

## **Self-assembly of biomass-based hybrid hydrogel electrode for additive-free flexible supercapacitor**

**Qiong Wu<sup>a</sup>, Chen Jiang <sup>a</sup>, Shouyun Zhang <sup>a</sup>, Shitao Yu <sup>a</sup> and Lang Huang<sup>b\*</sup>**

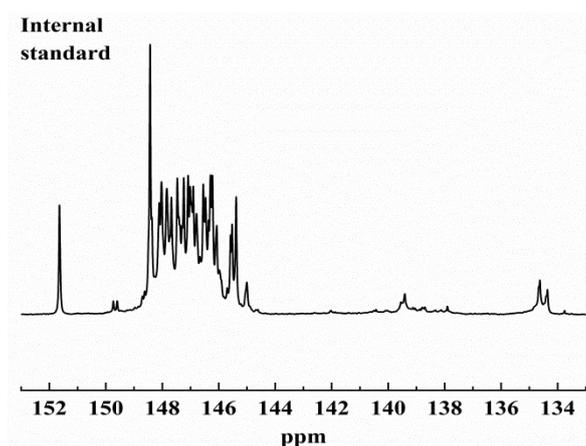
*<sup>a</sup>State key laboratory base of eco-chemical Engineering, College of Chemical Engineering, Qingdao University of Science and Technology, 53 Zhengzhou Road, Qingdao, Shandong province 266042, PR China*

*<sup>b</sup>Qingdao Institute of Bioenergy and Bioprocess Technology, Chinese Academy of Sciences, Qingdao, Shandong province, 26101, PR China*

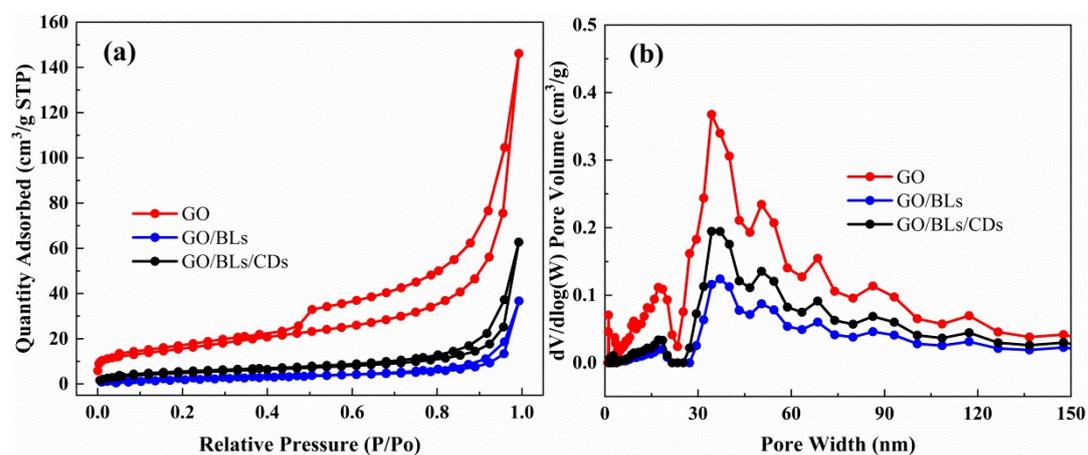
*\*Corresponding author: Tel: +86 53284022719 E-mail: wuqiong0506@hotmail.com (Q Wu)*

**Table S1** Detailed structure composition of Loblolly pine

Sample	Klason Lignin	Glucan	Xylan	Arabinan	Galactan	Mannan	Ash	HHV (MJ/kg)
Loblolly Pine	32.06±0.3	39.88±0.2	5.71±0.1	1.10±0.02	2.11±0.04	9.71±0.2	1.34±0.03	20.16±0.3



**Figure S1** Quantitative <sup>31</sup>P NMR spectrum of BL<sub>S</sub> derivatized with TMDP using NHND as internal standard.



**Figure S2** (a) N<sub>2</sub> adsorption-desorption isotherms and (b) corresponding pore size distributions samples.

**Table S2** The *d*-spacing values of different samples.

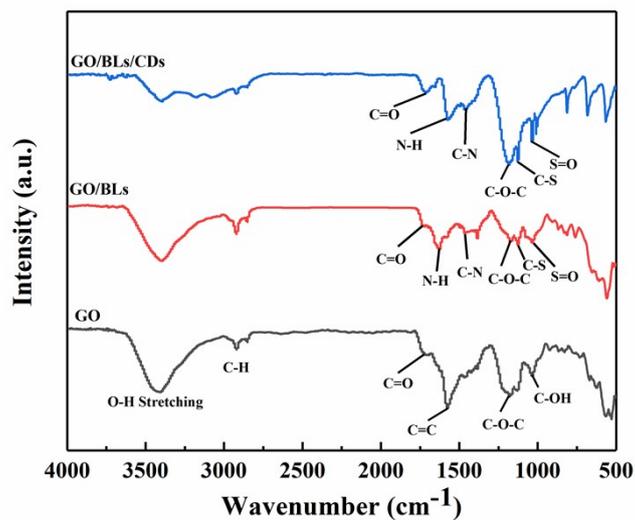
Samples	2 $\theta$ (°)	<i>d</i> (Å)
GO	24.22±0.05	3.62±0.01
	43.12±0.08	2.07±0.01
GO/BLs	24.89±0.05	3.52±0.01
	43.37±0.08	2.05±0.01
GO/BLs/CDs	24.52±0.05	3.58±0.01
	43.65±0.08	2.04±0.01

**Table S3** Composition of samples obtained by XPS

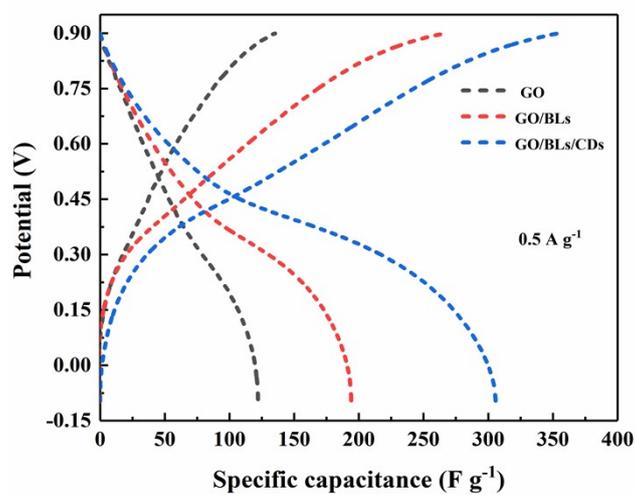
Samples	C (Mass.%)	O (Mass.%)	N (Mass.%)	S (Mass.%)
GO	86.91	13.09	--	--
GO/BLs	79.63	14.96	0.65	4.76
GO/BLs/CDs	78.49	15.53	1.42	4.57

**Table S4** The percentage of functional groups on surface of different samples.

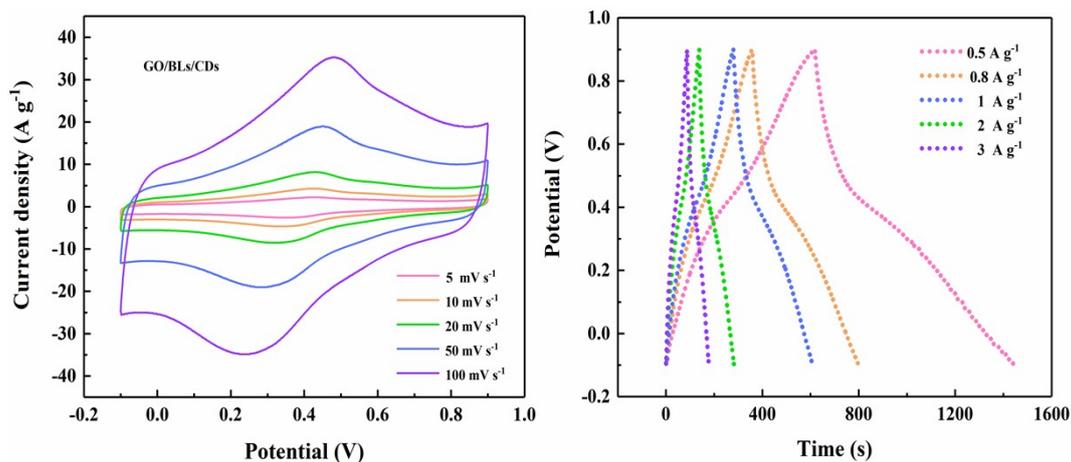
Samples	C=O	C-O-C	C-OH	C-N=C	C-N-C	N-C <sub>3</sub>	C-N-O	C-S-C	C-SO <sub>x</sub>
GO	24.2	24.7	51.1	-	-	-	-	-	-
GO/BLs	32.4	32.0	35.6	7.3	14.9	45.9	31.9	46.1	53.9
GO/BLs/CDs	36.3	23.8	39.9	11.0	15.6	35.1	38.3	39.5	60.5



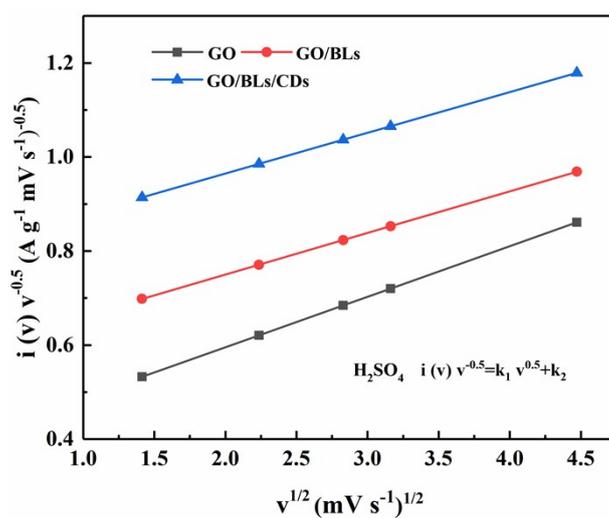
**Figure S3** FT-IR spectra of GO, GO/BL<sub>s</sub> and GO/BL<sub>s</sub>/CDs.



**Figure S4** Voltage-specific capacitance curves of different samples at 0.5 A g<sup>-1</sup>.



**Figure S5** (a) CV curves at different scan rates and (b) GCD curves at different current densities of GO/BL<sub>S</sub>/CDs in 1 M H<sub>2</sub>SO<sub>4</sub> at three-electrode test system.



**Figure S6** Linear equines at given potentials.