Electronic Supplementary Material (ESI) for Materials Chemistry Frontiers.

Solid-state integrated micro-supercapacitor arrays construction with low cost porous biochar

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Formula for electrochemical characterization

The specific areal capacitance can be calculated from CV or GCD curve by the following equations:

$$C_{sp} = \frac{1000 \times Q}{2 \times A \times v \times V}$$

$$C_{sp} = \frac{I}{A \times \frac{dV}{dt}} = 0.1\ mA \text{ /cm}^2 \times \frac{928\ s}{0.8\ V} = 116 \text{ mF/cm}^2$$

Where C_{sp} is the specific areal capacitance (mF cm^{-2}); Q is the integrated area of CV curve (A V); A is the electrode area (cm^2); v is the scan rate (V s^{-1}); V is the potential window (V); $\frac{dV}{dt}$ is the discharge slope after the IR drop (V s^{-1}); I is the discharge current (mA).

The energy density and power density can be calculated using the equation below:

$$E_{areal} = \frac{1}{2} \frac{C_{sp}(\Delta V)^2}{3.6}$$

$$P_{areal} = \frac{E_{areal}}{\Delta t}$$

Where C_{sp} is the specific areal capacitance (mF cm^{-2}); E_{areal} is the areal energy density (mWh cm^{-2}); ΔV is the potential window ($\Delta V = V_{max} - V_{drop}$) (V); Δt is the discharge time; P_{areal} is the areal power density (kW cm^{-2}).

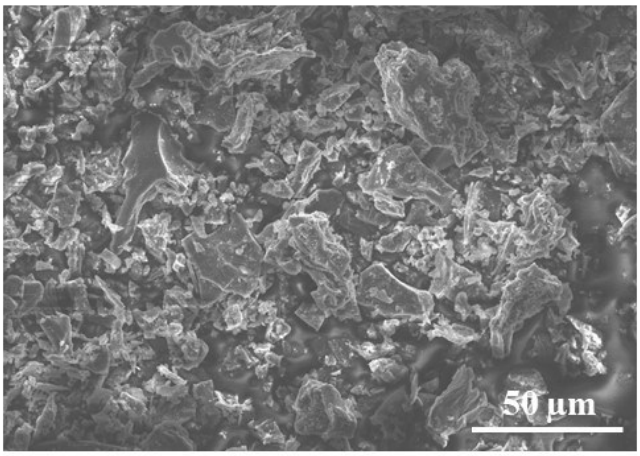

Figure S1 SEM images of OC

Figure S2 The flexibility of obtained MSCs.

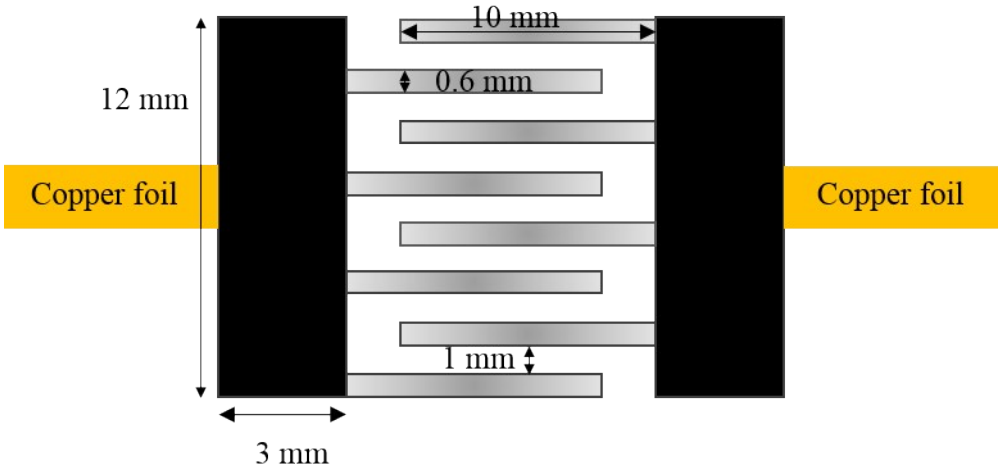

Figure S3 Size parameters for the effective area of screen printing MSCs with the thickness of 0.04 mm.

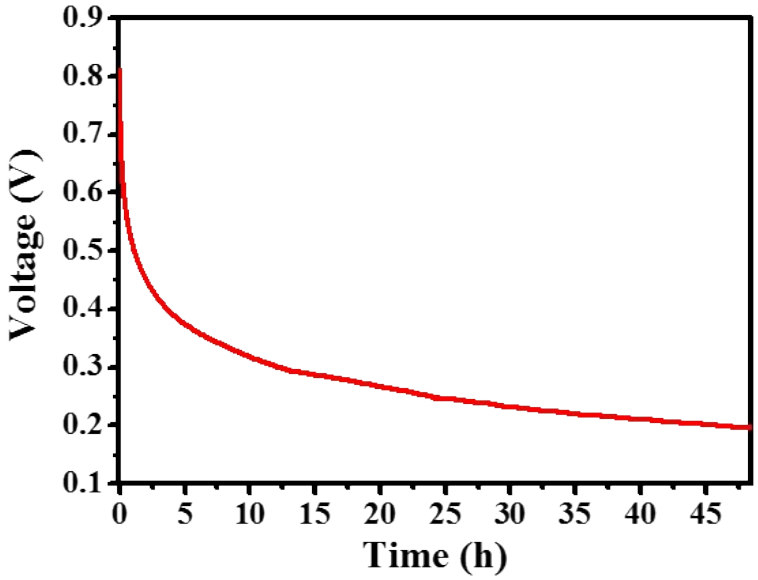

Figure S4 Time dependence of the voltage decay of MSC.

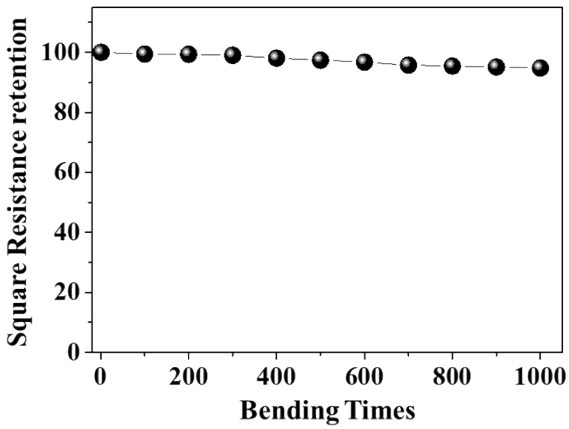

Figure S5 The square resisitance retention of MSC after bending 180° for 1000 cycles.

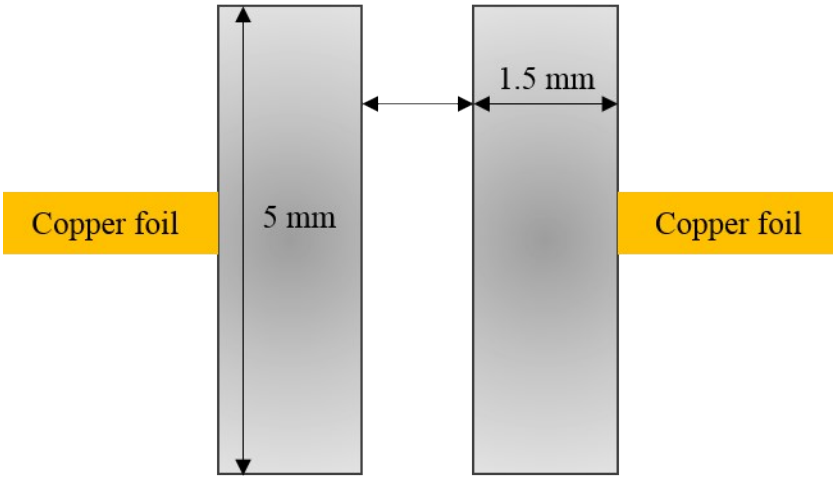

Figure S6 Size parameters for the effective area of programing controlled writing MSCs.

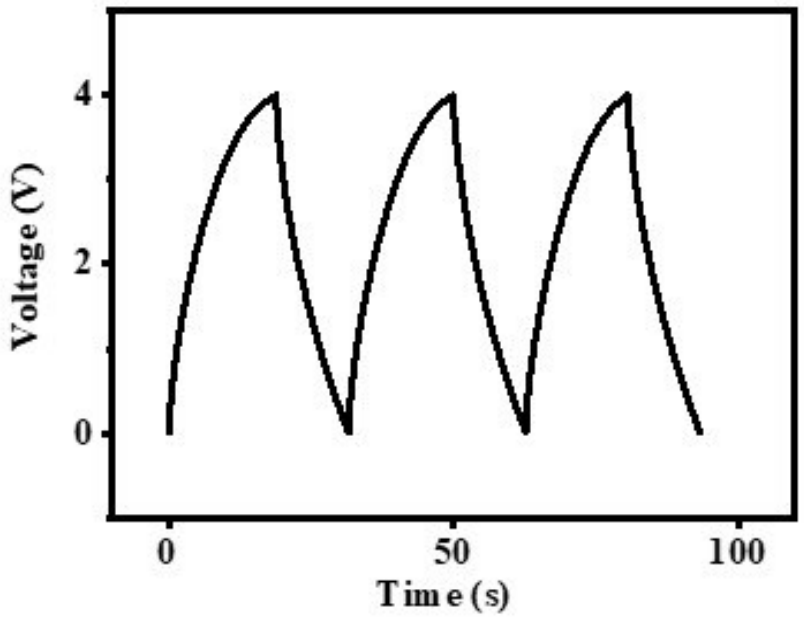

Figure S7 GCD curve of programing controlled writing MSCs consisting 5 series-connected MSC.

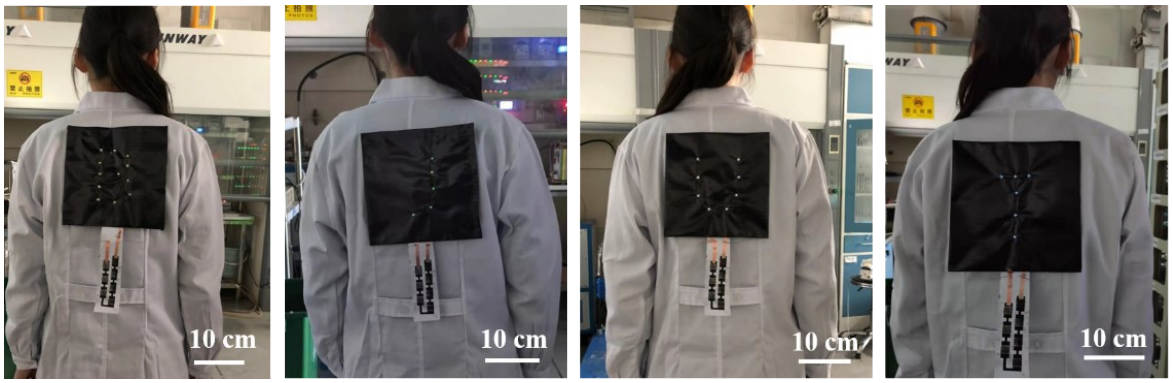

Figure S8 Photographs of the integrated MSCs arrays lighting up four soft LED displays.

Table S1 Comparisons of the major flexible MSCs

NO.	Electrode Material	Electrolyte	Potential Window	Capacitance	Energy Density	Ref.
1	Graphene	PVA/H_3PO_4	0.8 V	1.0 mF cm^{-2}		[S1]
2	Laser-irradiated graphene	PVA/H_3PO_4	1.2 V	2.32 mF cm^{-2} 3.3 F cm^{-3}	459 μWh cm^{-2} 655 μWh cm^{-3}	[S2]
3	all-MXene-N printed MSC	PVA/H_2SO_4	0.6 V	70.1 mF cm^{-2}	-	[S3]
4	extrusion-printed all-MXene MSC	PVA/H_2SO_4	0.5 V	43 mF cm^{-2}	0.32 μWh cm^{-2}	[S4]
5	inkjet-printed all-MXene MSC	PVA/H_2SO_4	0.5 V	562 F cm^{-3} 12 mF cm^{-2}	-	[S4]
6	MXene	PVA/H_2SO_4	0.6 V	5 mF cm^{-2}	-	[S5]
7	Stamping MXene MSC	PVA/H_2SO_4	0.6 V	61 mF cm^{-2}	0.76 μWh cm^{-2}	[S6]
8	Graphene	PVA/H_2SO_4	1.0 V	5.4 mF cm^{-2} 27 F cm^{-3}	-	[S7]
9	GF@3D-GSC	PVA/H_2SO_4	0.8 V	1.7 mF cm^{-2}	0.17 μWh cm^{-2}	[S8]
10	HCF fiber SC	PVA/H_3PO_4	0.8 V	304.5 mF cm^{-2}	27.1 μWh cm^{-2}	[S9]
11	Graphene Films SC	H_2SO_4 (1 M)	1.0 V	71.0 mF cm^{-2}	8.4 μWh cm^{-2}	[S10]
12	RGO+CNT@CMC YSCs	PVA/H_3PO_4	0.8 V	177 mF cm^{-2}	3.84 μWh cm^{-2}	[S11]
13	Biochar	PVA/H_2SO_4	0.8 V	116.04 mF cm^{-2}	9.26 μWh cm^{-2}	This work

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