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Supporting Information

Improving film uniformity and interface solvent resistance to realize multilayer printing of OLED devices

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Supporting information

different proportions for VNPB.

Table S6. The $\boldsymbol{\delta_D}$, $\boldsymbol{\delta_P}$, $\boldsymbol{\delta_H}$ of chlorobenzene and acetonitrile solution with different proportions for VNPB.

Table S7. The optimized printing voltage, pulse length, diameter and velocity of the droplets.

Table S8. The thickness of VNPB/PEDOT:PSS film after spin-rinsing with different solvents.

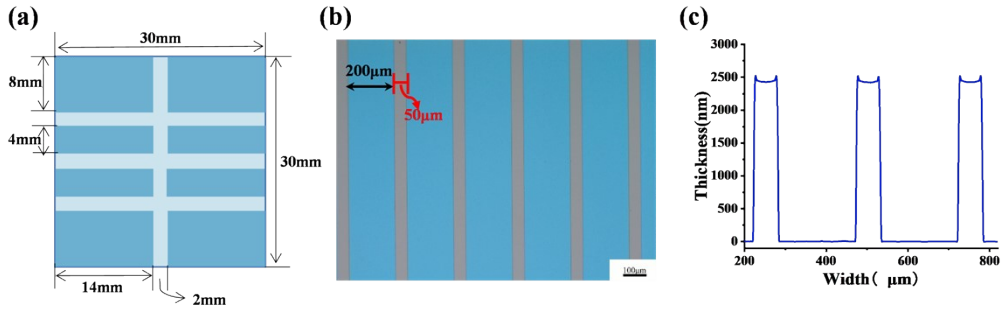

Figure S1. (a) The subtract with ITO patterned of high-transparency glass. (b) The optical image and sizes of the banks on ITO substrate (c) The profile of the bank.

Figure S2. The inkjet printer AD-P-8000 Printing System from Microdrop.

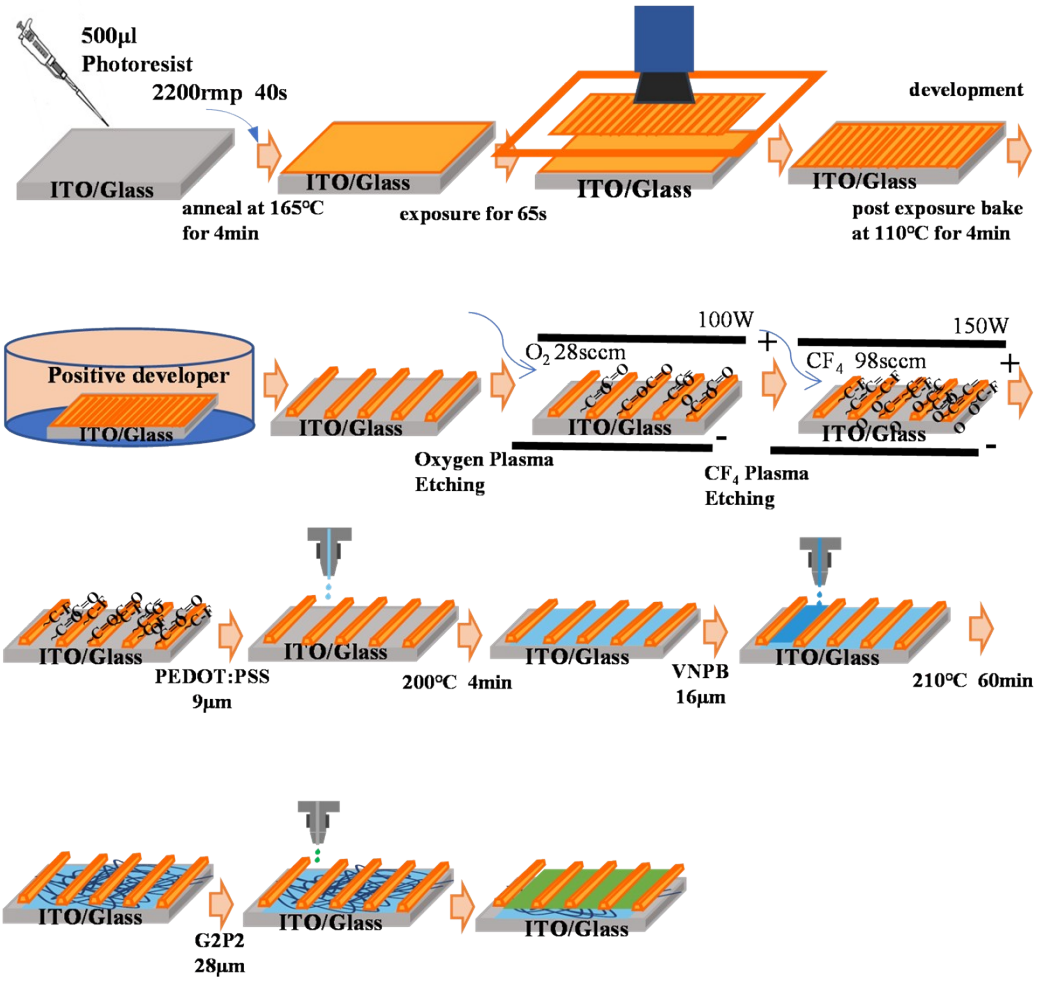

Figure S3. The process of patterning substrate and printing films.

Table S1. The $\boldsymbol{\delta_D}$, $\boldsymbol{\delta_P}$, $\boldsymbol{\delta_H}$ of chlorobenzene and propylene carbonate solution with different proportions, the solution to the G2P2 is recorded as 1, the insolubility is recorded as 0.

CB/PC	δ_D **(MPa1/2)**	δ_P **(MPa1/2)**	δ_H **(MPa1/2)**	**Score**
100/0	19.0	4.3	2.0	1
90/10	19.1	5.7	2.2	1
80/20	19.2	7.0	2.4	1
70/30	19.3	8.4	2.6	1
60/40	19.4	9.8	2.8	1
50/50	19.5	11.2	3.1	0
40/60	19.6	12.5	3.3	0
30/70	19.7	13.9	3.5	0
20/80	19.8	15.3	3.7	0
10/90	19.9	16.6	3.9	0
0/100	20.0	18.0	4.1	0

Table S2. The $\boldsymbol{\delta_D}$, $\boldsymbol{\delta_P}$, $\boldsymbol{\delta_H}$ of chlorobenzene and n-Butanol solution with different proportions, the solution to the G2P2 is recorded as 1, the insolubility is recorded as 0.

CB/n-Butanol	δ_D **(MPa1/2)**	δ_P **(MPa1/2)**	δ_H **(MPa1/2)**	**Score**
100/0	19.0	4.3	2.0	1
90/10	18.7	4.4	3.4	1
80/20	18.4	4.6	4.8	1
70/30	18.1	4.7	6.1	1
60/40	17.8	4.9	7.5	0
50/50	17.5	5.0	8.9	0
40/60	17.2	5.1	10.3	0
30/70	16.9	5.3	11.7	0
20/80	16.6	5.4	13.0	0
10/90	16.3	5.6	14.4	0
0/100	16.0	5.7	15.8	0

Table S3. The $\boldsymbol{\delta_D}$, $\boldsymbol{\delta_P}$, $\boldsymbol{\delta_H}$ of chlorobenzene and acetonitrile solution with different proportions, the solution to the G2P2 is recorded as 1, the insolubility is recorded as 0.

CB/Acetonitrile	δ_D **(MPa1/2)**	δ_P **(MPa1/2)**	δ_H **(MPa1/2)**	**Score**
100/0	19.0	4.3	2.0	1
90/10	18.6	5.7	2.4	1
80/20	18.3	7.0	2.8	1
70/30	17.9	8.4	3.2	1
60/40	17.5	9.8	3.6	1
50/50	17.2	11.2	4.1	0
40/60	16.8	12.5	4.5	0
30/70	16.4	13.9	4.9	0
20/80	16.0	15.3	5.3	0
10/90	15.7	16.6	5.7	0
0/100	15.3	18.0	6.1	0

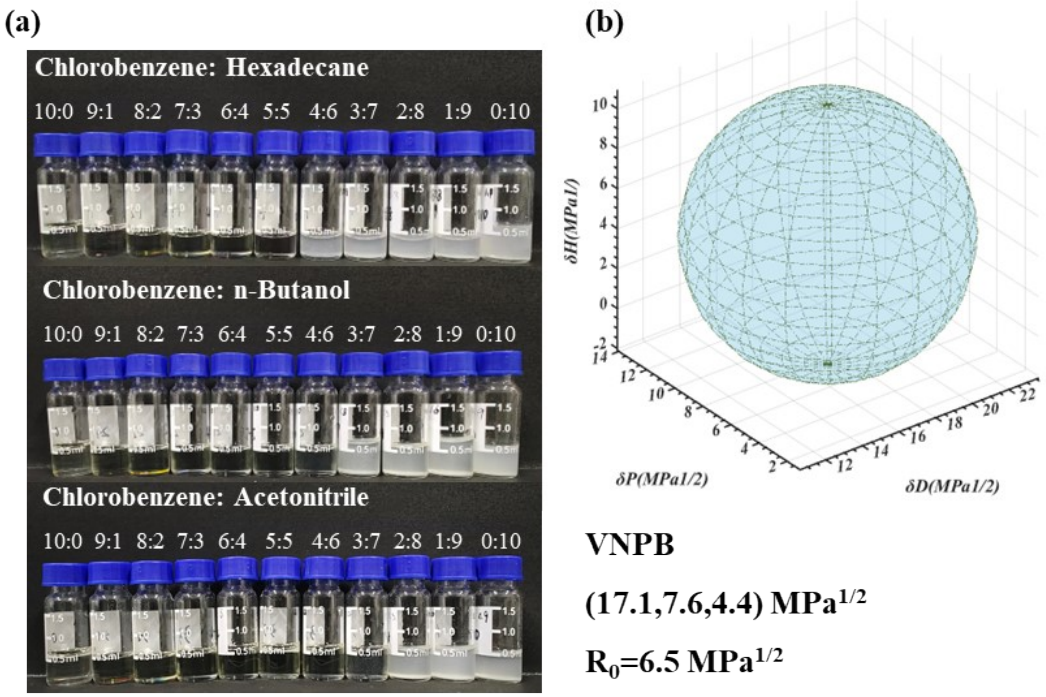

Figure S4. (a) Binary solvents with different ratios of chlorobenzene and hexadecane, chlorobenzene and n-butanol, chlorobenzene and acetonitrile in which the concentration of VNPB is 2 mg/ml. (b) Dissolved spheres of VNPB in 3D Hansen's solubility space.

Table S4. The $\boldsymbol{\delta_D}$, $\boldsymbol{\delta_P}$, $\boldsymbol{\delta_H}$ of chlorobenzene and hexadecane solution with different proportions, the solution to the VNPB is recorded as 1, the insolubility is recorded as 0.

CB/Hexadecane	δ_D ($MPa^{1/2}$)	δ_P ($MPa^{1/2}$)	δ_H ($MPa^{1/2}$)	Score
100/0	19.0	4.3	2.0	1
90/10	18.7	3.9	1.8	1
80/20	18.5	3.4	1.6	1
70/30	18.2	3.0	1.4	1
60/40	17.9	2.6	1.2	1
50/50	17.7	2.2	1.0	1
40/60	17.4	1.7	0.8	0
30/70	17.1	1.3	0.6	0
20/80	16.8	0.9	0.4	0
10/90	16.6	0.4	0.2	0
0/100	16.3	0.0	0.0	0

Table S5. The $\boldsymbol{\delta_D}$, $\boldsymbol{\delta_P}$, $\boldsymbol{\delta_H}$ of chlorobenzene and n-Butanol solution with different proportions, the solution to the VNPB is recorded as 1, the insolubility is recorded as 0.

CB/n-Butanol	δ_D **(MPa$^{1/2}$)**	δ_P **(MPa$^{1/2}$)**	δ_H **(MPa$^{1/2}$)**	**Score**
100/0	19	4.3	2.0	1
90/10	18.7	4.4	3.4	1
80/20	18.4	4.6	4.8	1
70/30	18.1	4.7	6.1	1
60/40	17.8	4.9	7.5	1
50/50	17.5	5.0	8.9	1
40/60	17.2	5.1	10.3	1
30/70	16.9	5.3	11.7	0
20/80	16.6	5.4	13.0	0
10/90	16.3	5.6	14.4	0
0/100	16.0	5.7	15.8	0

Table S6. The $\boldsymbol{\delta_D}$, $\boldsymbol{\delta_P}$, $\boldsymbol{\delta_H}$ of chlorobenzene and acetonitrile solution with different proportions, the solution to the VNPB is recorded as 1, the insolubility is recorded as 0.

CB/Acetonitrile	δ_D **(MPa$^{1/2}$)**	δ_P **(MPa$^{1/2}$)**	δ_H **(MPa$^{1/2}$)**	**Score**
100/0	19.0	4.3	2.0	1
90/10	18.6	5.7	2.4	1
80/20	18.3	7.0	2.8	1
70/30	17.9	8.4	3.2	1
60/40	17.5	9.8	3.6	1
50/50	17.2	11.2	4.1	1
40/60	16.8	12.5	4.5	1
30/70	16.4	13.9	4.9	1
20/80	16.0	15.3	5.3	0
10/90	15.7	16.6	5.7	0
0/100	15.3	18.0	6.1	0

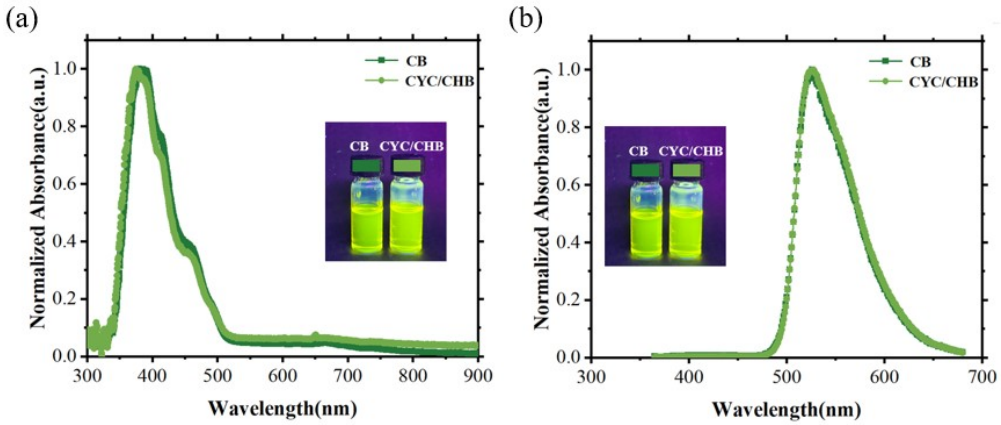

Figure S5. (a) Absorption spectra and (b) Photoluminescence spectra of G2P2 dissolved in CB and binary solvent.

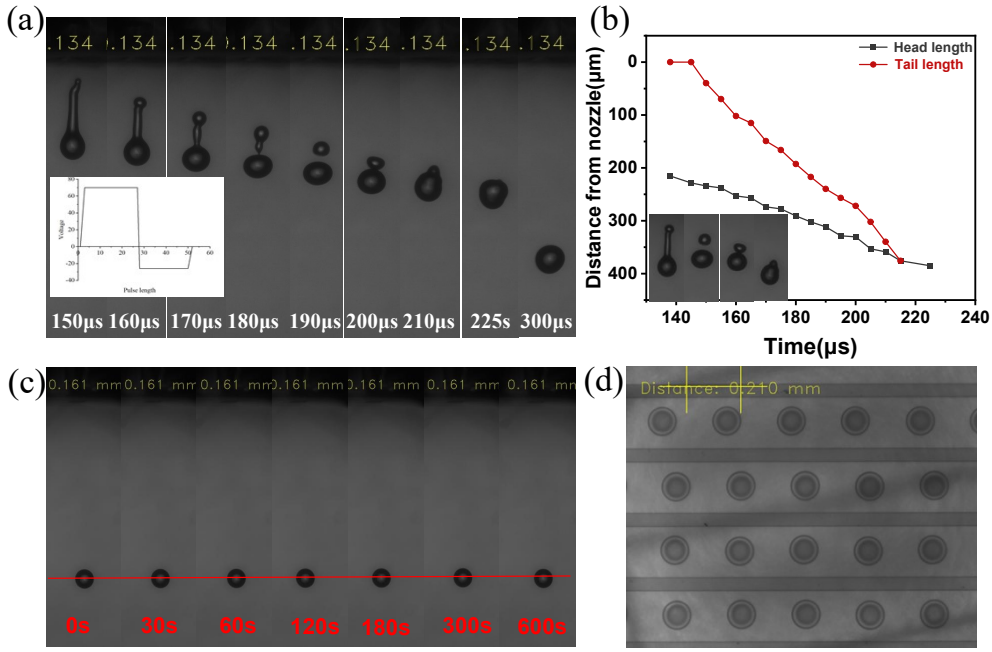

Figure S6. (a) Droplet behavior of PEDOT:PSS ink in an optimized waveform. (b) The distance of the head droplet and the tail droplet from the nozzle. (c) Images of the drop after applying the waveform at times of 0s, 30s, 60s, 120s, 180s, 300s, and 600s. The position of the droplet in a period does not change. (d) Image of the position of the PEDOT:PSS droplets in the bank.

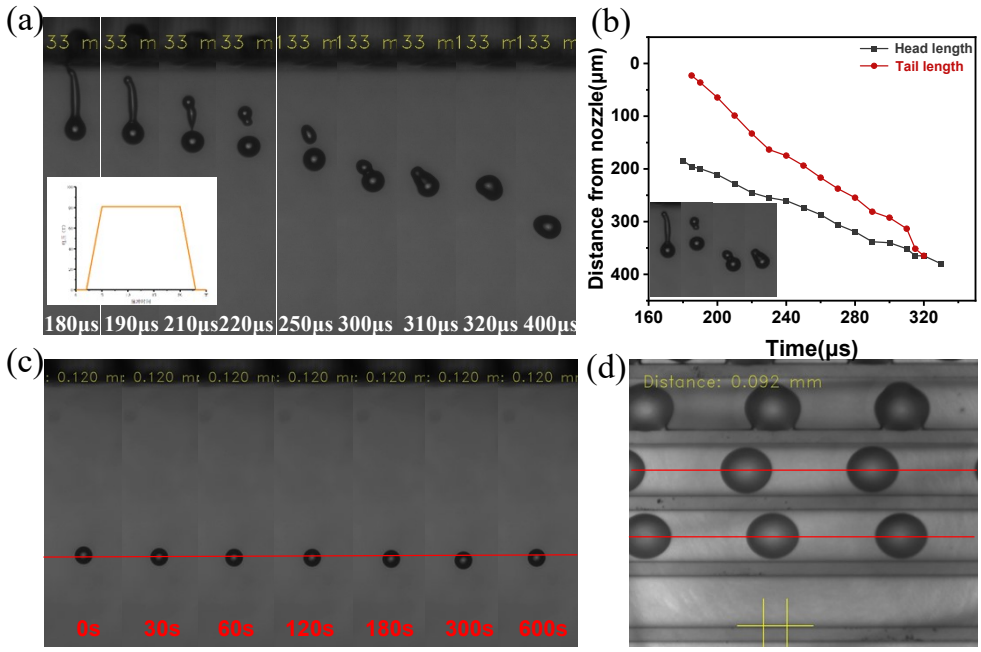

Figure S7. (a) Droplet behavior of VNPB ink in an optimized waveform. (b) The distance of the head droplet and the tail droplet from the nozzle. (c) Images of the drop after applying the waveform at times of 0s, 30s, 60s, 120s, 180s, 300s, and 600s. The position of the droplet in a period does not change. (d) Image of the position of the VNPB droplets in the bank.

Table S7. The optimized printing voltage, pulse length, diameter and velocity of the droplets.

Ink	Voltage (V)	Pulse length (μs)	Diameter (μm)	Velocity (m/s)
PEDOT:PSS	70/-24	24/20	86	1.7
VNPB	77	33	79	1.7
G2P2	79	33	79	1.5

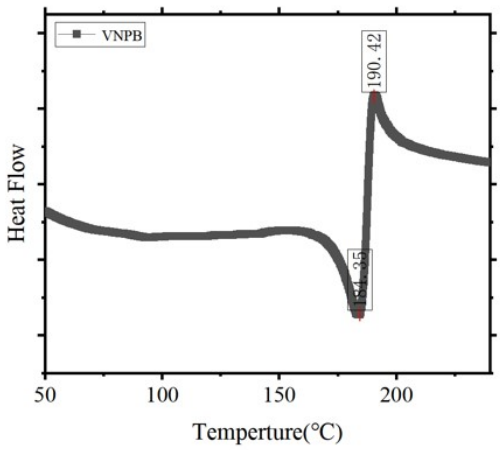

Figure S8. DSC record of VNPB sample. The peak at 190°C corresponds to the thermal polymerization of VNPB.

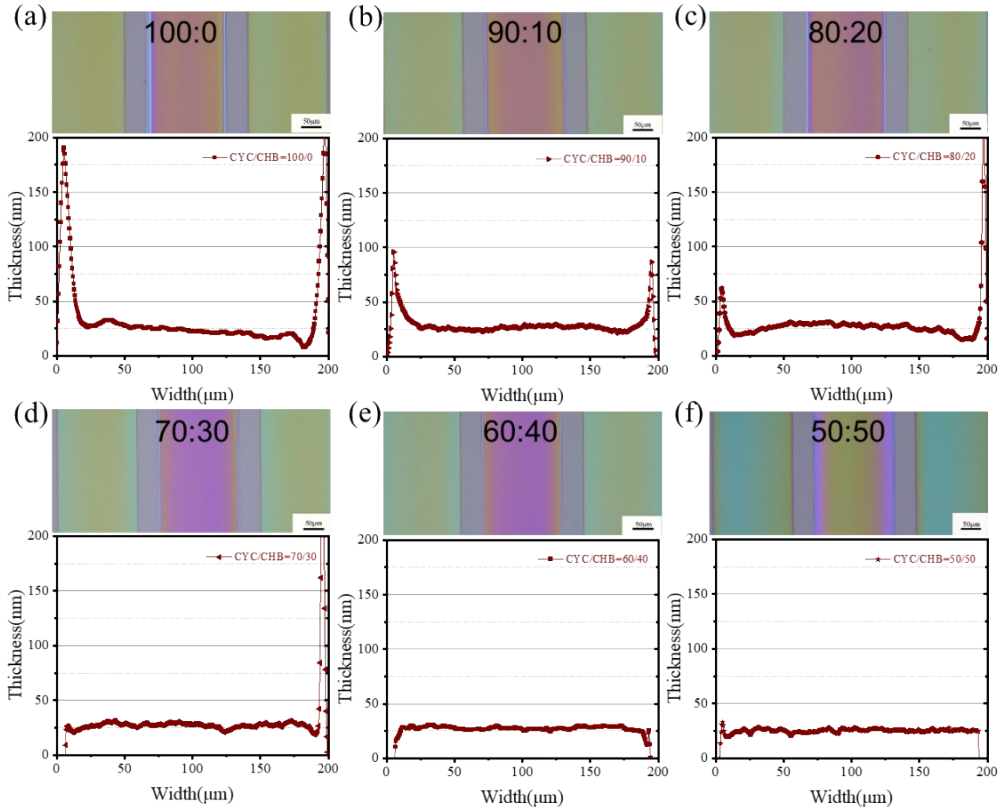

Figure S9. The fluorescence images and the profiles of different CYC and CHB ratios of (a) 100:0, (b) 90:10, (c) 80:20, (d) 70:30, (e) 60:40, and (f) 50:50 for printed VNPB films.

Table S8. The thickness of VNPB/PEDOT:PSS film after spin-rinsing with different solvents.

	Thickness(nm)					Average (nm)
	1	2	3	4	5	
Pristine	54.3	51.4	53.4	54.7	53.9	53.5±1.3
Rinsing with CB	47.1	45.1	45.9	45.6	43.4	45.4±1.3
Rinsing with CYC	49.1	50.6	52.8	48.5	52.2	51.0±1.9
Rinsing with IPB	47.9	48.8	47.5	48.1	46.2	47.6±1.0
Rinsing with MB	47.6	48.9	46.5	46.3	46.4	47.3±1.2
Rinsing with CHB	50.1	52.5	51.3	51.7	52.3	51.6±1.0
Rinsing with CYC/CHB	52.4	49.4	51.4	50.5	51.3	51.0±1.1

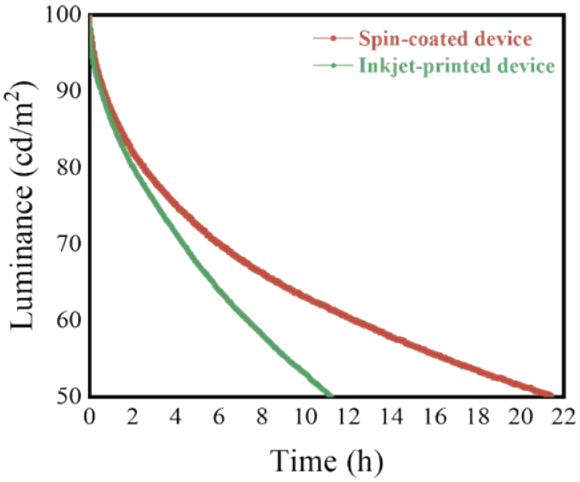

Figure S10. The luminance half-lifetime (LT50) of the devices under 100 cd/m^2.