Supporting information

Construction of Composite Films Using Carbon Nanodots for Blocking Ultraviolet Light from the Sun

Yibing Bai[a], Bin Zhao[a], Jiaxin Ni[a], Lianhang Sun[a], Yuning Wang[a], Jing Wang[a], Yu Liu[a], Shiyan Han[a,*], Fugang Gao[b], Chunlei Zhang[a,*]

[a] Key Laboratory of Bio-Based Material Science & Technology (Northeast Forestry University), Ministry of Education, Harbin 150040, China

[b] Jiangsu Transline Technology Co., Ltd., Changzhou 213100, China

[*] Corresponding author at: Key Laboratory of Bio-based Material Science and Technology of Ministry of Education, Northeast Forestry University, Hexing Road 26, Harbin 150040, P.R. China.

E-mail addresses: hanshiyan80@163.com (S. Han), zhangchunlei@nefu.edu.cn (C. Zhang).

Characterization

The morphology of the samples was analyzed using a JEM-2100 transmission electron microscope (JEOL Ltd., Tokyo, Japan). An ESCALAB 250Xi spectrometer (Thermo Fisher Scientific, New York, USA) was used for X-ray photoelectron spectroscopy. Fourier-transform infrared (FTIR) spectra, recorded using a Fourier FT-IR spectrometer (Perkin Elmer Inc., Waltham, MA, USA), were used to identify surface functional groups on the CNDs. X-ray diffraction (XRD) patterns were measured using an X'Pert 3 Powder X-ray diffractometer (Malvern Panalytical Ltd., Malvern, UK). UV-visible absorption spectra were recorded using a TU-1901 UV-visible fluorescence spectrometer (Persee General Instrument Co., Ltd., Beijing, China). The photoluminescence spectra of the samples were recorded using an LS55 fluorescence spectrometer (Perkin Elmer Co., Ltd., Waltham, MA, USA). Photoluminescence quantum yield and fluorescence lifetime decay curves were measured using an FLS1000 fluorescence spectrometer (Edinburgh Instruments Ltd., Edinburgh, UK). Electroluminescence spectra were recorded using an OHSP350 spectrometer (Hongpu Photoelectric Technology Co., Ltd., Hangzhou, China). Stress-strain curves were measured using an UTM2203 electronic universal testing machine (Shenzhen Suns Technology Stock Co., Ltd., Shenzhen, China).

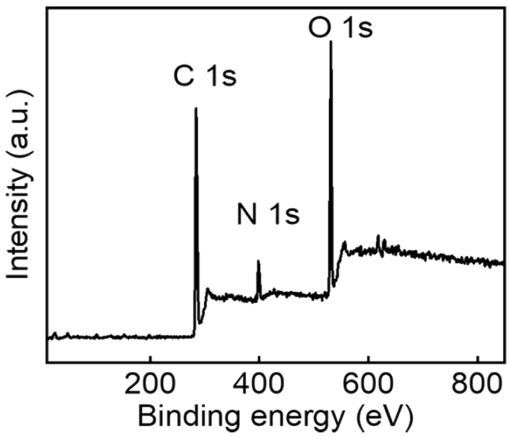

Figure S1. Full X-ray photoelectron spectrum of hydrothermal product formed from chitosan alone.

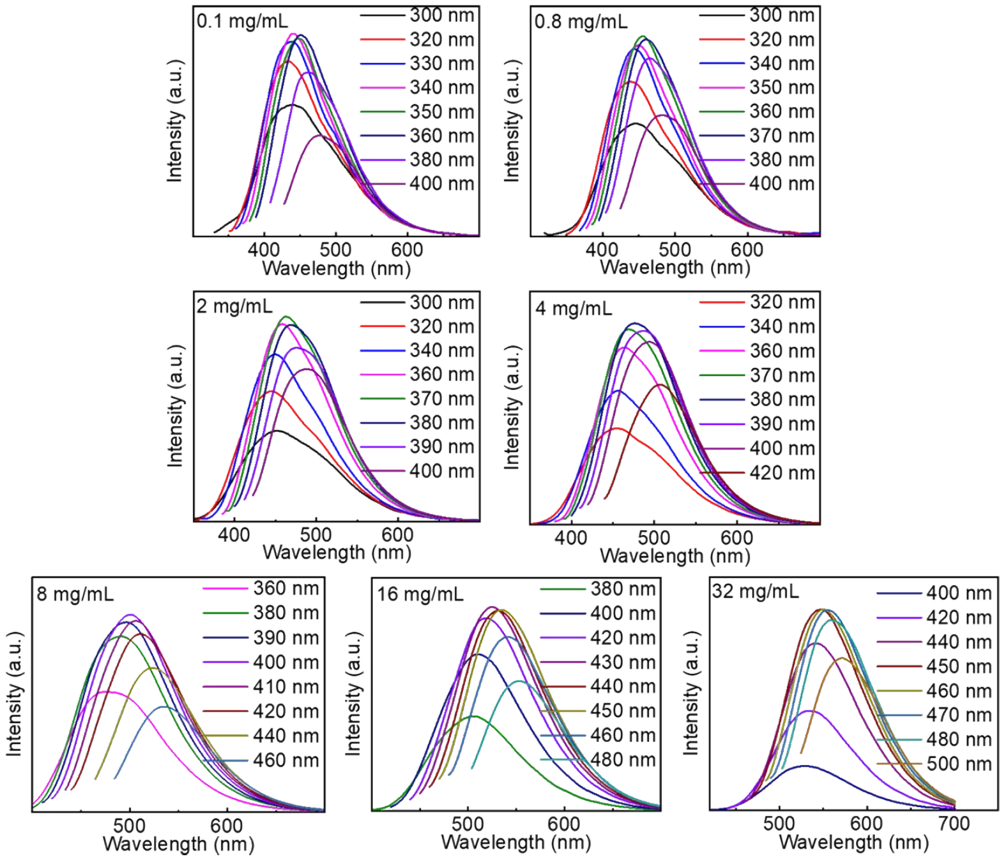

Figure S2. Fluorescence emission spectra of aqueous solutions of CNDs with different concentrations (0.1–32 mg/mL).

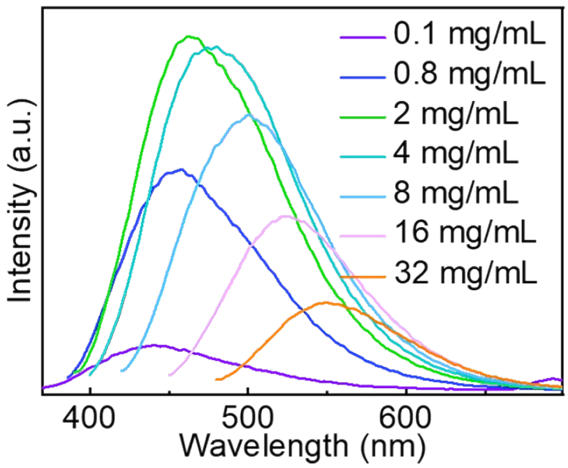

Figure S3. Emission spectra of aqueous solution of CNDs with different concentrations (0.1-32 mg/mL) at optimal excitation.

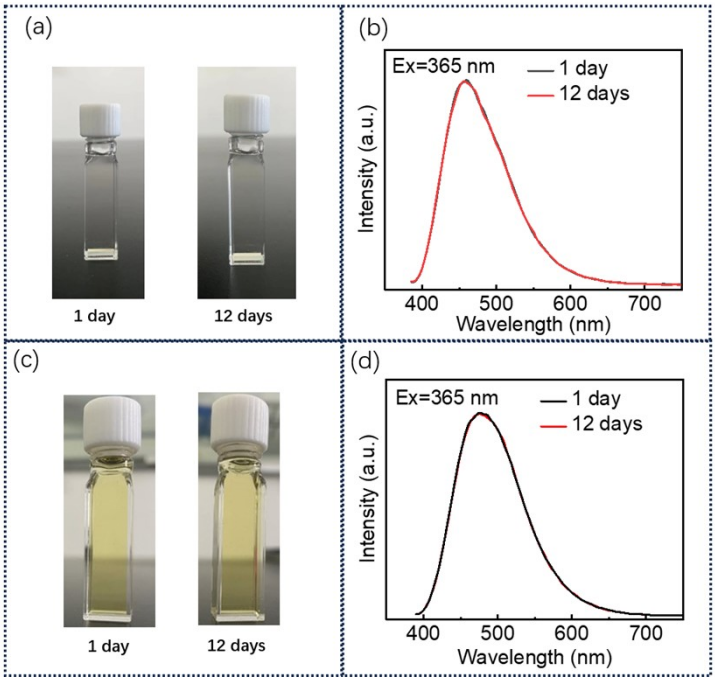

Figure S4 Photos under natural light and fluorescence spectra (Ex=365 nm) of 0.2mg/mL (a, b) and 2mg/mL (c,d) CNDs solution at 1 and 12 days

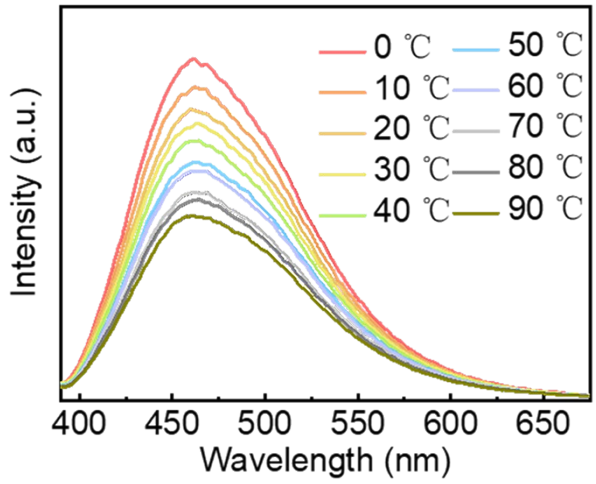

Figure S5. Fluorescence emission spectra of solutions of CNDs at different temperatures (2 mg/mL, Ex=370 nm).

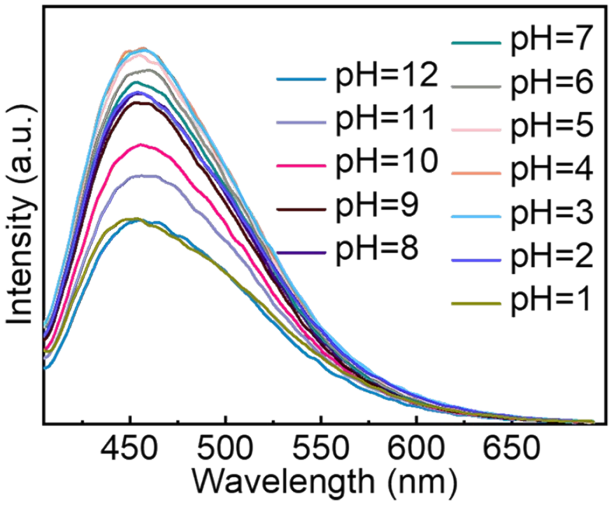

Figure S6. Fluorescence emission spectra of solutions of CNDs at different pH (2 mg/mL, Ex=370 nm).

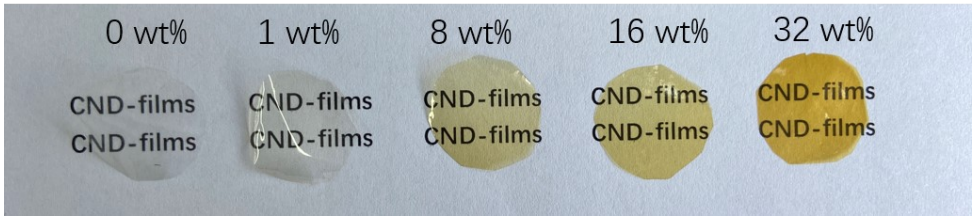

Figure S7 Photos of different CND-films under natural light

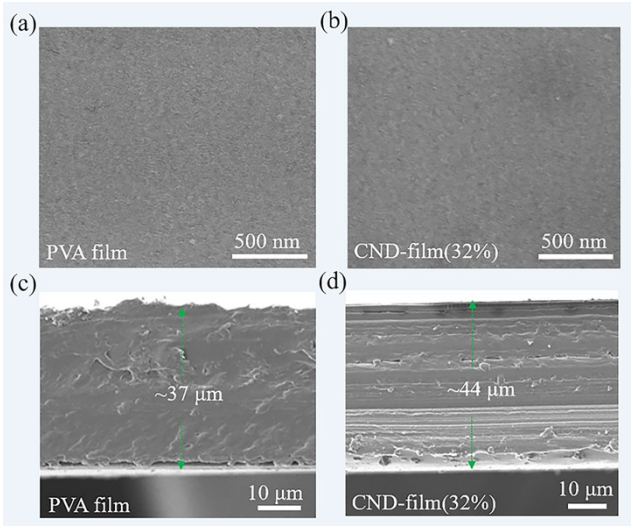

Figure S8. SEM images of (a) PVA film and (b) CND-film (32%); SEM images showing thickness of (c) PVA film and (d) CND-film (32%).

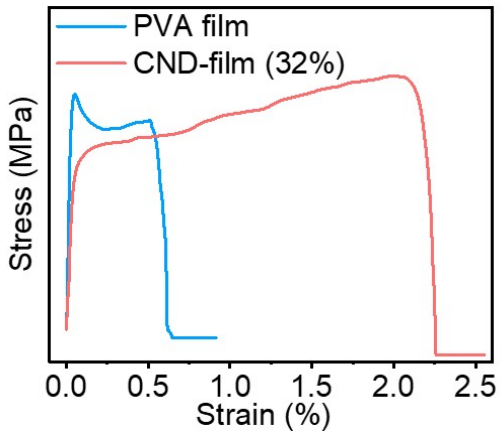

Figure S9. Mechanical experiment of PVA film and CND-film (32%)

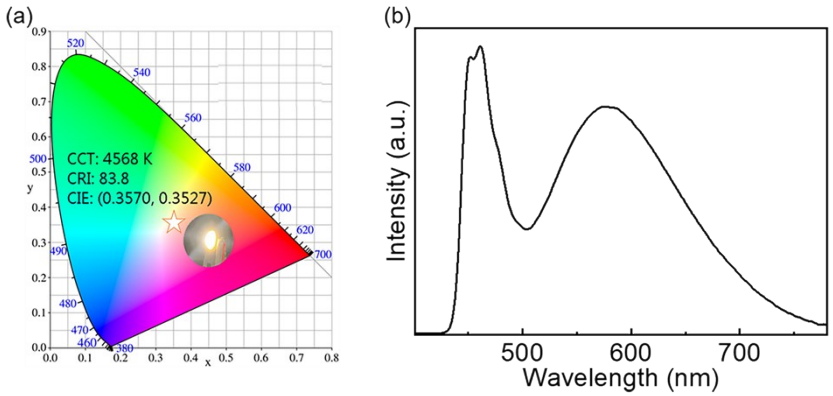

Figure S10. (a) CIE1931 chromaticity diagram (inset: Photo of WLED after energization); (b) Electroluminescence spectrum of WLED.

Table S1. Proportion of C, N, and O-containing chemical bonds in CNDs and hydrothermal product formed from chitosan alone.

Sample	C (%)	N (%)	O (%)
CNDs	54.22	25.77	20.01
Chitosan	67.27	6.85	25.88

Table S2. Fluorescence lifetime of solution of CNDs.

Sample	τ_1 (ns)	A_1 (%)	τ_2 (ns)	A_2 (%)	Average lifetime (ns)
CNDs solution	7.19	59.04	2.15	40.96	5.67

Table S3. Photoluminescence quantum yields (PLQY) of different CNDs

Raw materials	Synthetic method	PLQY	Reference
Microcrystalline cellulose	Hydrothermal	6.3%	[1]
Rosin and ethylenediamine	Hydrothermal	21.5%	[2]
Microcrystalline cellulose and ethylenediamine	Hydrothermal	10.1%	[3]
Alkali lignin, citric acid and ethylenediamine	Hydrothermal	43% (Relative)	[4]
Citric acid and diethylenetriamine	Hydrothermal	39 %	[5]
3-Aminophenylboronic acid and citric acid	Hydrothermal	35% (Relative)	[6]
Chitosan and ethylenediamine	Hydrothermal	45%	This work

References

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