Electronic Supplementary Material (ESI) for Engineered Science

Electronic Supplementary Information

Robust construction of flexible bacterial cellulose@$Ni(OH)_2$ paper: Toward high capacitance and sensitive H_2O_2 detection

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Methods

The areal specific capacitance (C_s) of supercapacitor electrode can be estimated based on the charge-discharge curves using the following equation [1].

$$C_s = \frac{I\Delta t}{S\Delta V}$$

Here I is the discharge current (mA cm^{-2}), Δt represents to the discharge time (s), ΔV is the potential difference (v) and S refers the nominal electrode area (cm^{-2}).

The recovery percent (% R) of milk samples was determined reagent based on the following equation [2].

$$R\ (\%) = \frac{C_{sp} - C_{un}}{C_{kn}} \times 100\%$$

C_{sp}: result of spiked sample

C_{un}: result of unspiked sample

C_{kn}: known spike added concentration

Figures

Fig.S1

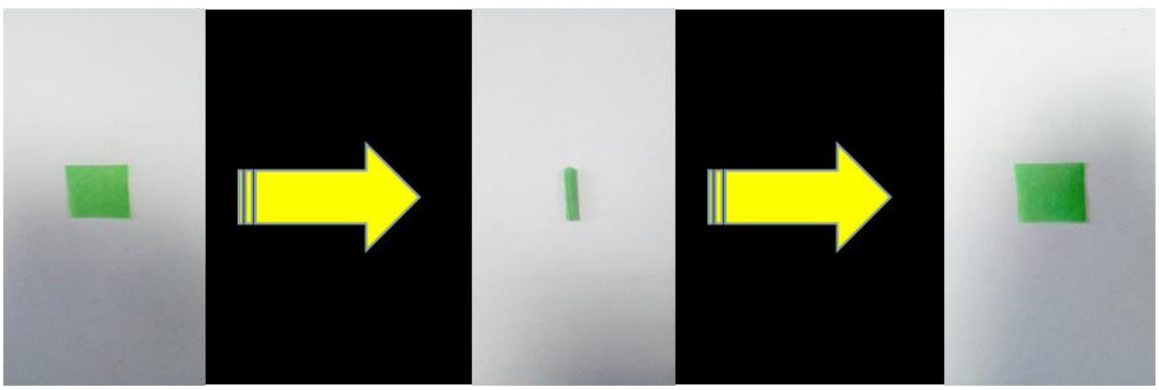

Fig.S1 Photographs showing the flexibility of BC@$Ni(OH)_2$ paper.

Fig.S2

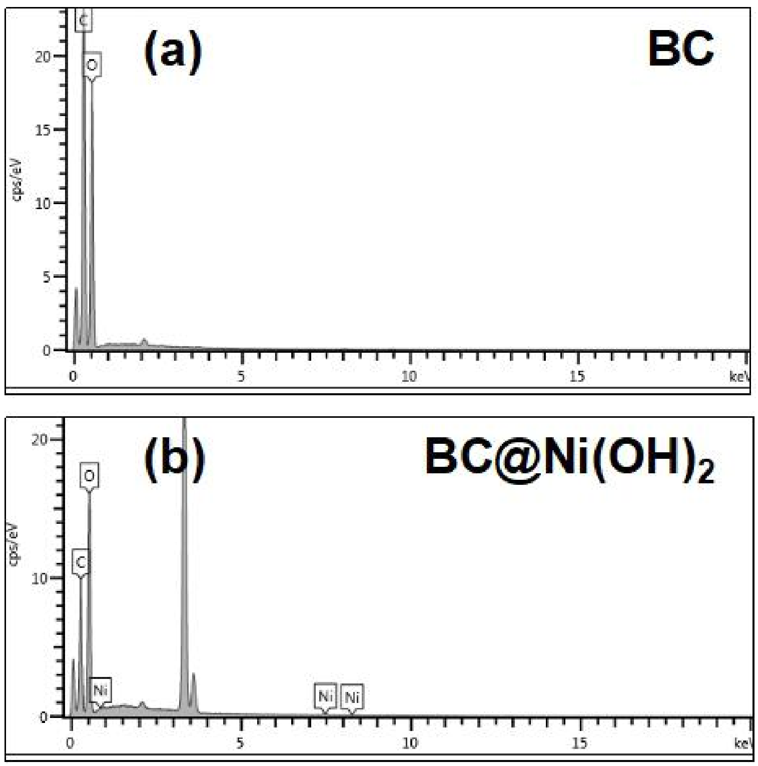

Fig.S2 EDS patterns of the BC (a) and BC@$Ni(OH)_2$ (b) membranes.

Fig.S3

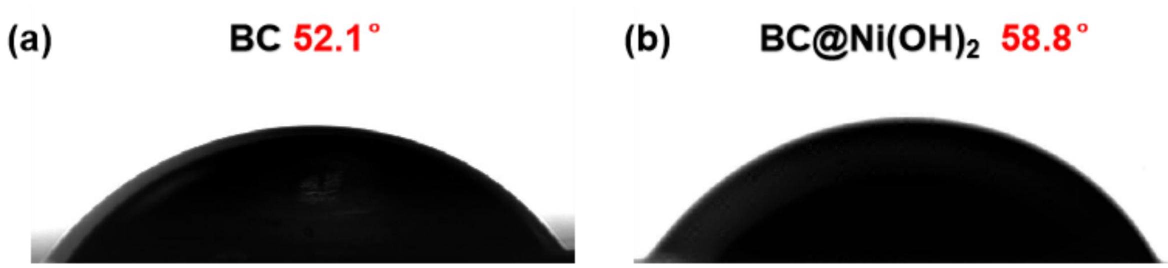

Fig.S3 Water contact angle measurement for BC (a) and BC@Ni$(OH)_2$ (b).

Fig.S4

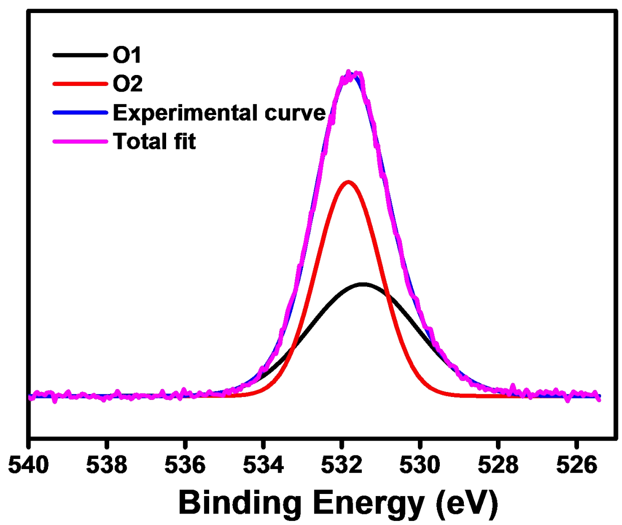

Fig.S4 O1s XPS core-level spectrum of BC.

Fig.S5

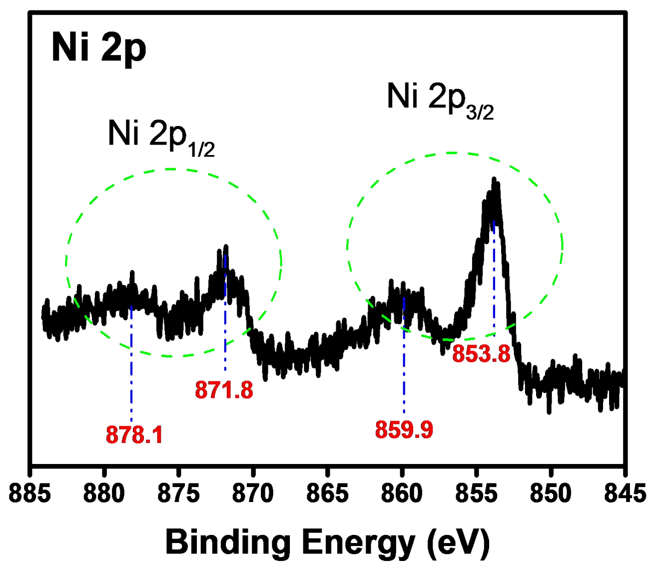

Fig.S5 High-resolution XPS spectra of deconvoluted Ni2p of BC@$Ni(OH)_2$.

Tables

Table S1

Specific capacitance (C_s) of metal oxide/hydroxide flexible electrodes reported the literature.

Electrode sample	Electrolyte	C_s (mF cm^{-2})		Ref
MnO_2 nanosheet/carbon cloth	0.1 M Na_2SO_4	230	(at 0.13 mA cm^{-2})	[3]
Co-Al Hydroxide nanosheets/Graphene	1.0 M KOH	70	(at 5 mV s^{-1})	[4]
Graphite/PEDOT/MnO_2	0.1 M Na_2SO_4	316	(at 10 mV s^{-1})	[5]
$Ni(OH)_2$/conducting paper	1.0 M KOH	1646	(at 5 mV s^{-1})	[6]
Bi_2O_3/carbon nanofiber	1.0 M Na_2SO_4	525	(at 0.13 mA cm^{-2})	[7]
$Ni(OH)_2$-H/RGO/BC	2.0 M KOH	10437	(at 5 mA cm^{-2})	[1]
NiO@MnO_2	2.0 M KOH	159.2	(at 1.5mA cm^{-2})	[8]
BC@$Ni(OH)_2$	6.0 M KOH	2047	(at 5 mA cm^{-2})	This work

Table S2

Comparison of the performances of different H_2O_2 sensors. Comparison of performance of the present sensor with recently reported sensors

electrode materials	Linear range (mM)	Detection limit (uM)	Ref.
AgNPs/CNT/GET	0.1-10	2	[9]
$Cu-Ni(OH)_2/GCE$	$5-145\times10^{-3}$	1.5	[10]
Pure Pd hollow	0.1-24	7.4	[11]
Ag@C@Ag/GCE	0.07-10	23	[12]
Ag NW	0.1-3.1	29.2	[13]
Ni/Ag@C	0.03-17	10	[14]
Fe_3O_4@C-Cu/GET	0.08-372	32.6	[15]
Ag microspheres/GCE	0.25-2	1.2	[16]
Ni-BC@$Ni(OH)_2$	0.1-12.4	0.28	This work

Table S3 Determination results of H_2O_2 in real sample (different kinds of milk)

Sample	H_2O_2 concentration in the sample (mmol L^{-1})	Added H_2O_2 concentration (mmol L^{-1})	Analyte H_2O_2 concentration (mmol L^{-1})	Recovery (%)
No.1	0	0.5	0.476	95.2%
	0	1	0.985	98.5%
No.2	0	0.5	0.513	102.6%
	0	1	0.969	96.9%
No3	0	0.5	0.482	96.4%
	0	1	1.047	104.7%

References

1. L. Ma, R. Liu, L. Liu, F. Wang, H. Niu and Y. Huang, *J Power Sources*, 2016, **335**, 76-83.
2. M. Saraf, R. Rajak and S. M. Mobin, *J Mater Chem A*, 2016, **4**, 16432-16445.
3. Y. C. Chen, Y. K. Hsu, Y. G. Lin, Y. K. Lin, Y. Y. Horng, L. C. Chen and K. H. Chen, *Electrochim Acta*, 2011, **56**, 7124-7130.
4. X. Dong, L. Wang, D. Wang, C. Li and J. Jin, *Langmuir*, 2012, **28**, 293-298.
5. P. Tang, L. Han and L. Zhang, *Acs Appl Mater Interfaces*, 2014, **6**, 10506-10515.
6. J. X. Feng, S. H. Ye, X. F. Lu, Y. X. Tong and G. R. Li, *Acs Appl Mater Interfaces*, 2015, **7**, 11444-11451.
7. H. Xu, X. Hu, H. Yang, Y. Sun, C. Hu and Y. Huang, *Adv Energy Mater*, 2015, **5**, 1401882.
8. X. Liu, J. Wang and G. Yang, *Chem Eng J*, 2018.
9. A. Afraz and A. A. Rafati, *J Solid State Electr*, 2013, **17**, 2017-2025.
10. A. Gu, G. Wang, J. Gu, X. Zhang and B. Fang, *Electrochimica Acta*, 2010, **55**, 7182-7187.
11. G. Nie, X. Lu, J. Lei, L. Yang, X. Bian, Y. Tong and C. Wang, *Electrochimica Acta*, 2013, **99**, 145-151.

12. Q. M. Wang, H. L. Niu, C. J. Mao, J. M. Song and S. Y. Zhang, *Electrochim Acta*, 2014, **127**, 349-354.

13. E. Kurowska, A. Brzózka, M. Jarosz, G. D. Sulka and M. Jaskuła, *Electrochimica Acta*, 2013, **104**, 439-447.

14. Q. Sheng, Y. Shen, J. Zhang and J. Zheng, *Anal Methods*, 2016, **9**, 1759-9660.

15. M. Zhang, Q. Sheng, F. Nie and J. Zheng, *J Electroanal Chem*, 2014, **730**, 10-15.

16. B. Zhao, Z. Liu, Z. Liu, G. Liu, Z. Li, J. Wang and X. Dong, *Electrochem Commun*, 2009, **11**, 1707-1710.