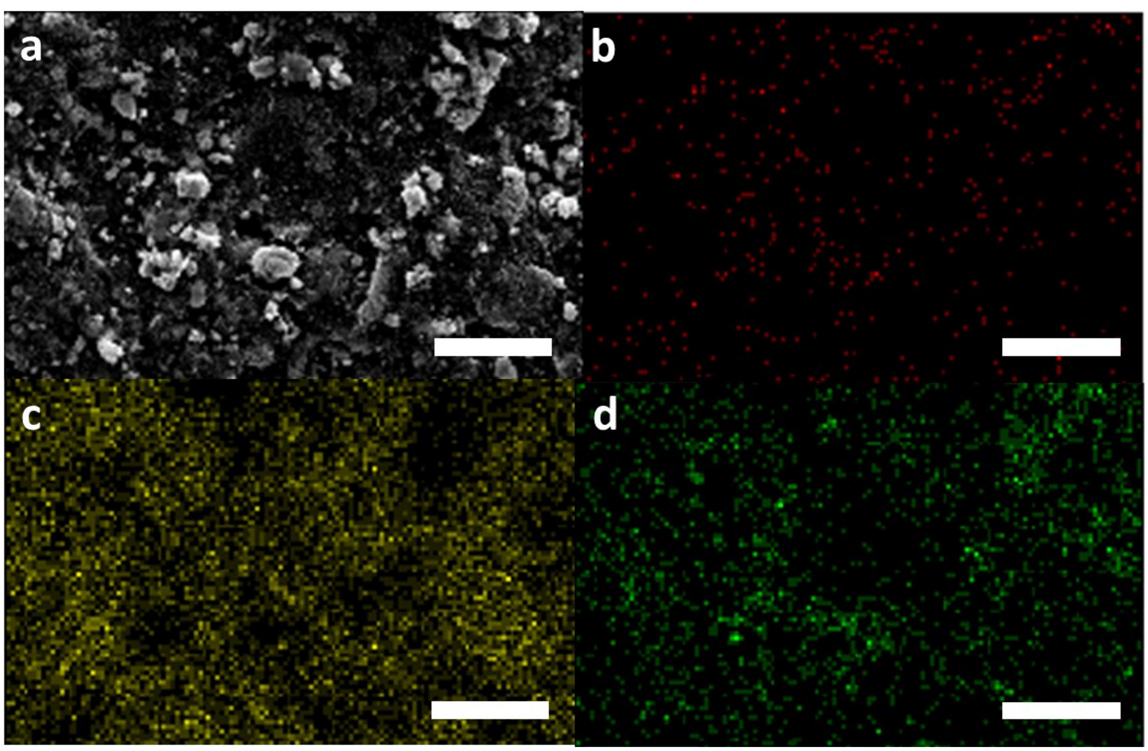

Figure S7. (a) SEM image of the MnO_2-CNT/CNT/PEDOT: PSS electrode. (b, c, and d) Corresponding EDX images showing Mn, C, and O maps, respectively. Scar bar: 10 µm.

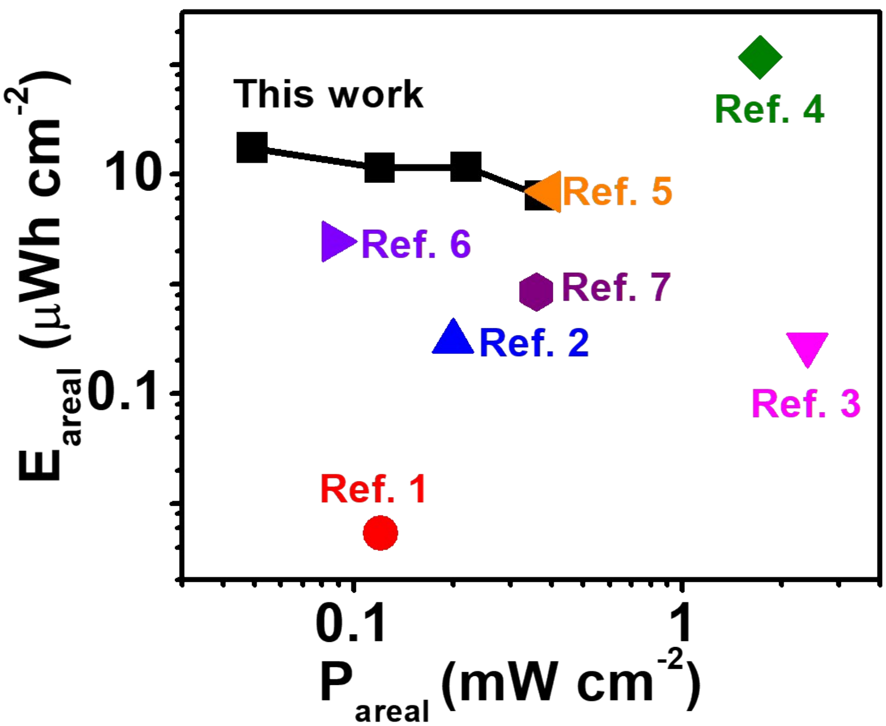

Figure S8. The areal power and energy density of the printed stretchable supercapacitor in this work in comparison with the reported supercapacitors.

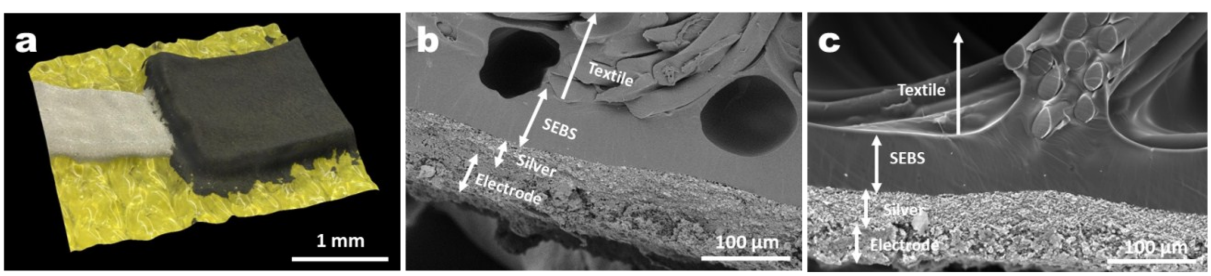

Figure S9. (a) The topographic image of the SC electrode obtained by a 3D optical profiler. (b and c) SEM images showing cross-sectional view (b) before and (c) after 100 cycles of 20% stretching.

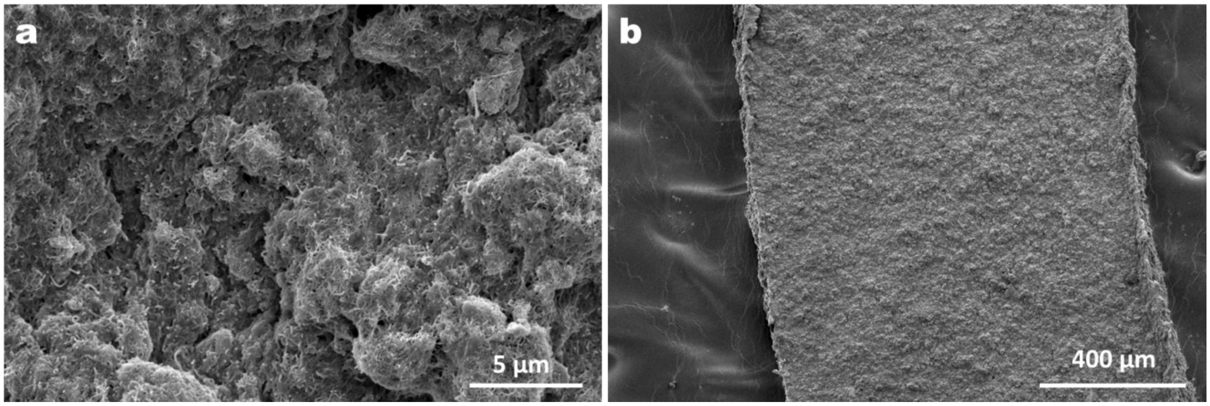

Figure S10. SEM images of the printed CNT electrode: (a) high and (b) low magnification.

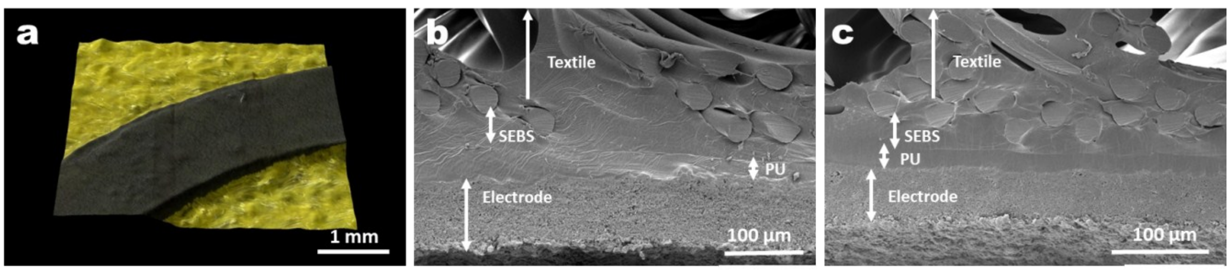

Figure S11. (a) The topographic image of the BFC electrode obtained by a 3D optical profiler. SEM images (cross-sectional view) (b) before and (c) after 100 cycles of 20% stretching.

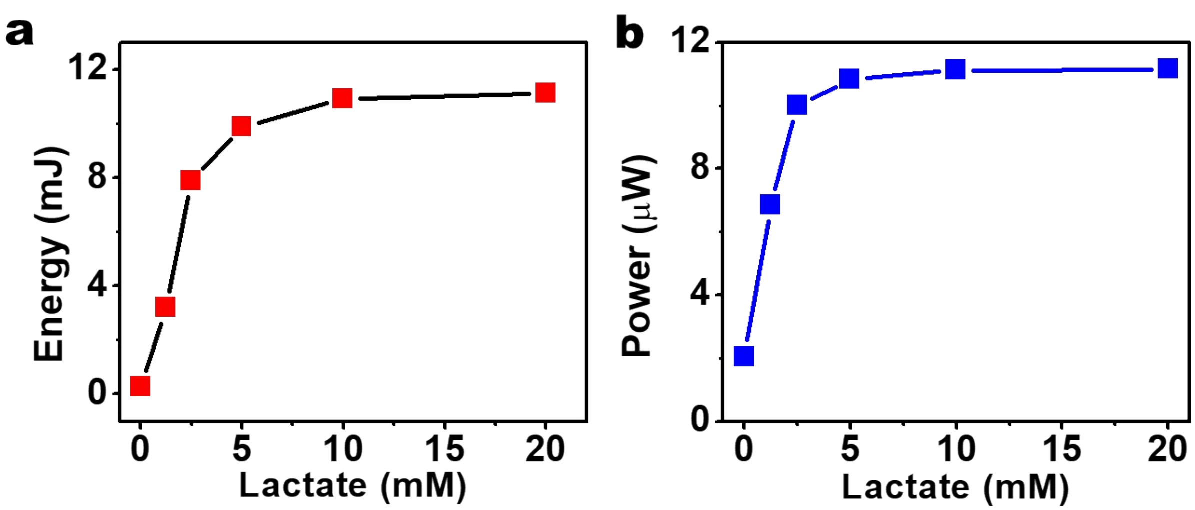

Figure S12. The (a) energy and (b) power stored in the supercapacitor after it was charged by BFC for a single time in different lactate concentrations. The discharging current of supercapacitor: 50 μA.

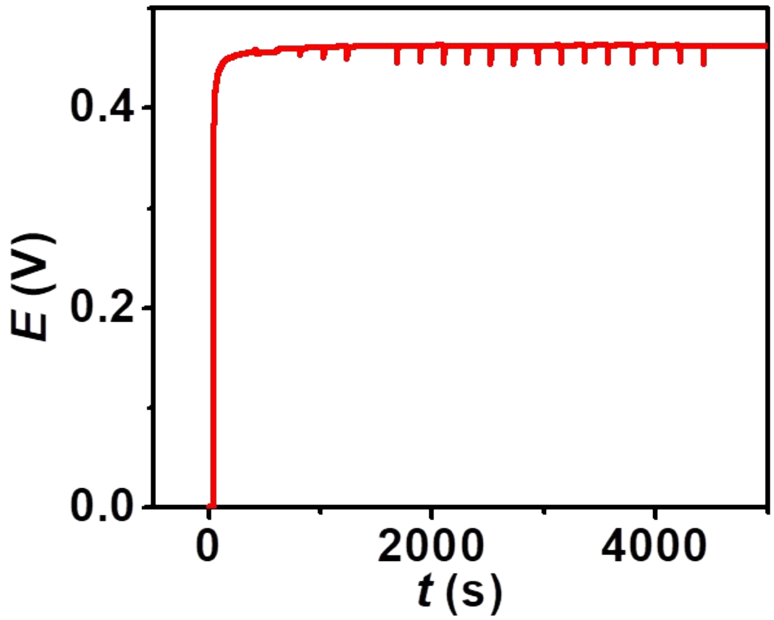

Figure S13. Simultaneous 20% Stretching of connected BFC and SC during charging.

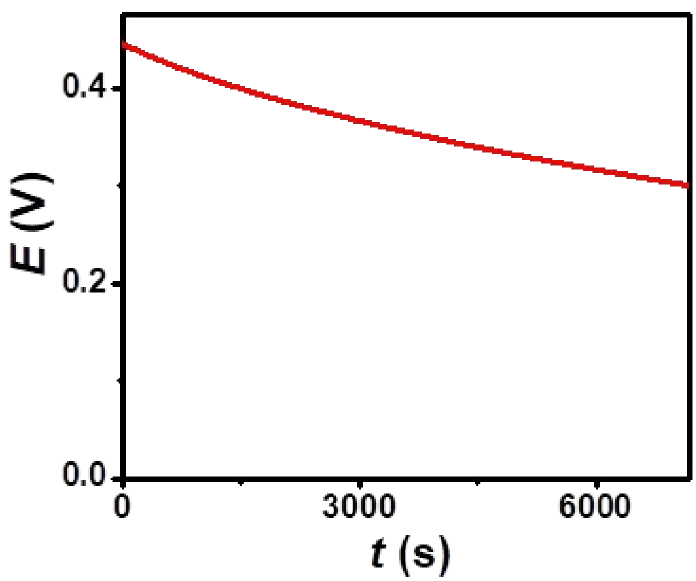

Figure S14. Self-discharge of the supercapacitor after fully charging by using the BFC in 10 mM lactate solution.

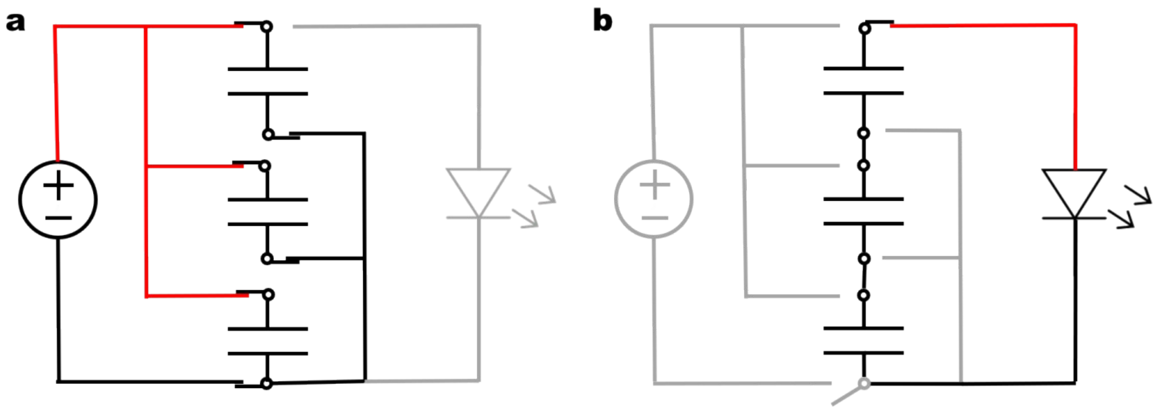

Figure S15. The circuit diagrams of the connection between the SC and BFC, corresponding to the Figure 5. (a) charging. (b) upon disconnecting BFCs and SCs.

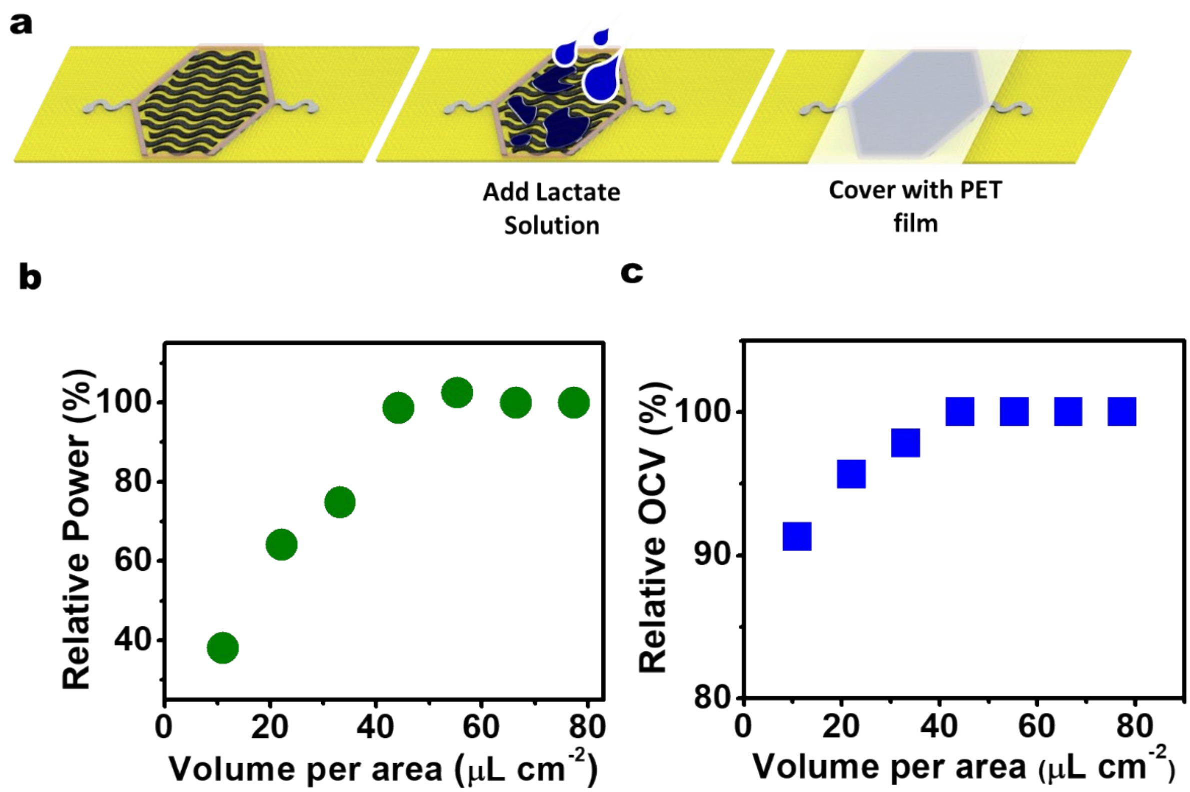

Figure S16. (a) Schematic showing the study of the dependency of BFC performance outputs upon sweat volume. (b and c) The plots showing the relative (b) power and (c) open circuit voltage (OCV) of the biofuel cell upon different volume of the lactate biofuel.

Supporting Tables

Table S1 The parameters of printed SC and BFC.

Parameter	Supercapacitor	Biofuel Cell
Weight Density (mg cm^{-2})	6.4	4.8
Printing Thickness (µm)	38	95
Half Working Area (cm^2)	0.6	0.9

Table S2. Performances of wearable textile-based or stretchable enzymatic biofuel cells.

Platforms	Biofuels	Concentrations (mM)	Power Density (µW cm^{-2})	Open Circuit Voltage (V)	References
Textile	Fructose	200	550	0.40	8
Tattoo	Lactate	20	44	0.53	9
Textile	Fructose	200	250	0.74	10
Patch	Glucose	100	0.98	0.29	11
Patch	Fructose	200	60	0.75	12
Textile	Lactate	20	250	0.46	13
Textile	Glucose	50	160	0.44	13
Tattoo	Glucose	70	125	0.40	14
Patch	Lactate	20	1,200	0.50	15
Textile	Lactate	10	252	0.49	This work

Supporting Video

Video 1. Video showing applications of strains, bending, and twisting to the integrated textile-based devices

References

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