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Electronic Supplementary Information

MnO_2-decorated Highly Porous 3D-Printed Graphene Supercapacitor for Photosynthetic Power Systems

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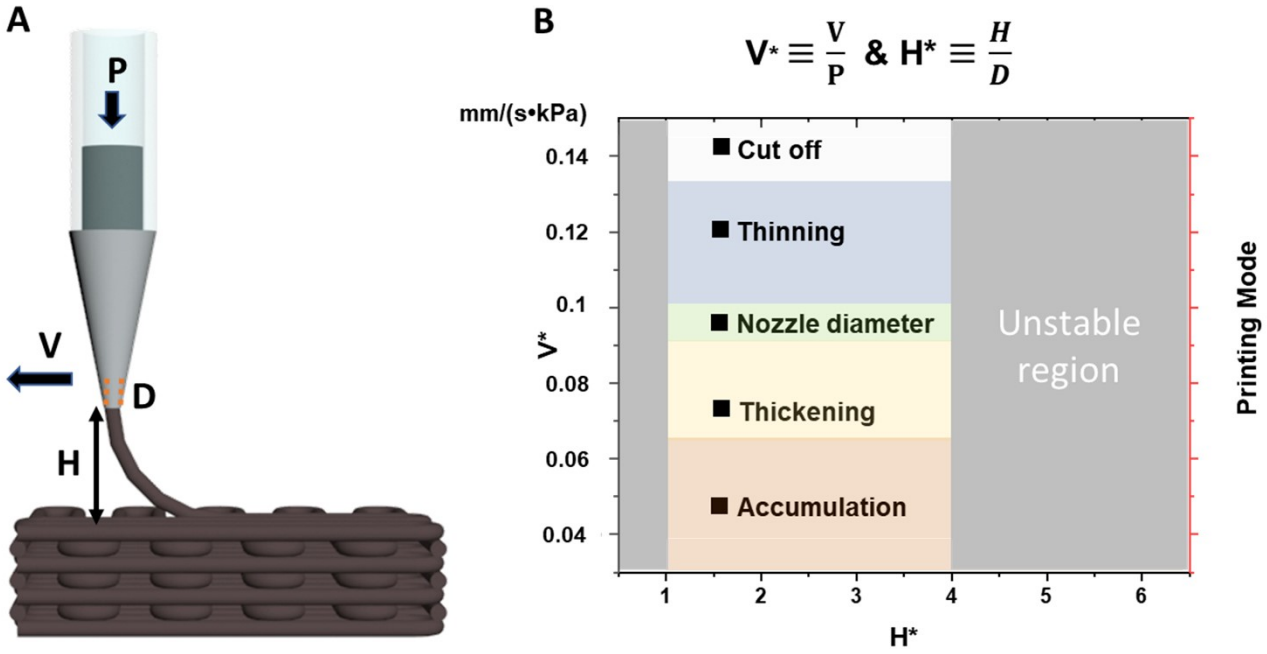

Fig. S1 (a) Schematic of DIW printing with printing parameters for optimization of printing viscoelastic hydrogel ink. (b) Printing modes based on V* and H*.

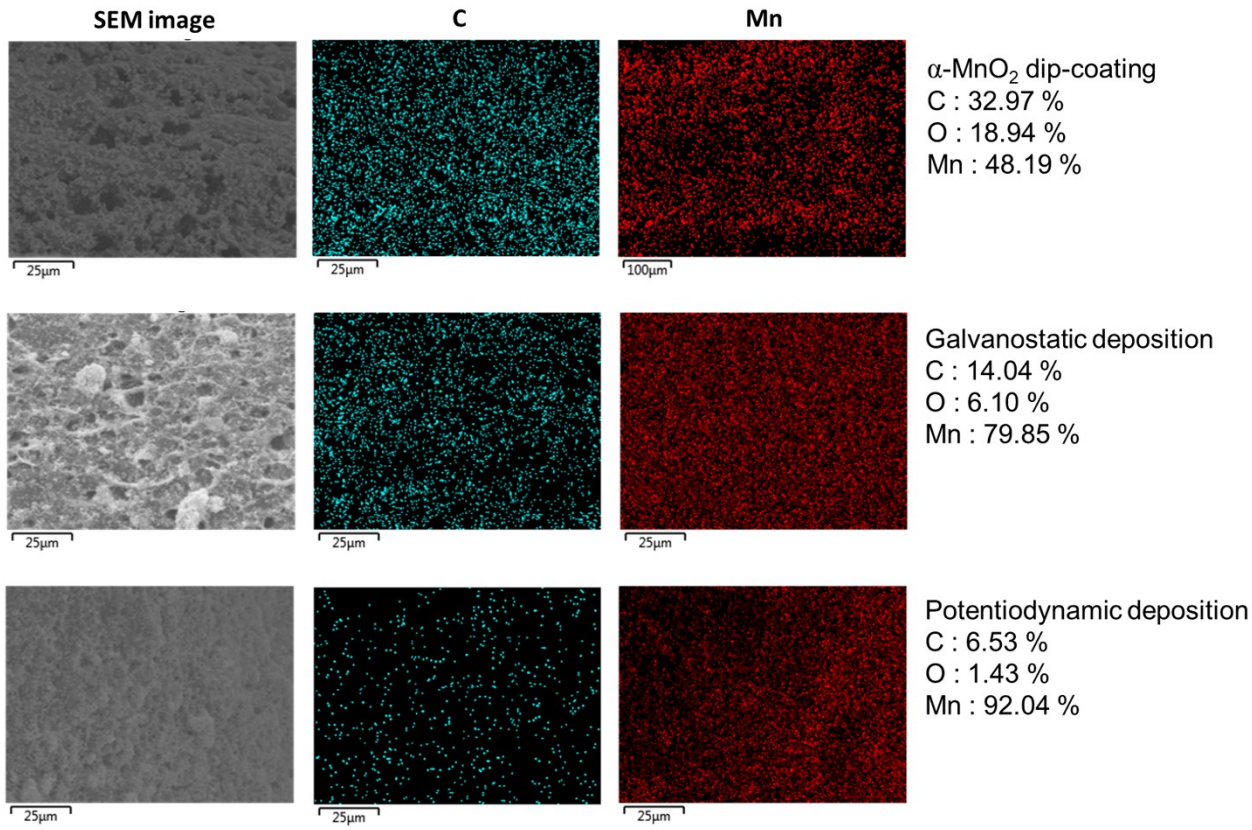

Fig. S2 EDS images that show the compositions of C, O, and Mn on MnO_2-deposited samples by different deposition methods.

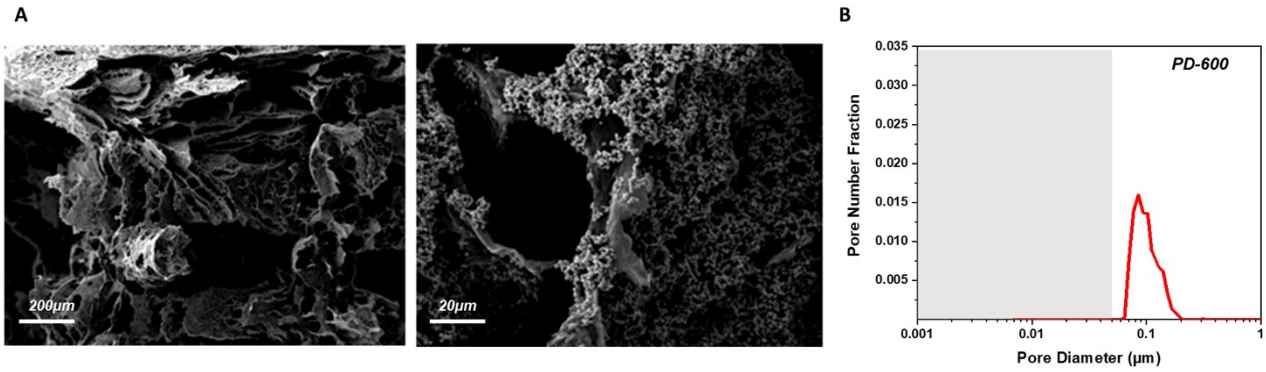

Fig. S3 (a) SEM images of PD-600 electrode. (b) Pore size distribution of PD-600 electrode.

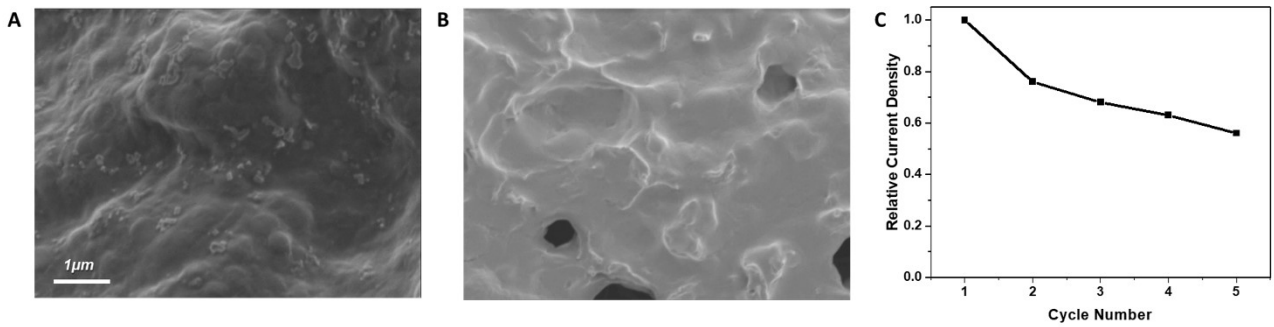

Fig. S4 (a) SEM images of TM-coated electrode after gentle washing in DI water. (b) SEM image of TM-coated electrode after heat treatment at 80°C for 30 minutes in a vacuum oven. (c) Change of PE current density after each measurement cycle.

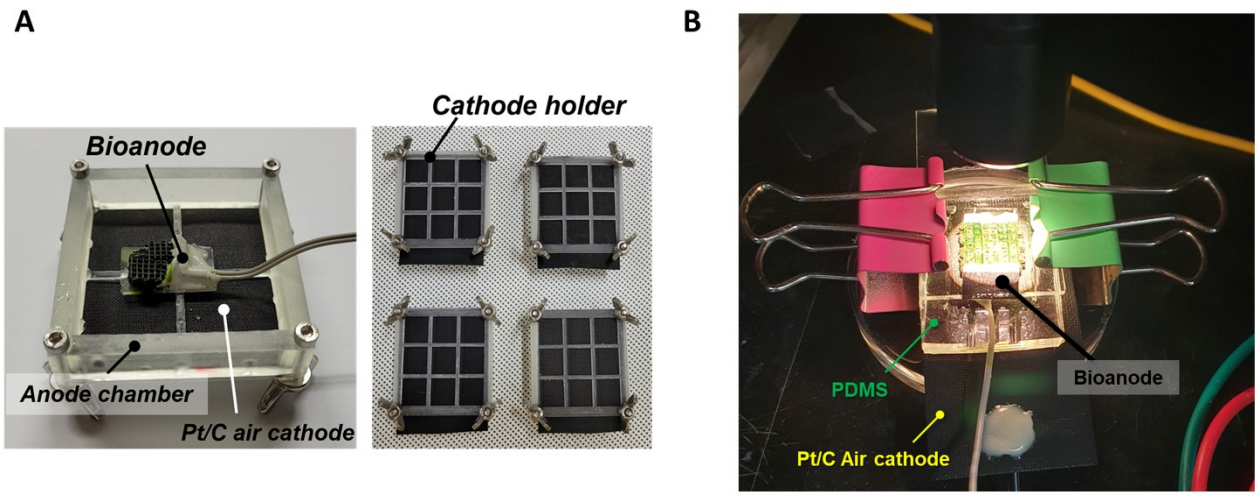

Fig. S5 (a) Images of customized anode chamber and cathode holder by SLA 3D printer. To maximize the performance of the cell, the area where the cathode contacts the anode and air is maximized. (b) Full cell configuratrion using PDMS and clamp to close the distance between TMG electrode and air-breathing cathode.

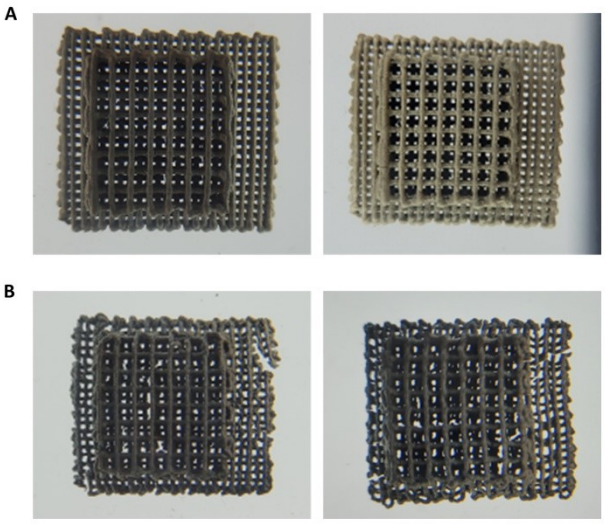

Fig. S6 Images of electrode structure 3D printed with (a) CB1.3 or (b) CB2.0 inks and freeze-dried for 24 hours (left) and 48 hours (right), respectively.

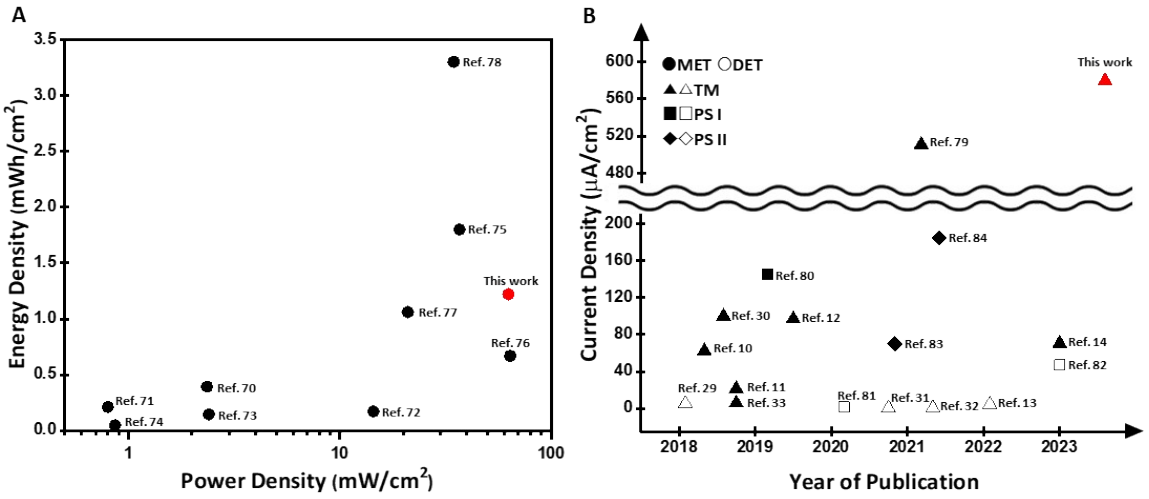

Fig. S7 a) Areal energy/power densities compared with other reported devices. b) The plot of the photocurrent density values of the research according to the year of publication.

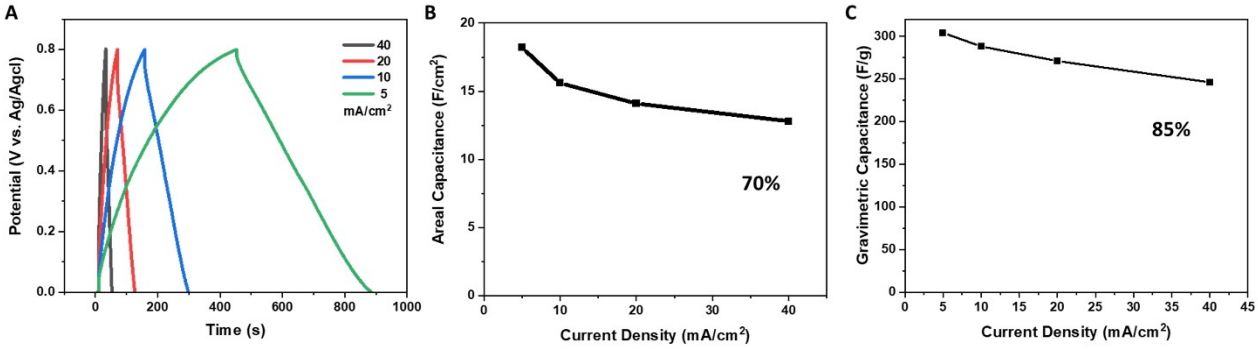

Fig. S8 (a) Charge-discharge, (b) rate capability, and (c) areal capacitance curves of 8-layer supercapacitor electrode at different current densities.

	Mn 3s			
	E_1 (eV)	E_2 (eV)	ΔE (eV)	Valence state
Potential scan rates for electrodeposition				
100 mV/s	83.28	88.68	5.4	+2, 3, 4
200 mV/s	83.38	88.58	5.2	+3, 4
300 mV/s	83.58	88.68	5.1	+3, 4
400 mV/s	83.68	88.58	4.9	+3, 4
Authentic Samples				
MnO			5.79	+2
Mn_3O_4			5.50	+2, 3
Mn_2O_3			5.41	+3
MnO_2			4.78	+4

Table S1 XPS Mn 3s peak analytical results of Mn oxide layer.