Supplementary Information

Nitrogen-containing three-dimensional biomass porous carbon materials as an efficient enzymatic biosensing platform for glucose sensing

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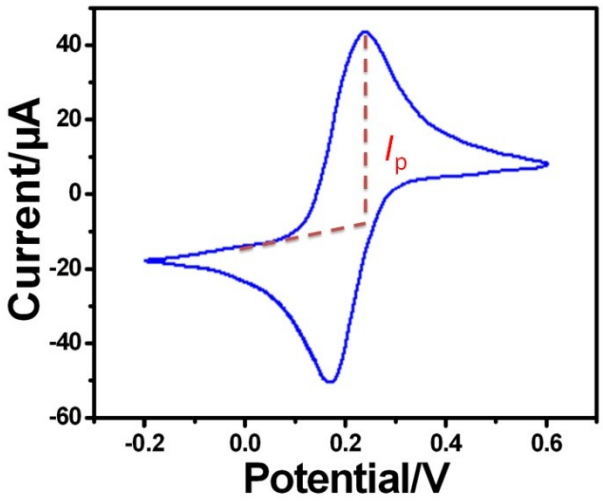

Fig. S1. CVs of GC electrode (A) and 3D-KSC electrode (B) in 0.1 M KCl solution containing 5.0 mM $Fe(CN)_6^{3-/4-}$ at 50 mVs^{-1}.

The effective surface areas (A_{eff}) of various 3D-CVS electrodes were estimated before use based on the CVs in 0.1 M KCl solution containing 5.0 mM $Fe(CN)_6^{3-/4-}$ at 0.05 V s^{-1} according to Randles-Sevcik equation:

$$I_p = 2.69\times10^5 A n^{3/2} D_0^{1/2} v^{1/2} C_0 \quad (1)$$

where n is the number of electrons participating in the redox (n = 1 for $Fe(CN)_6^{3-/4-}$), D_0 is the diffusion coefficient of the molecule in a solution (0.673×10^{-5} cm^2 s^{-1} for $Fe(CN)_6^{3-/4-}$ in 0.1 M KCl solution, C_0 is the bulk concentration of the redox probe (C_0 = 5 mM of the $Fe(CN)_6^{3-/4-}$). As shown in Fig. S1, the I_p was calculated to be 53.26 and accordingly the value of A_{eff} for the 3D-CVS electrode was estimated to be 0.0682 cm^2.

Preparation of 3D-CVS Porous Carbon

Cane vine (Wisteria) as shown in Fig. S1A is a common wild plant in the subtropical zone. It has strong vitality and fast growth and its stem can grow up to tens of meters. Wisteria stems are brown after natural air drying (as shown in Fig. S1B). After high temperature carbonization, the stem of Wisteria tenuifolia changed from brown to black (as shown in Fig. S1C), but the shape remained cylindrical. More importantly, after high temperature carbonization, the stem of Wisteria tenuifolia had three-dimensional ordered porous structure (as shown in Fig. 1). The procedure for preparing 3D-CVS from Wisteria sinensis stem by high temperature carbonization is as follows: The natural air-dried Wisteria stem was placed in a vacuum oven (80 °C) for drying and dewatering. Then the dried Wisteria stem was put into a high temperature reaction furnace and carbonized at high temperature under the protection of nitrogen. The carbonization process is as follows:

(1) Starting from room temperature, the temperature rises to 100 °C at 10 °C min^{-1} and stays at 100 °C for 30 min;

(2) rises to a specific temperature (800 °C, 900 °C, 1000 °C at 5 °C min^{-1}) and stays at a specific temperature for 1 h;

(3) When the sample is naturally cooled below 100 °C, the 3D-CVS can be obtained.

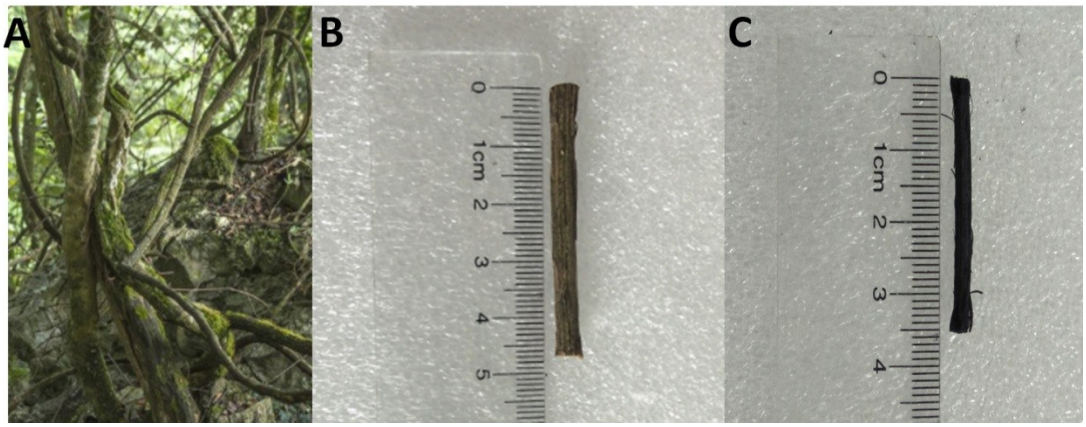

Fig. S2 Digital photograph of wild Cane vine (Wisteria) (A), Cane vine (Wisteria) stem before (B) and after (C) high temperature carbonization

Conductivity test

The conductivity of 3D-CVS processed at different temperatures was tested by a four-probe conductivity tester. The test results are shown in Table S1.

Table S1 Conductivity comparison of 3D-CVS treated at different temperatures.

Sample	Resistivity (Ω.cm)	Conductivity ($s.cm^{-1}$)
3D-CVS-800 °C	1.64	0.61
3D-CVS-900 °C	0.39	2.56
3D-CVS-1000 °C	0.33	3.03

It can be seen from the table S1 that the high temperature carbonized 3D-CVS has good conductivity and is very suitable for the preparation of electrode. In addition, it is found that the higher the temperature, the better the conductivity of the material. The electrical conductivities of 3D-CVS treated at 900 and 1000 °C are 2.10 $s.cm^{-1}$ and 3.20 $s.cm^{-1}$, respectively, and which are four and five times higher than that

treated at 800 °C. In order to reduce the internal resistance of the integrated electrode as much as possible and ensure the toughness of the electrode material, we chose 900 °C as the carbonization temperature.

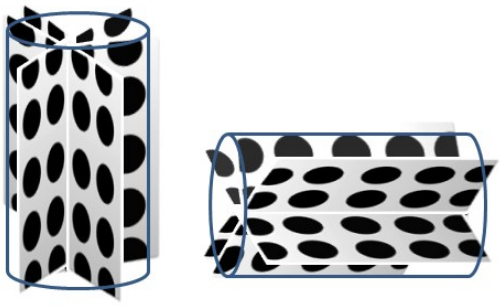

Fig. S3 Cartoon structures of 3D-CVS.

Table S2. Fitting results of the impedance spectra for the 3D-CVS/GOD electrode

Electrode	R_S (Ω.)	Cdl (μF)	Rct (Ω)	W (mΩ)
3D-CVS	4.59	3.09	49.32	3.116
3D-CVS/GOD	13.92	1.83	168.6	3.007

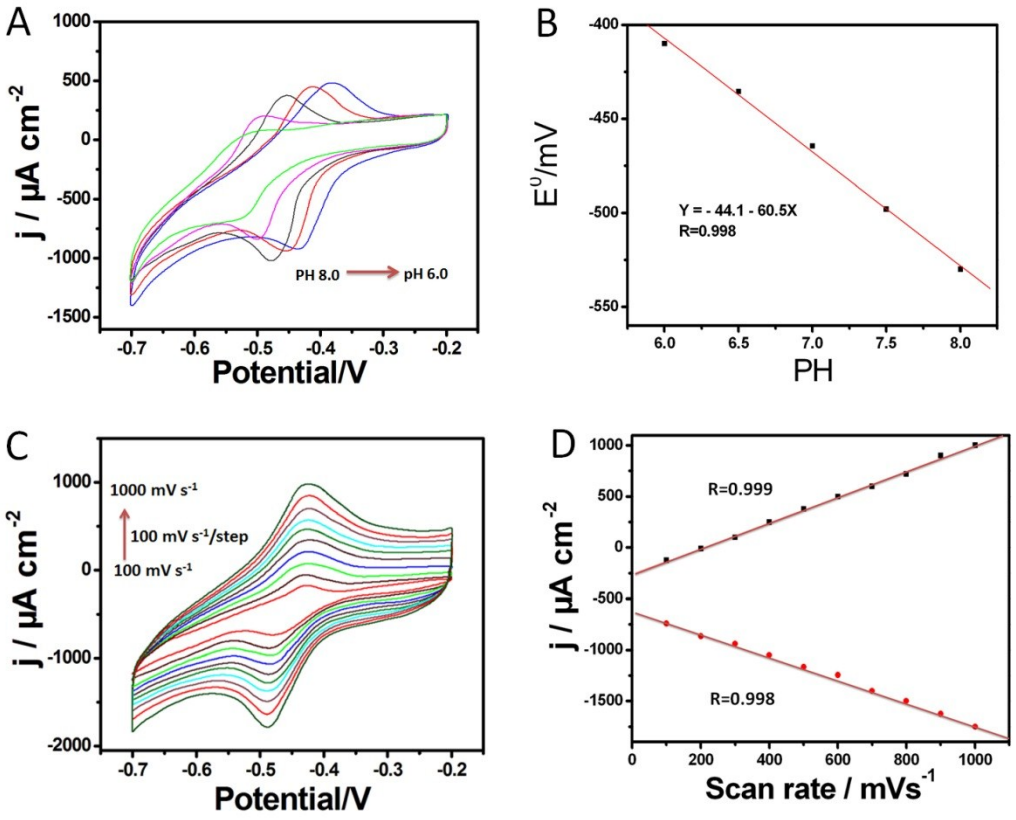

Fig. S4 Schematic illustration of the fabrication and structure of the 3D-CVS/GOD electrode.

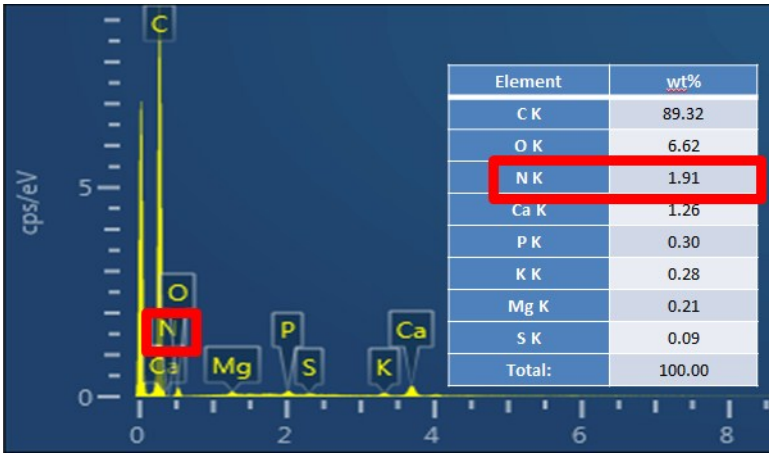

Fig. S5 EDS curve of 3D-CVS.

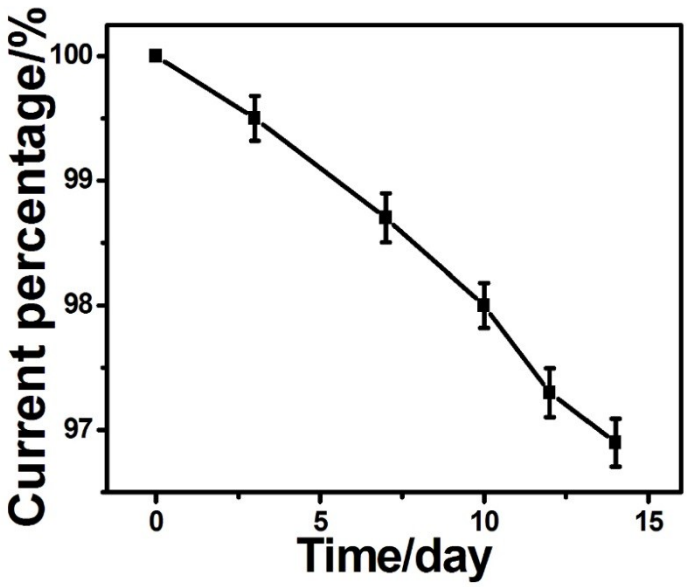

Fig. S6. Stability test of the 3D-CVS/GOD electrode in determination of 2.0 mM glucose in 15 days.

Table S3. Determination of glucose in blood serum sample.

Blood serum sample (mM)	Diluted samples (mM)	Added (mM)	Determined by colorimetric enzymatic method (mM)	Determined by 3D-CVS/ GOD sensor (mM)	Recovery (%)	RSD (%, n=5)
9.25	1.85	1.00	2.89	2.82	98.95	3.20
	4.57	1.00	5.68	5.53	99.28	3.16
	6.31	1.00	7.20	7.25	99.18	3.19
	7.95	1.00	9.01	8.86	98.99	3.17
	9.05	1.00	10.14	10.17	101.19	3.21