One-step preparation of eggplant-derived hierarchical porous graphitic biochar as efficient oxygen reduction catalyst in microbial fuel cells

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Text S1. Conversion of potential between Ag/AgCl electrode and reversible hydrogen electrode (RHE)

All the electrochemical measurements were performed with a three-electrode system in 50 mM PBS solution. The reference electrode Ag/AgCl was filled with 4 M KCl gel solution. The potentials could be converted to vs. a reversible hydrogen electrode (RHE) which is calculated from Eq. (S1).

$$E_{RHE} = E_{vs.\,Ag/AgCl} + 0.0591 * pH + 0.199 \qquad \text{(S1)}$$

Where E_{RHE} would be the measured potential vs. a reversible hydrogen electrode, $E_{vs.\ Ag/AgCl}$ is the experimentally tested potential vs. Ag/AgCl reference electrode. 0.199 V is the formal potential of an Ag/AgCl electrode with 4 M KCl filling solution at 25 °C vs. NHE according to the Phychemi Co., Ltd.

Test. S2 Electrode preparation method

The anode material is carbon felt (2 × 2 cm), soaked in acetone overnight, then thoroughly washed with deionized water, and dried in an oven at 60°C for using. Cathode material was carbon cloth (project area: 7 cm^2) including a gas diffusion layer, carbon-based layer, and catalyst layer (0.5 mg/cm^2). The gas diffusion layer was fabricated by coating polytetrafluoroethylene (PTFE) solution (60 wt%, Hesen, Shanghai, China) on the carbon-based layer and annealing at 370 °C for 15 min in a muffle furnace; this process was repeated four times. The catalyst ink was prepared by sonicating a mixture comprising the catalyst (3.5 mg), nafion solution (25 μL), isopropanol (15 μL), and deionized water (5 μL) for 20 min. The uniform catalyst ink was brushed on the carbon cloth and dried at 28 °C for 24h. In addition, Pt/C cathode (20 wt%, 0.5 mg/cm^2) was fabricated by the same operation process as a reference to probe the performance of the EPGC catalysts.

Table S1 Nutrient solution formula used in MFCs.

Phosphate buffer solution (g / L)		Trace metal solution (mg / L)		Vitamin solution (mg / L)	
Component	Concentration	Component	Concentration	Component	Concentration
NH_4Cl	0.31	Nitrilotriacetic acid	1.5	Biotin	2.0
KCl	0.13	$MgSO_4 \cdot 7H_2O$	3.0	folic acid	2.0
$NaH_2PO_4 \cdot 2H_2O$	2.75	$MnSO_4 \cdot 2H_2O$	0.5	pyridoxine HCl	10.0
$Na_2HPO_4 \cdot 12H_2O$	11.466	NaCl	1.0	riboflavin	5.0
		$FeSO_4 \cdot 7H_2O$	0.1	thiamin	5.0
		$CaCl \cdot 2H_2O$	0.1	nicotinic acid	5.0
		$CoCl_2 \cdot 6H_2O$	0.1	Pantothenic acid	5.0
		$ZnSo_4$	0.1	Vitamin B12	0.1
		$CuSO_4 \cdot 5H_2O$	0.01	paminobenzoic acid	5.0
		$AlK(SO_4)_2 \cdot 12H_2O$	0.01	thioctic acid	5.0
		H_3BO_3	0.01		
		$Na_2MoO_4 \cdot 2H_2O$	0.01		
		$NiCl_2 \cdot 6H_2O$	0.024		
		$NaWO_4 \cdot 2H_2O$	0.025		

Table S2 Chemical composition of the samples and N1s components (values given in % of total amount N) based on XPS measurements

Samples	at.% (C)	at.% (O)	at.% (N)	Pyridinic N (%)	Pyrrolic N (%)	Graphitic N (%)	Oxidized N (%)
EPGC-700-2	85.35	8.82	5.83	43.73	38.67	6.93	10.67
EPGC-800-1	85.96	9.62	4.43	46.10	35.13	9.42	9.35
EPGC-800-2	86.37	10.01	3.62	67.40	20.88	7.89	3.83
EPGC-800-3	89.82	7.52	2.66	58.91	30.63	4.68	5.78
EPGC-900-2	90.55	7.63	1.82	62.94	25.74	8.32	3.00

Table S3 Comparison of the structure and performance of EPGC-800-2 and other carbon-based ORR catalysts

Catalysts	Specific surface area (m^2/g)	I_D/I_G	Onset potential (V vs Ag/AgCl)	half-wave potential (V vs Ag/AgCl)	*n*	Ref.
EPGC-800-2	1137	0.76	0.153	-0.022	3.90	This study
NC/Fe_8Co_2	561.02		-0.02	-0.12	3.87-3.93	[1]
PR-C (1:3.5)	416.7	1.27	0.087	-0.048	3.2	[2]
CE–Fe–MWNT	680	1.05	−0.007	−0.133	3.83	[3]
PAC-800	1273.8	1.05	0.03	-0.13	3.72-3.96	[4]
e-BAC	114	2.26	-0.200	-0.3		[5]
Fe_3O_4@N-mC	26.73	1.24		-0.257	3.76	[6]
NC-3	609.1	1.13	0.132	-0.041	3.34-3.71	[7]
TGC-900	651.78	1.04	-0.027	-0.154	3.48-3.84	[8]
Mn–Fe@g-C3N4	268.6	1.14	0.197	-0.174	3.94	[9]
ZIF-8	1416		0.11	−0.32	3.83	[10]
CP-M-Z	636.99	2.64	0.16	-0.128	3.87-3.93	[11]
CN800	143		0.215	-0.096	3.1	[12]
HC-900	908.9	1.29	-0.015	-0.129	3.65-3.93	[13]

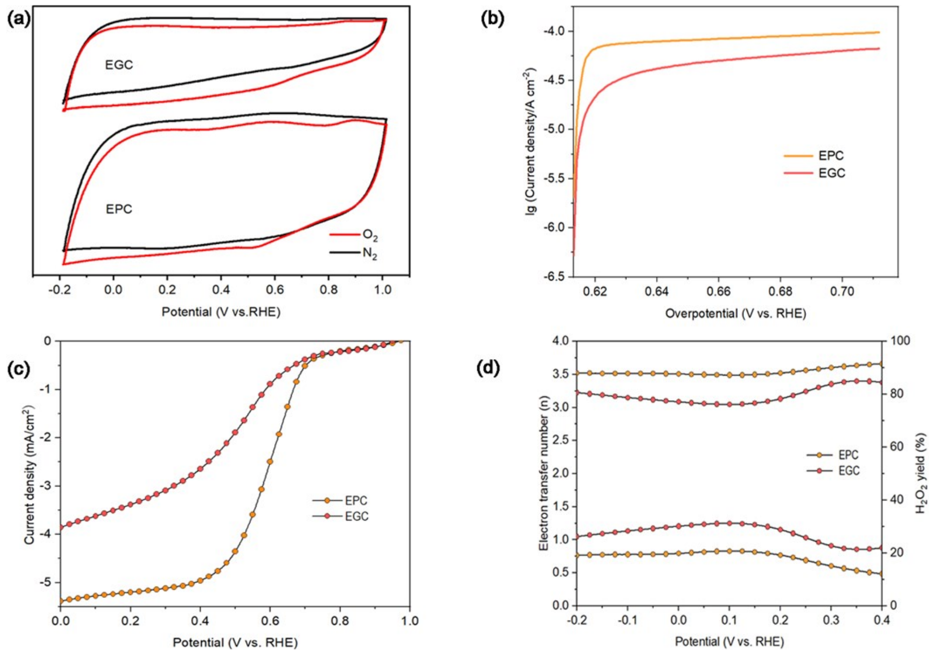

Fig. S1 (a) CV curves in N_2- and O_2-saturated 50 mM PBS solutions at 5 mV/s, (b) Tafel plots, (c) LSV curves in O_2-saturated 50 mM PBS with 1600 rpm at 5 mV/s, (d) electron transfer numbers (*n*) and H_2O_2 yield of EPC and EGC.

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