Supporting Information

Enokitake Mushroom-like Standing Gold Nanowires Towards Wearable Non-Invasive Bimodal Glucose and Strain Sensing

Qingfeng Zhai[1,2], Shu Gong[1,2],Yan Wang[1,2], Quanxia Lyu[1, 2], YiYi Liu[1,2,] Yunzhi Ling[1,2], Joseph Wang[3],

George. P. Simon[2,4], Wenlong Cheng[1,2,5*]

[1]*Department of Chemical Engineering, Monash University, Clayton, Victoria 3800, Australia;*

[2]*New Horizon Research Centre, Monash University, Clayton, Victoria 3800, Australia;*

[3]*Department of Nanoengineering, University of California, San Diego, La Jolla, CA, USA;*

[4]*Department of Materials Science and Engineering, Monash University, Clayton, Victoria 3800, Australia;*

[5]*The Melbourne Centre for Nanofabrication, Clayton, Victoria 3800, Australia;*

*Correspondence author. Email: W. L. Cheng (wenlong.cheng@monash.edu)

Table of contents

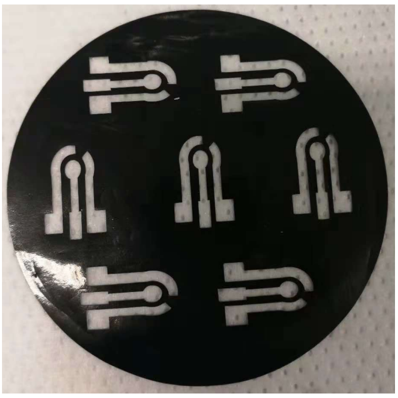


Figure S1. Specially designed mask for the fabrication of v-Au NWs arrays based stretchable electrode.

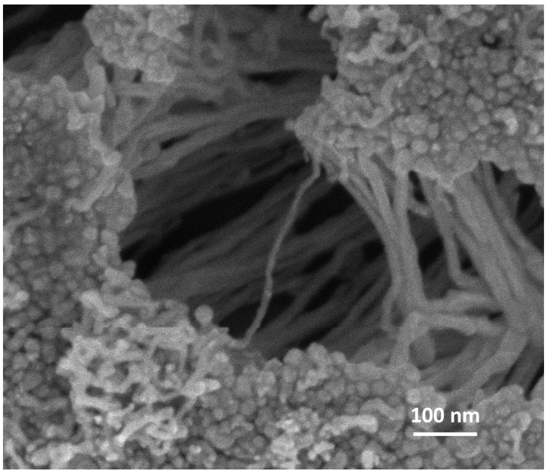


Figure S2. SEM micrograph of the obtained v-Au NWs arrays film.

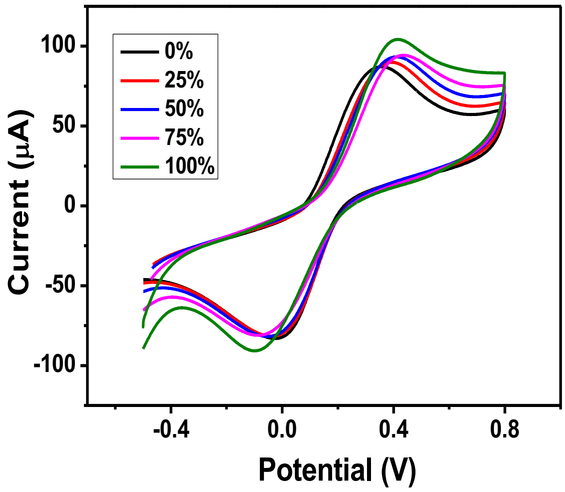


Figure S3. Cyclic voltammograms in 5 mM $Fe(CN)_6^{3-/4-}$ after strain was applied 50 times at 0%, 25%, 50%, 75% and 100%.

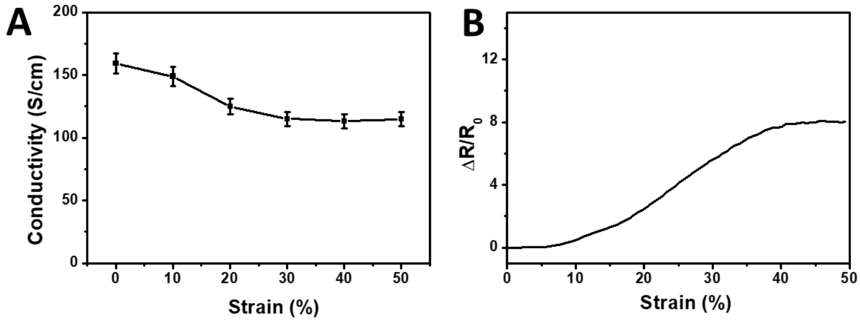


Figure S4. The conductivity and resistance change of the stretchable electrode that along with the strains from 0% to 50%.

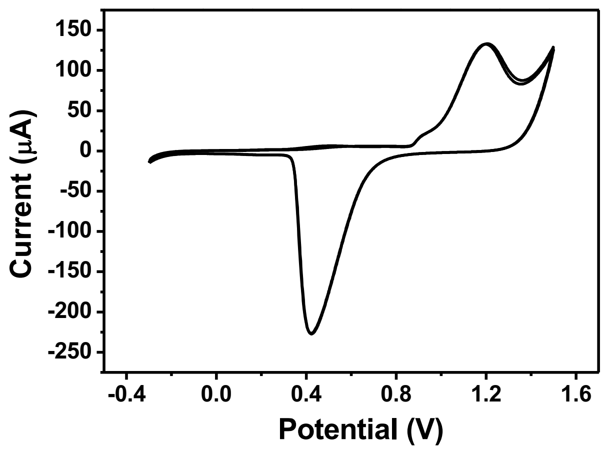


Figure S5. Cyclic voltammograms in 1.0 M H_2SO_4 that scan from -0.3 V to 1.5 V with the scan rate of 0.1 V/s.

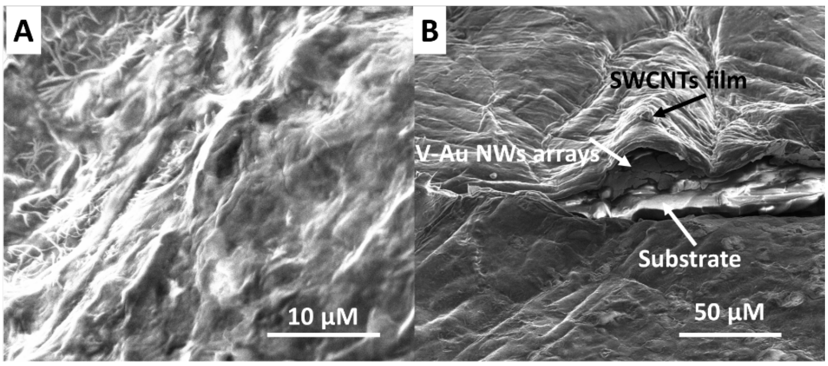


Figure S6. SEM micrographs of SWCNTs-coated v-AuNWs arrays electrode. (A) Top view, (B) Cross-section.

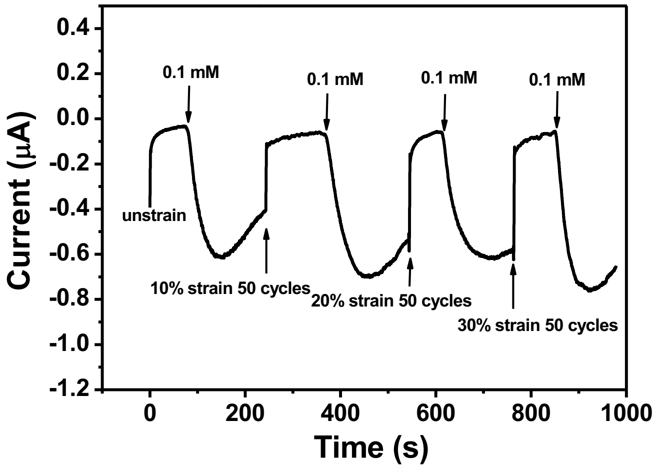


Figure S7. The detection performance of the proposed biosensor for 0.1 mM glucose after strain was applied for 50 times at different states.

Table S1. Comparison of analytical characteristics for several GOx based electrochemical glucose sensors.

Electrodes	Sensitivity ($\mu A\ mM^{-1}\ cm^{-2}$)	LOD (μM)	Linear Range (mM)	Flexiblity	Stretchability	Detection Performance at Stretched State	Ref.
chitosan–ferrocene/graphene oxide/GOx	10	7.6	0.02 - 6.78	Yes	No	No	1
GOx/ZnO-NWs/Au/PET	19.5	<50	0.2-2.0	Yes	No	No	2
PET/VACNT-Al foil/PFLO/GOx	65.816	7	0.02-0.5	Yes	No	No	3
rGO/PtAu/GOx	48	5	0-2.4	Yes	No	No	4
GOx/Pt-graphite	105	10	0-0.9	Yes	Yes	Not Given	5
PPy/PB/GOx-modified graphite	1.9	-	-0.05-0.5	No	No	No	6
GOx/ nanostructured graphene/polyaniline	22.1	2.8	0.01-1.48	No	No	No	7
Au nanosheet/$CoWO_4$/CNTs	10.89	1.3	0-0.3	Yes	Yes	Not given	8
v-Au NWs/PBs/CNTs-GOx	23.7	10	0-1.4	Yes	Yes	Under 30% strain with the sensitivity of 4.55 $\mu A \cdot mM^{-1} \cdot cm^{-2}$	This work

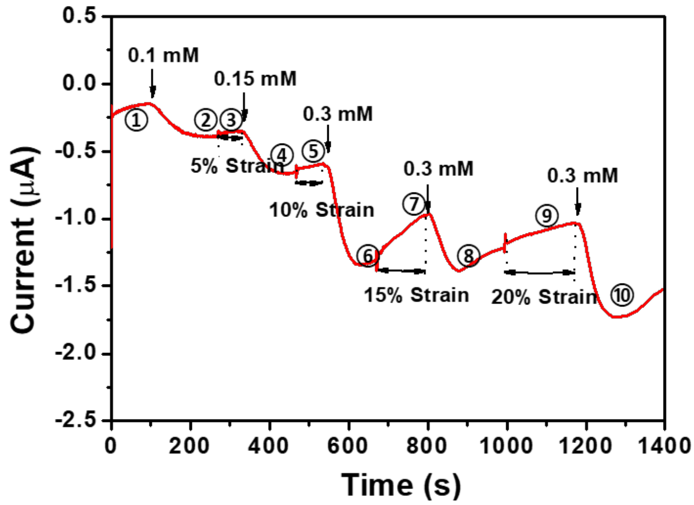
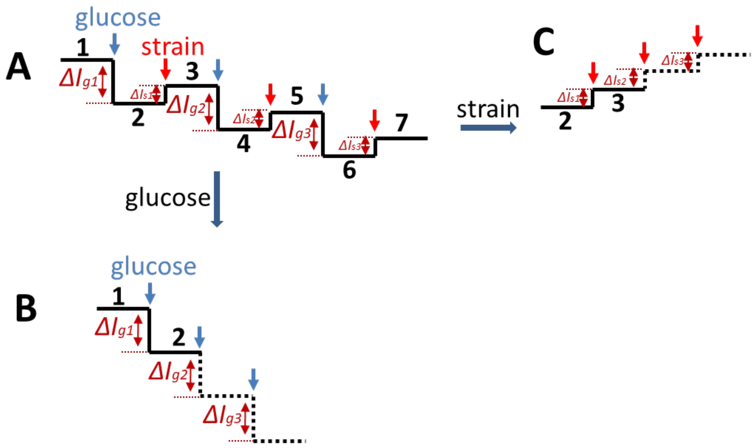


Figure S8. The chronoamperometric response of the stretchable bimodal sensor based on the 3-electrode system upon the successive addition of glucose and application of strains.

Table S2. The value of current that extracted from the original chronoamperometric response of the proposed bimodal sensor at the corresponding states that addition of glucose and application of strains.

States	Current (I, μA)	Glucose (mM)	ΔI (μA)	Strain (%)	ΔI (μA)
①	0.1489	0.1	0.2377		
②	0.3866			5	-0.0253
③	0.3613	0.15	0.2451		
④	0.6640			5	-0.0613
⑤	0.6027	0.3	0.7237		
⑥	1.3264			5	-0.3393
⑦	0.9871	0.3	0.3932		
⑧	1.3803			5	-0.3399
⑨	1.0404	0.3	0.6881		
⑩	1.7285				



Scheme S1. Schematics of extracting the Faradic current responses to glucose (B) and strains (C) respectively from one ideal chronoamperometric curve (A) of the stretchable biosensor.

Scheme S1 illustrates how we extracted the Faradic current responses to glucose and strains respectively from one ideal chronoamperometric curve as shown in **Scheme S1**. Basically, glucose addition caused current increase; whereas, strain caused current reduction. Therefore, we essentially applied 'background' subtraction rule to extract the Faradic signal and resistive signal. For the glucose detection, we subtracted all the "background" from strain, replotted as shown in **Scheme S1 B**; as for strain detection, we subtracted all "Faradic background currents" from glucose addition, and then replotted as shown in **Scheme S1** C. And the detailed discussions have been added in Supporting Information (Page S-8).

In this work, the gauge factor was calculated by the value of the current using the following equation[9]:

$$\mathrm{GF} = \frac{\frac{I - I_0}{I_o}}{\varepsilon}$$

Where the I and I_0 was the current before and after applying strains, ε is the applied strain.

References:

1. Qiu, J.-D.; Huang, J.; Liang, R.-P. Nanocomposite Film Based on Graphene Oxide for High Performance Flexible Glucose Biosensor. *Sensor. Actuat. B- Chem.* **2011**, 160 (1), 287-294.
2. Pradhan, D.; Niroui, F.; Leung, K. High-performance, Flexible Enzymatic Glucose Biosensor Based on ZnO Nanowires Supported on A Gold-coated Polyester Substrate. *ACS Appl. Mater. Inter.* **2010**, 2 (8), 2409-2412.
3. Gokoglan, T. C.; Soylemez, S.; Kesik, M.; Dogru, I. B.; Turel, O.; Yuksel, R.; Unalan, H. E.; Toppare, L. A Novel Approach for The Fabrication of A Flexible Glucose Biosensor: The Combination of Vertically Aligned CNTs and A Conjugated Polymer. *Food Chem.* **2017**, 220, 299-305.
4. Xuan, X.; Yoon, H. S.; Park, J. Y. A Wearable Electrochemical Glucose Sensor Based on Simple and Low-cost Fabrication Supported Micro-patterned Reduced Graphene Oxide Nanocomposite Electrode on Flexible Substrate. *Biosens. Bioelectron.***2018**, 109, 75-82.
5. Abellán-Llobregat, A.; Jeerapan, I.; Bandodkar, A.; Vidal, L.; Canals, A.; Wang, J.; Morallon, E. A Stretchable and Screen-printed Electrochemical Sensor for Glucose Determination in Human Perspiration. *Biosens. Bioelectron.* **2017**, 91, 885-891.
6. Ramanavicius, A.; Rekertaitė, A. I.; Valiūnas, R.; Valiūnienė, A. Single-step Procedure for The Modification of Graphite Electrode by Composite Layer Based on Polypyrrole, Prussian Blue and Glucose Oxidase. *Sensor. Actuat. B-Chem.* **2017**, 240, 220-223.
7. Feng, X.; Cheng, H.; Pan, Y.; Zheng, H. Development of Glucose Biosensors Based on Nanostructured Graphene-Conducting Polyaniline Composite. *Biosens. Bioelectron.* **2015**, 70, 411-417.
8. Oh, S. Y.; Hong, S. Y.; Jeong, Y. R.; Yun, J.; Park, H.; Jin, S. W.; Lee, G.; Oh, J. H.; Lee, H.; Lee, S.-S., Skin-Attachable, Stretchable Electrochemical Sweat Sensor for Glucose and pH Detection. *ACS Appl. Mater. Inter.* 2018, 10 (16), 13729.
9. Gong, S.; Schwalb, W.; Wang, Y.; Chen, Y.; Tang, Y.; Si, J.; Shirinzadeh, B.; Cheng, W., A Wearable and Highly Sensitive Pressure Sensor with Ultrathin Gold Nanowires. *Nat. Commun.* **2014,** *5*, 3132.