Luminescent Transparent Wood Based on Lignin-Derived Carbon Dots as a Building Material for Dual-Channel, Real-Time, and Visual Detection of Formaldehyde Gas

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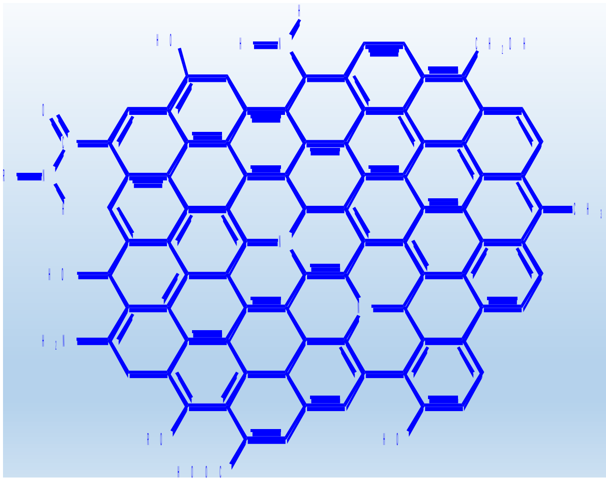

Figure S1 Carbon-core and surface-functional group composition of CDs.

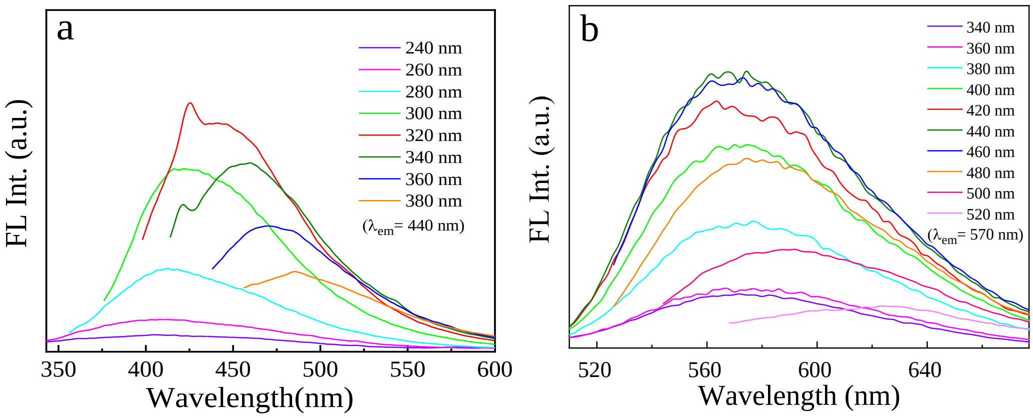

Figure S2 Fluorescence emission spectra of **(a)** B-LTW and **(b)** Y-LTW recorded at different excitation wavelengths, respectively.

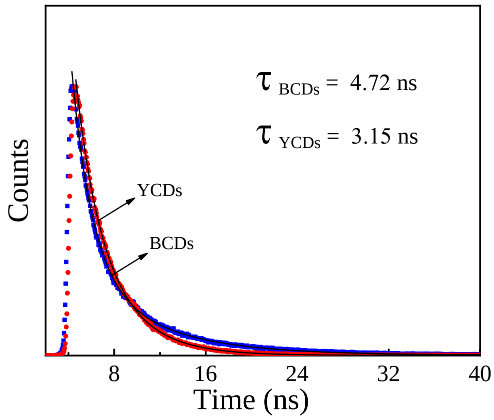

Figure S3 Fluorescence decay spectra of BCDs and YCDs excitation at 320 and 440 nm, respectively.

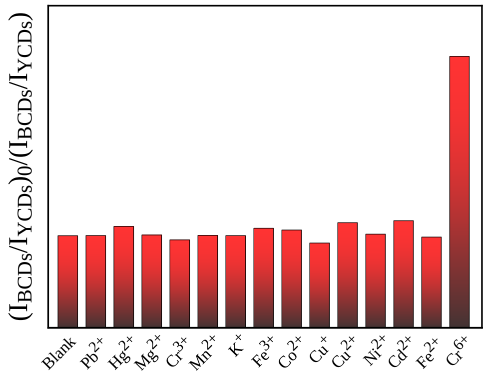

Figure S4 Selectivity of Dual-CDs against various metal ions (the concentrations were all 1000 μM).

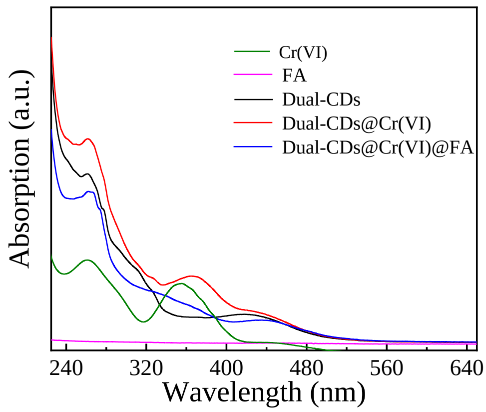

Figure S5 UV-vis absorption spectra of Cr(VI), FA, Dual-CDs, Dual-CDs@Cr(VI), and Dual-CDs@Cr(VI)@FA.

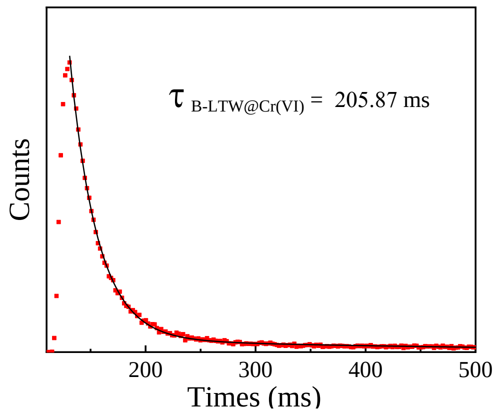

Figure S6 RTP decay spectra of the B-LTW@Cr(VI) excitation at 380 nm.

Table S1 Functional group assignments for lignin from FT-IR spectra

Wavenumber (cm^{-1})	**Functional group**
3408	Stretching vibration of O-H in hydroxyl
2950, 2832	Stretching vibration of alkyl C-H
1714	Stretching vibration of non-conjugated C=O in ketone
1670	Stretching vibration of conjugated C=O
1596	Stretching vibration of aromatic nucleus with C=O
1508	Stretching vibration of aromatic nucleus
1462	Deformation vibration of C-H in alkyl
1428	Plane deformation vibration of C-H on aromatic ring
1368	Stretching vibration of O-H in phenol hydroxyl
1266	Stretching vibration of guaiac and C=O
1212	Stretching vibration of C-C/C-O and C=O
1134	In-plane deformation vibration of C-H on aromatic nuclei
1047	Out-plane deformation vibration of C-H on aromatic nuclei

Table S2 Element contents and atomic ratios in CDs determined by XPS results

Sample	**C(%)**	**N(%)**	**O(%)**	**O/C**	**N/C**
BCDs	59.4	29.13	11.47	0.19	0.49
YCDs	76.81	9.07	14.12	0.18	0.12

Table S3 XPS data analyses of the C1s and N1s spectra of CDs

XPS	**C1s**				**N1s**		
Sample	C=C/C-C	C-N	C-O	C=O	C=N-C	C-N-C	$N-(C)_3/H-N-(C)_2$
BCDs	0.49	0.28	0.16	0.070	0.35	0.44	0.21
YCDs	0.63	0.23	0.13	0.010	0.30	0.50	0.20

Table S4 Lifetimes of CDs and LTW

Sample	**A_1**	**T_1**	**A_2**	**T_2**	**T_{ave}**
BCDs	6418.38	1.58 ns	3728.30	6.11 ns	4.72 ns
YCDs	4303.94	1.91ns	5977.64	3.62 ns	3.15 ns
B-LTW	3394.34	23.37 ms	223.12	381.60 ms	208.83 ms
Y-LTW	3897.01	16.06 ms	168.92	304.31 ms	146.06 ms

Table S5 Comparison of the gas-sensing properties of sensors based on different materials toward FA gas

Materials	**Detection methods**	**Working Temperature(°C)**	**Linear range**	**LOD**	**Visual-ization**	**Ref.**
Hollow TiO_2@SnO_2nanospheres	Electrochemistry	Room Temperature	1-10 ppm	/	No	1
Ag^+-SiO_2 microspheres	Electrochemistry	Room Temperature	2 - 6000 pmol/ 4.66 - 13967.6 ppb	0.5 pmol·L^{-1}/ 1.16 ppb	No	2
Cd-doped SnO_2 nanofibers	Electrochemistry	160	1 - 1000 ppm	100 ppm	No	3
ZnO@ZIF-8 core-shell nanorods	Electrochemistry	300	10 - 200 ppm	5.6 ppm	No	4
Hydrazinium polyacrylate	Electrochemistry	Room Temperature	4 - 16 ppm	/	No	5
CuO nanocubes	Electrochemistry	300	0.05 - 3 ppm	6 ppb	No	6
Electronic nose	Electrochemistry	Room Temperature	0 - 180 ppb	3 ppb	No	7
2,4-dinitrophenylhydrazlne. coated silica gel	Liquid Chromatography	Room Temperature	0.10 - 3.8 ppm	/	No	8
N-benzylethanolamlne coated chromosorb 102 sorbent	Capillary gas chromatography	Room Temperature	0.55 - 4.71 mg·m^{-3}	/	No	9
Nano-$Ti_3SnLa_2O_{11}$	Cataluminescence	350	0.17 - 51.5 mg·m^{-3}	0.06 mg·m^{-3}	No	10
2,4-pentandione	Fluorescence	Room Temperature	2 - 300 μg·m^{-3}	1.6 μg·m^{-3}	No	11
Ag^+-CD@SiO_2-NH_2 spheres	Fluorescence	Room Temperature	10 ppb - 1 ppm	3 ppb	Yes	12
LTW	Fluorescence/ Phosphorescence	Room Temperature	20 - 1500 μM/ 20 - 2000 μM	1.08/45.8 nM	Yes	Current work

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