Hydrothermal synthesis of nitrogen-doped carbon quantum dots from lignin for formaldehyde determination

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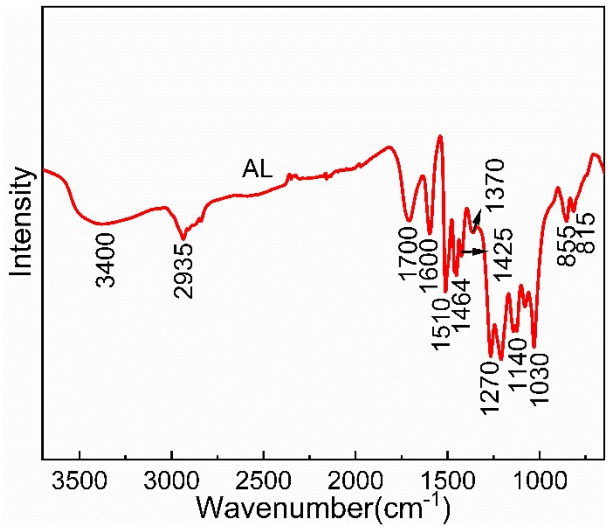

Fig. S1 FT-IR spectra of AL.

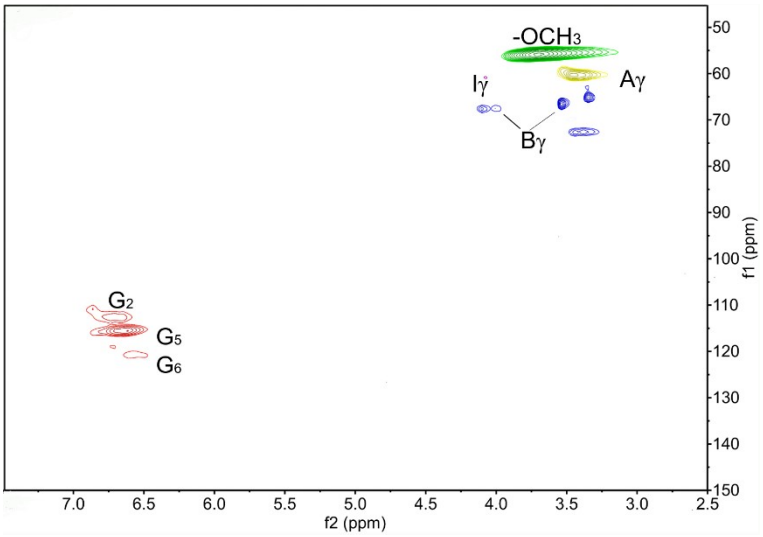

Fig. S2. 2D-HSQC spectra of AL.

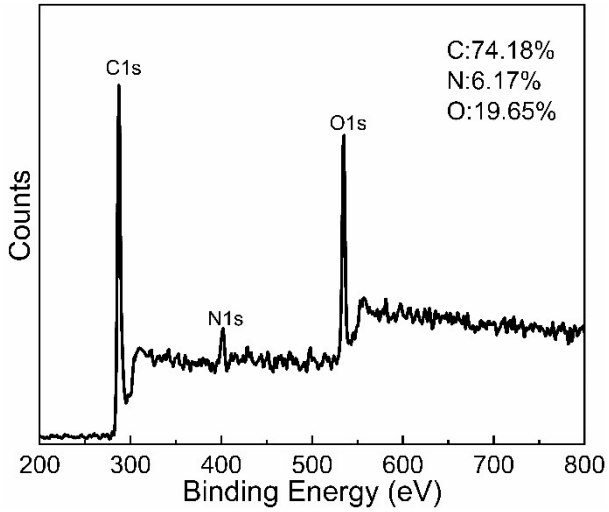

Fig. S3. XPS full-scan spectrum of the NCQDs.

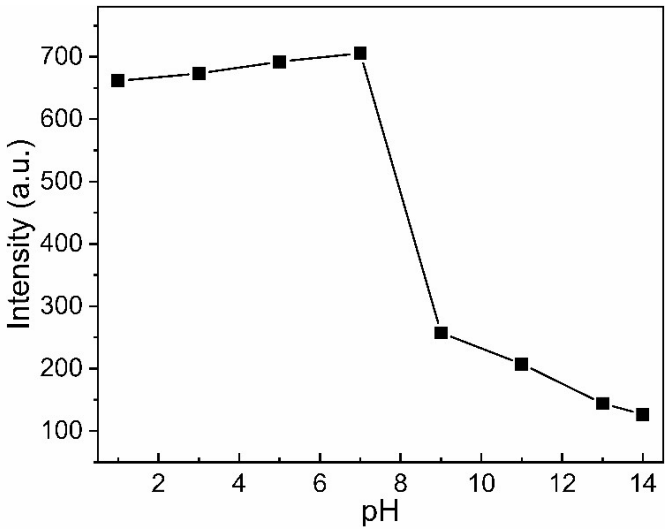

Fig. S4. PL intensity of CQDs at different pH values.

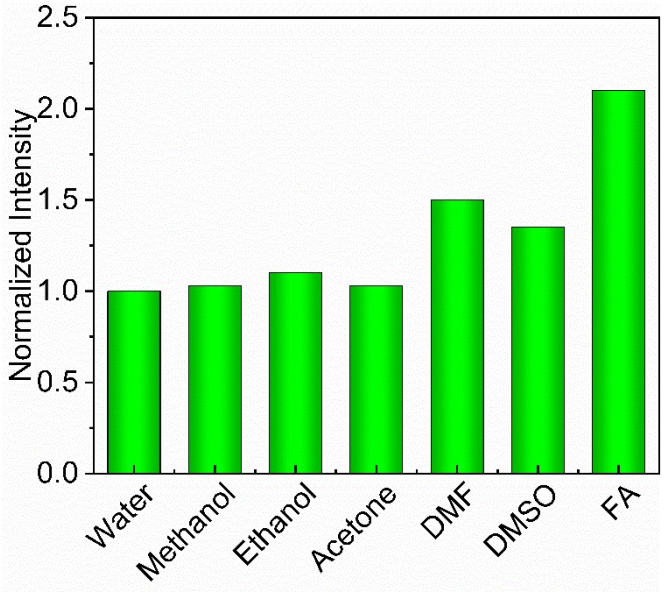

Fig. S5. The normalized FL intensity of the NCQDs in the presence of a range of solvent.

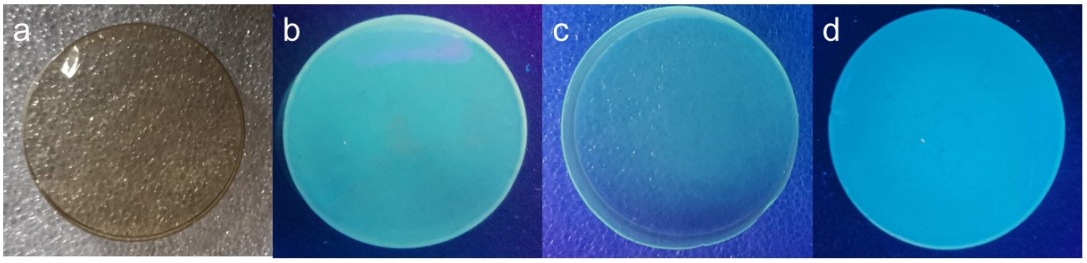

Fig. S6. (a) The digital photograph NCQDs/PVA composite film; from b to d is digital photograph of NCQDs/PVA composite film under initial conditions upon, treated with normal air and FA gass under a 365 nm UV light, respectively.

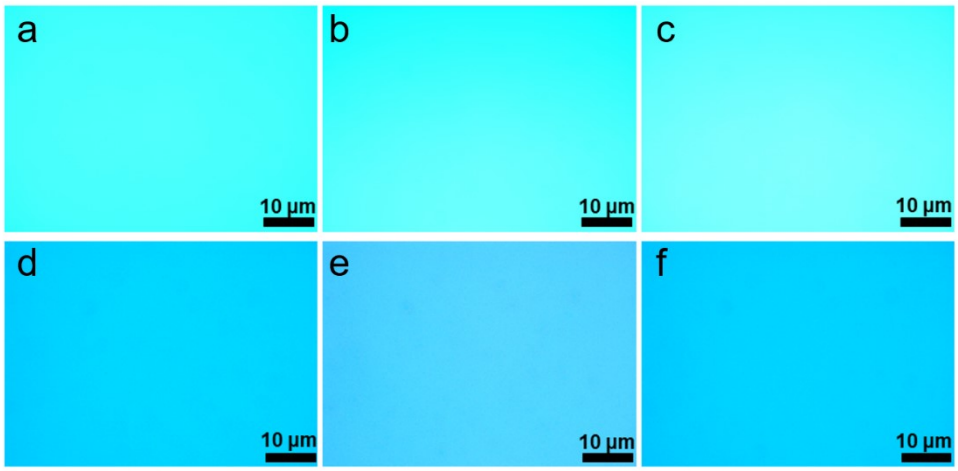

Fig. S7. The digital photograph NCQDs/PVA composite film under treated with normal air (a, b and c) and FA gass (d, e and f) under a 365 nm UV light, respectively.

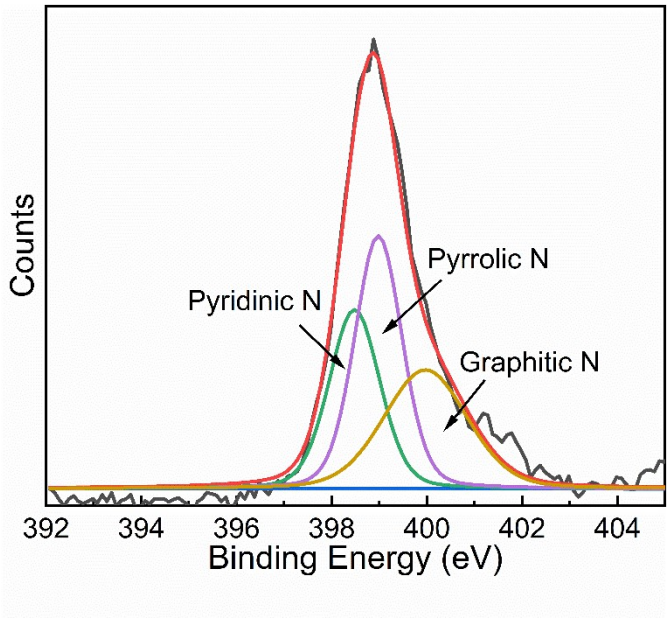

Fig. S8. The high-resolution N1s peak of NCQDs-FA.

Table S1 The molecular weight and dispersion of AL

samples	*Mw*(g/mol)	*Mn*(g/mol)	*Mw/Mn*
AL	11209	4538	2.47

Table S2 Functional group assignments for AL from FT-IR spectra

Functional group	Wavenumber (cm-1)
Stretching vibration of O-H in hydroxyl	3400 cm^{-1},
Stretching vibration of aromatic nucleus conjugated C=O	1700 cm^{-1}
Absorption bands of aromatic rings	1600 cm^{-1}，1510 cm^{-1}, 1425cm^{-1}
Stretching vibration of C=C	1464 cm-1
Stretching vibration of Ac-OH on aromatic nucleus	1370 cm^{-1}
Stretching vibration of C-O in Guaiacyl structural units	1270 cm-1
Stretching vibration of C-H in Guaiacyl structural units	1140 cm^{-1}
In-plane deformation vibration of C-H on aromatic nuclei	1030 cm^{-1}
Out-plane deformation vibration of C-H in Guaiacyl structural units	855 cm^{-1}, 815 cm^{-1}

Table S3 Assignment of ^{13}C-^{1}H cross-signals in the 2D-HSQC spectra of AL

label	δ_C/δ_H (ppm)	assignment
$-OCH_3$	55.2/3.5	C−H in methoxyls
A_γ	60.1/3.4	C_γ−H_γ in β-O-4’ substructures (A)
B_γ	65.4-71.4/3.4-4.1	C_γ−H_γ in resinol substructures (B)
G_2	110.9/6.75	C_2−H_2 in guaiacyl units (G)
G_5	115.6/6.66	C_5−H_5 in guaiacyl units (G)
G_6	120.7/6.54	C_6−H_6 in guaiacyl units (G)

Table S4 XPS data analysis of N1s spectra of samples

samples	pyridinic N	pyrollic N	graphitic N
NCQDs	0.22	0.42	0.36
NCQDs-FA	0.32	0.34	0.34