Supporting Information

Carbon nanoparticles of Chinese ink-wrapped natural loofah sponge: a low-cost three-dimensional electrode for high-performance microbial energy harvesting

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Table S1 Stock suspension of 5 brands of CI used in this study

Chinese ink	Suppliers
Zhujiang Ink	Jinjian office supplies factory, Guangzhou, China
Shuchang ink	Shaoyang renfa ink factory, Hunan, China
Red apple ink	Linyi a pen stationery Co., Ltd, Shandong, China
Song ink	Sangzhi stationery factory, Hunan, China
Xiangzi ink	Changsha Dongfeng Ink Co., Ltd, Hunan, China

Table S2 Performances of various 3D electrodes with different skeletons and brands of CI

Electrodes	Chinese ink	EIS (Ω)		Conductivity (S/m)	j (mA/cm^3)
		R_Ω	R_{ct}		
CF	No	4.2	132.2	220.0 ± 6.0	4.0 ± 0.6
LSC	No	4.1	10.8	15.8 ±1.0	18.6 ± 0.6
CI-SP	Zhujiang Ink	4.9	45.2	3.1 ± 0.3	5.6 ± 0.6
CI-LS-5	Zhujiang Ink	4.1	13.1	9.5 ± 0.8	16.3 ± 0.6
CI-LS-5	Shuchang Ink	4.2	42.8	4.3 ± 0.5	10.1 ± 0.4
CI-LS-5	Song Ink	4.0	61.2	1.8 ± 0.4	5.2 ± 0.3
CI-LS-5	Red apple Ink	3.9	102.8	0.8 ± 0.2	2.8 ± 0.4
CI-LS-5	Xiangzi Ink	4.0	127.5	0.3 ± 0.1	0.5 ± 0.1

Table S3 Capital expenditure of various 3D electrodes

Cost[a]	LSC[b]	CI-LS-5[c]	Carbon Felt[d]	Graphene-Sponge[e]
Raw materials	--	$ 1300		
Energy Consumption	$ 4400	--		
Total	$ 4400	$ 1300	$ 4200	$ 2000

[a]: the cost was calculated for 1 m^3.

[b]:The price of LSC is estimated as follows: The main cost of the LSC is assigned to the electricity for heat treatment. Our local electricity price is 0.11 US$ for 1000 W/h and the power of the furnace used in this study is 4 kW. We can once maximally treat 200 pieces (1.0 × 1.0 × 0.5 cm). So for 1 hour heat treatment, a piece of LSC costs 0.0022 US$, and the cost of LSC can be roughly calculated to be 4,400 UD $/$m^3$.

[c]:The price of CI-LS-5 is estimated as follows: The main cost of the CI-LS-5 is assigned to the CI. For instance, the price of Zhujiang ink is ca. 1.3 $/L. To make one piece of CI-LS-5 (1.0 × 1.0 × 0.5 cm), 0.5 mL ink is consumed. The cost of CI-LS-5 can be roughly calculated to be 1,300 UD $/$m^3$.

[d]: Purchased from JinGu Carbon Material CO., LTD. (Liaoning, China).

[e]: Calculated by Xie et al. (*Energy Environ. Sci.* **2012**, *5*, 6862−6866).

Note: the unit price used here is based on lab scale, which should be higher than unit price for industrial use.

Figure S1

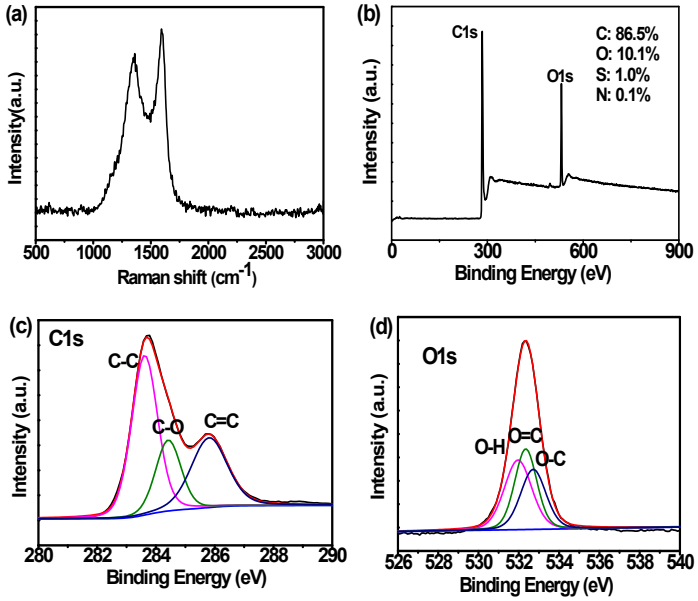

Figure S1 Chemical characterization of the traditional CI. (a) Raman spectrum of the traditional CI; (b) Full-scan XPS of the CI; (c) high resolution C 1s XPS scan of the CI; (d) high resolution O 1s XPS scan of the CI.

Figure S2

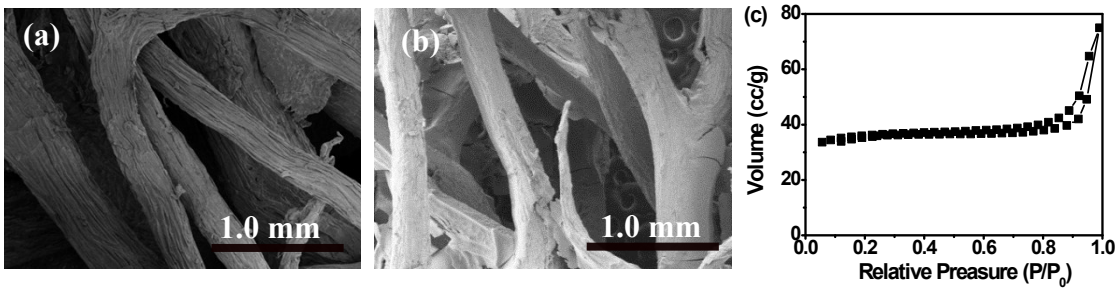

Figure S2 SEM images of the LS before (a) and after (b) application of the ink coating at low magnification, and (c) N_2 adsorption–desorption isotherm for CI-LS-5 electrode.

Figure S3

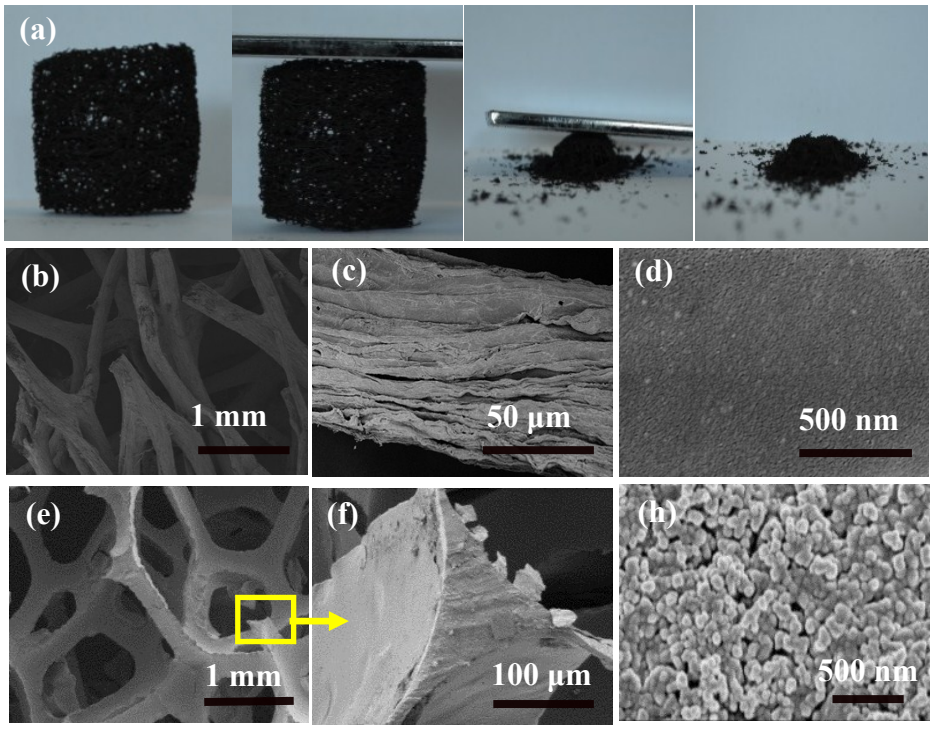

Figure S3 (a) A set of pictures shows the irretrievable process of a compressed LSC; (b-d) SEM images of the LSC; (e-h) SEM images of the CI-SP.

Figure S4

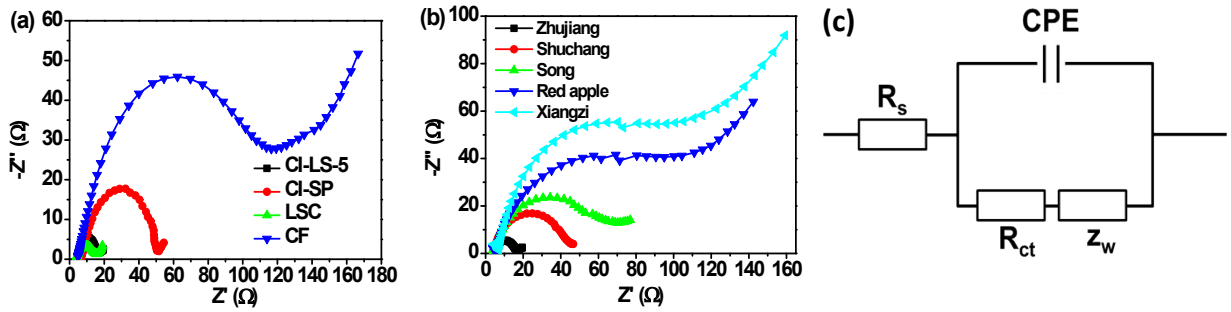

Figure S4 EIS tests for various 3D electrodes (a), CI-LS-5 electrodes with different brands of CI (b), and the equivalent circuit (c).

Figure S5

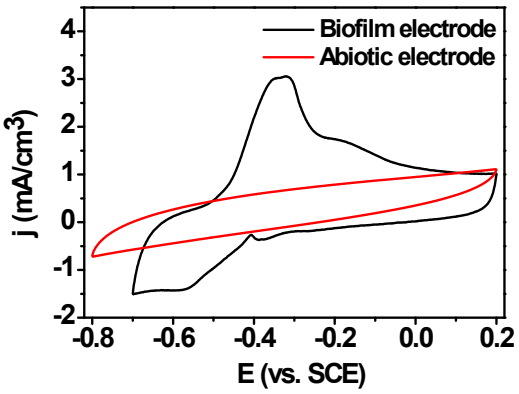

Figure S5 CV of electroactive biofilms grown on the CI-LS-5 electrode in the absence of acetate (Black line) and CV of CI-LS-5 electrode before biofilm growth (Red line) at scan rate of 5 mV/s.

Figure S6

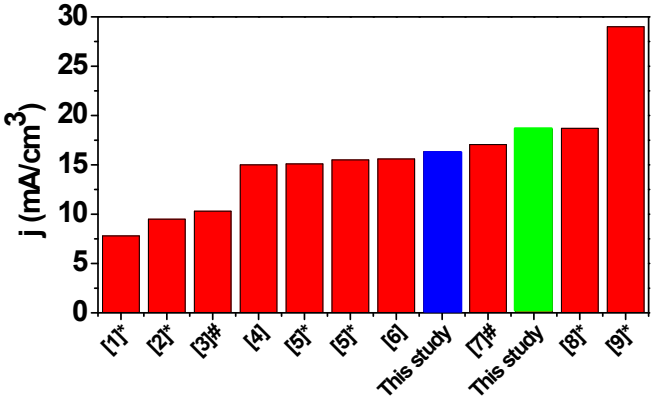

Figure S6 Comparison of CI-LS-5 electrode performance with that of the current state-of-the-art electrodes (The number in brackets indicates the corresponding reference; the blue and green columns represent the CI-LS-5 and LSC electrodes, respectively. The # symbol indicates the use of graphene or carbon nanotubes for constructing 3D electrodes, and the * symbol indicates the use of pyrolysis to fabricate 3D electrodes).

References

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Figure S7

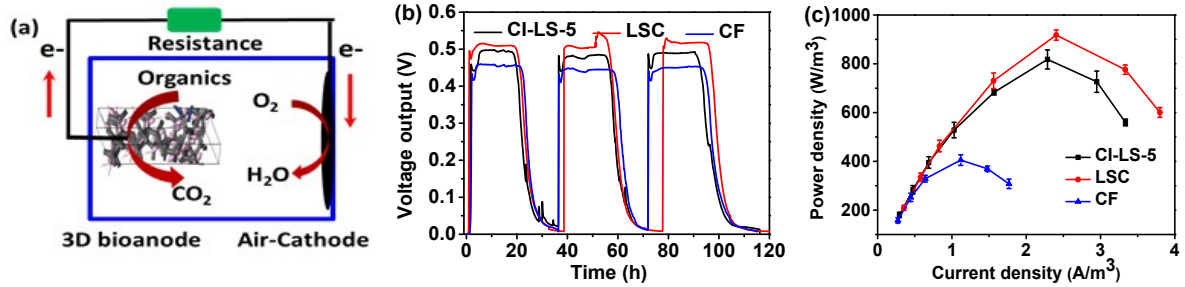

Figure S7 The performance of the as-prepared 3D electrode was examined in a single-chamber microbial fuel cell with an air-cathode. (a) Schematic of the basic configuration of a single chamber air-cathode MFC, in which a wet-proofed carbon cloth loaded with Pt/C is used as an air cathode and a biofilm-attached 3D electrode is used as a bioanode; (b) voltage output curves of the MFCs equipped with different anodes at 1000 ohm; (c) power output curves of the MFCs equipped with different anodes.

Figure S8

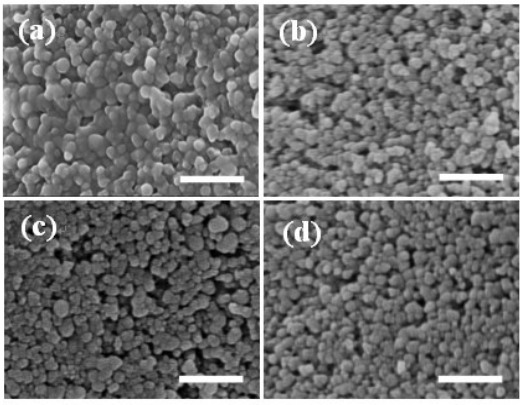

Figure S8 SEM images of four brands of CI used for coating LS (Scale bar: 1 μM): (a) Shuchang Ink; (b) Song Ink; (c) Red apple Ink; (d) Xiangzi Ink.

Figure S9

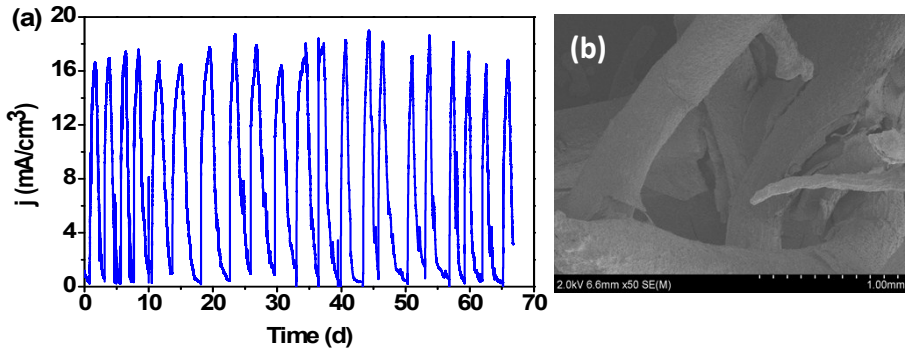

Figure S9 (a) Bioelectrocatalytic current generation at the CI-LS-5 electrode versus time during long-term operation; (b) SEM image of the bioelectrode after 70 days of operation.