

Supporting information

Color-tunable and ultralong organic room temperature phosphorescence from poly(acrylic acid)-based materials through hydrogen bond engineering

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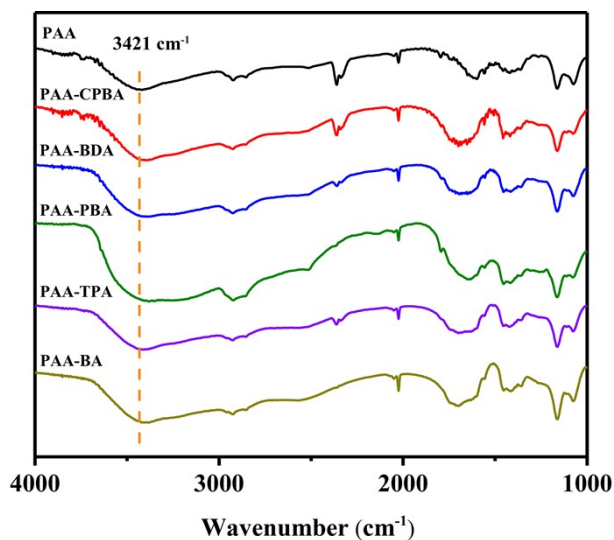


Fig. S1 FTIR spectra of PAA and PAA-based RTP materials with 1000:15 molar ratio of AA to the doped phosphors.

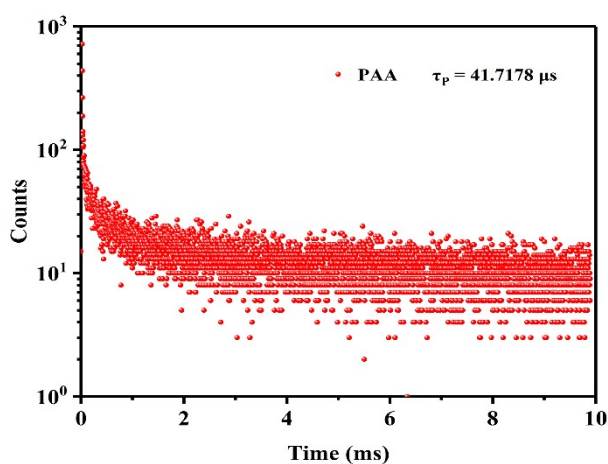


Fig. S2 Time-resolved emission decay curve of PAA with an excitation wavelength of 245 nm.

Table S1. Phosphorescence lifetime (τ) of PAA-CPBA, PAA-BDA, PAA-BA and PAA-TPA under ambient conditions.^a

Complex	λ_{em} (nm)	τ_1 (ms)	A_1 (%)	τ_2 (ms)	A_2 (%)	τ_3 (ms)	A_3 (%)
PAA-CPBA	425	21.1	3.57	218.7	39.53	789.1	56.91
PAA-BDA	430	1.7	2.15	29.8	23.40	161.0	74.45
PAA-BA	417	6.0	13.13	42.9	45.60	185.8	41.27
PAA-TPA	450	6.1	15.15	38.0	37.91	224.7	46.95
PAA-PBA	500	9.7	21.12	79.8	78.88	-	-

^a Determined from the fitting function of $I(t) = A_1e^{-t/\tau_1} + A_2e^{-t/\tau_2} + A_3e^{-t/\tau_3}$ according to the time-resolved emission decay curves.

Table S2. Phosphorescence lifetime (τ) of PAA-CPBA with different molar ratios of AA to CPBA under ambient conditions.^a

Molar ratio	λ_{em} (nm)	τ_1 (ms)	A_1 (%)	τ_2 (ms)	A_2 (%)	τ_3 (ms)	A_3 (%)
1000:1	425	34.1	8.01	205.3	49.85	717.8	42.14
1000:5	425	47.3	9.94	246.1	48.62	860.6	41.44
1000:10	425	37.1	7.67	227.3	45.56	859.6	46.77
1000:15	425	21.1	3.57	218.7	39.53	789.1	56.91
1000:20	425	36.3	7.62	216.0	46.72	799.1	45.66
1000:25	425	40.1	8.84	232.7	48.33	815.5	42.83

^a Determined from the fitting function of $I(t) = A_1e^{-t/\tau_1} + A_2e^{-t/\tau_2} + A_3e^{-t/\tau_3}$ according to the time-resolved emission decay curves.

Table S3. Photoluminescence and phosphorescence quantum yields of PAA-CPBA with different molar ratios of AA to CPBA under ambient conditions.

Molar ratio	Φ_{PL} (%)	Φ_{Phos} (%)
1000:1	8.39	4.49
1000:5	8.73	4.39
1000:10	8.83	4.65
1000:15	9.34	5.43
1000:20	7.68	4.27
1000:25	7.84	4.66

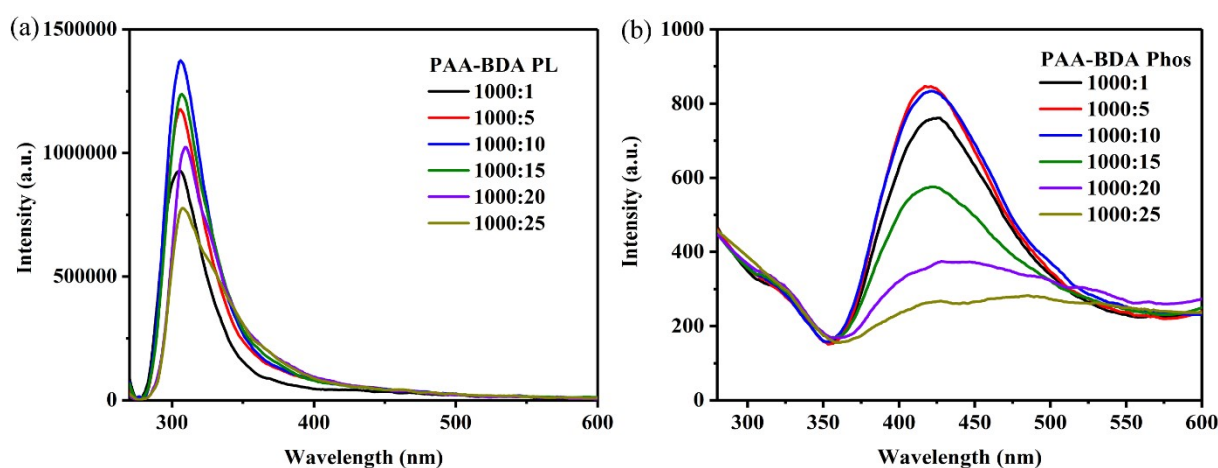


Fig. S3 (a) Steady state PL spectra of PAA-BDA with different molar ratios ($\lambda_{ex} = 240$ nm). (b) Phosphorescence spectra of PAA-BDA with different molar ratios ($\lambda_{ex} = 240$ nm).

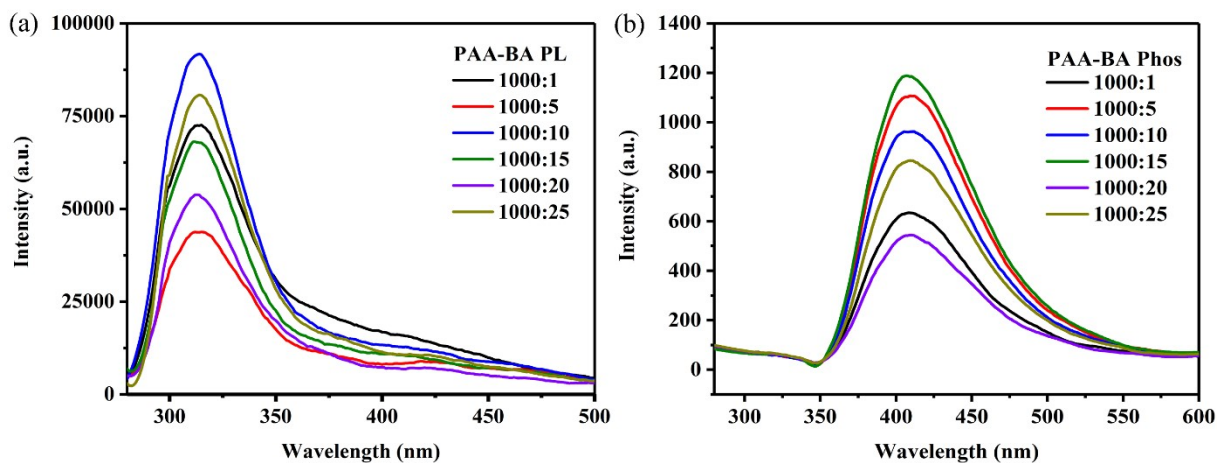


Fig. S4 (a) Steady state PL and spectra of PAA-BA with different molar ratios ($\lambda_{\text{ex}} = 245$ nm). (b) Phosphorescence spectra of PAA-BA with different molar ratios ($\lambda_{\text{ex}} = 245$ nm).

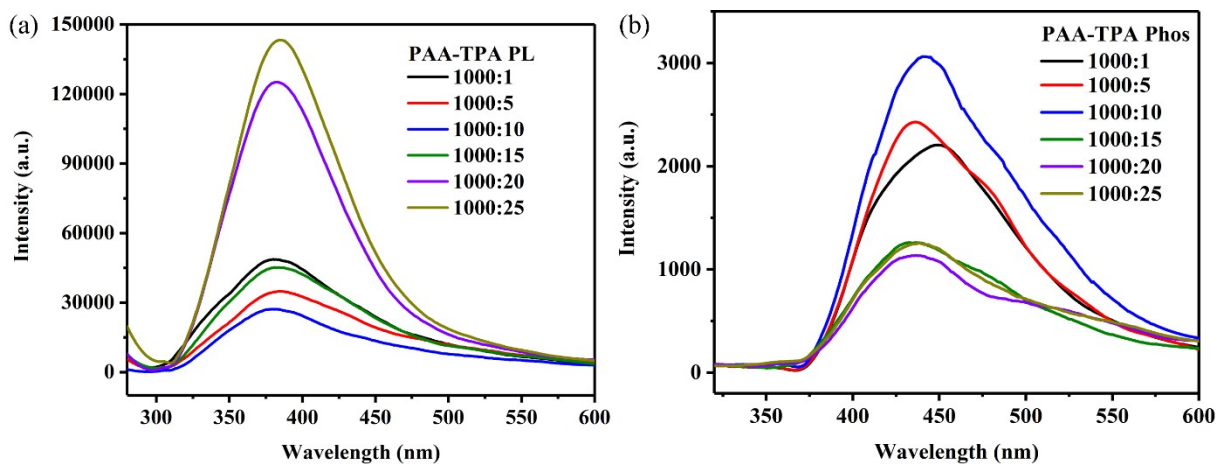


Fig. S5 (a) Steady state PL spectra of PAA-TPA with different molar ratios ($\lambda_{\text{ex}} = 268$ nm). (b) Phosphorescence spectra of PAA-TPA with different molar ratios ($\lambda_{\text{ex}} = 245$ nm).

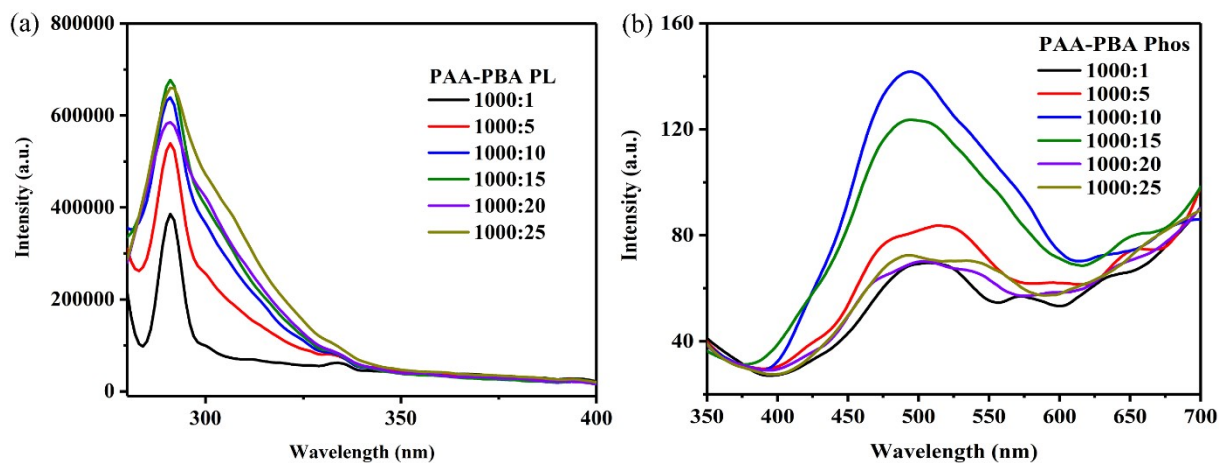


Fig. S6 (a) Steady state PL spectra of PAA-PBA with different molar ratios ($\lambda_{\text{ex}} = 278$ nm). (b) Phosphorescence spectra of PAA-PBA with different molar ratios ($\lambda_{\text{ex}} = 295$ nm).

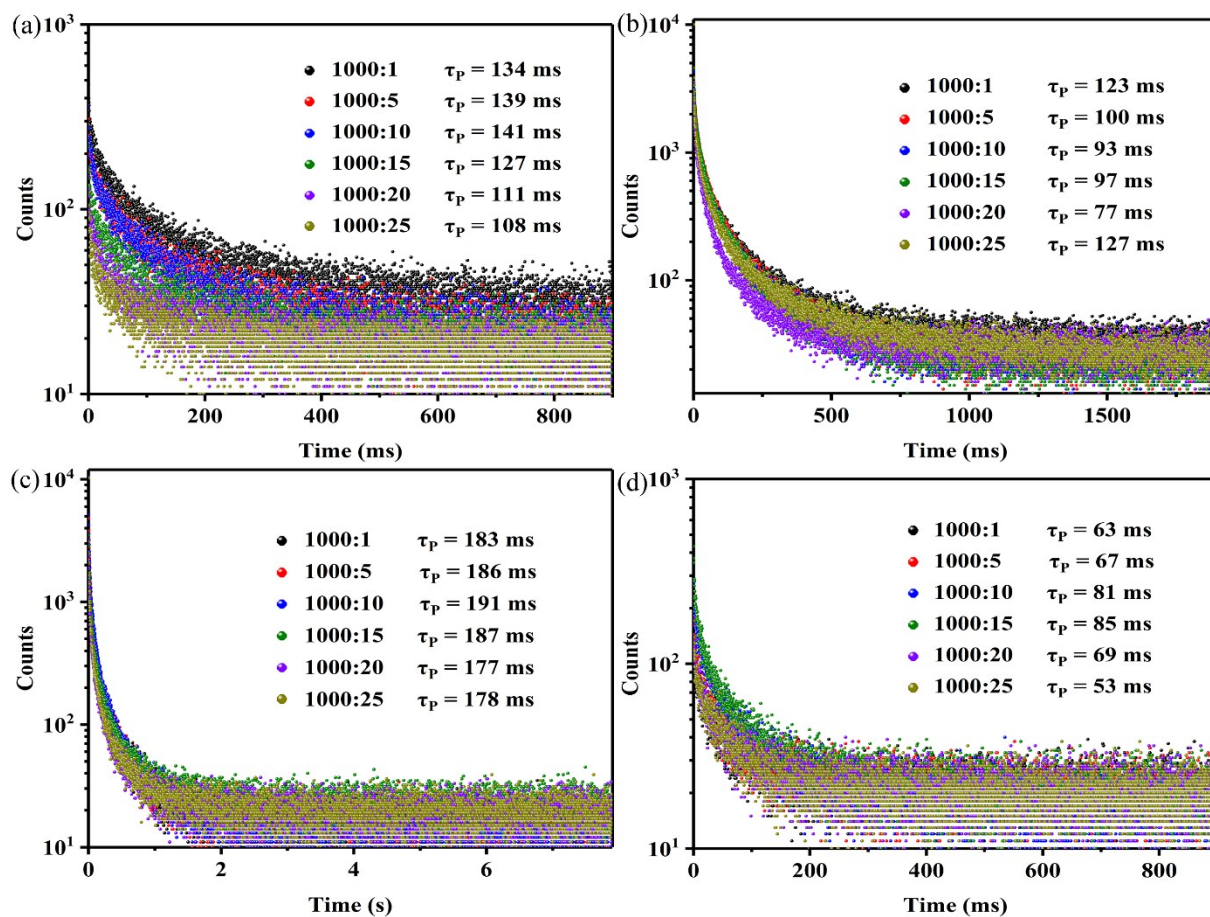


Fig. S7 Time-resolved emission decay curves of PAA-BDA at 420 nm (a), PAA-BA at 417 nm (b), PAA-TPA at 450 nm (c), and PAA-PBA at 500 nm (d) with different molar ratios under ambient conditions.

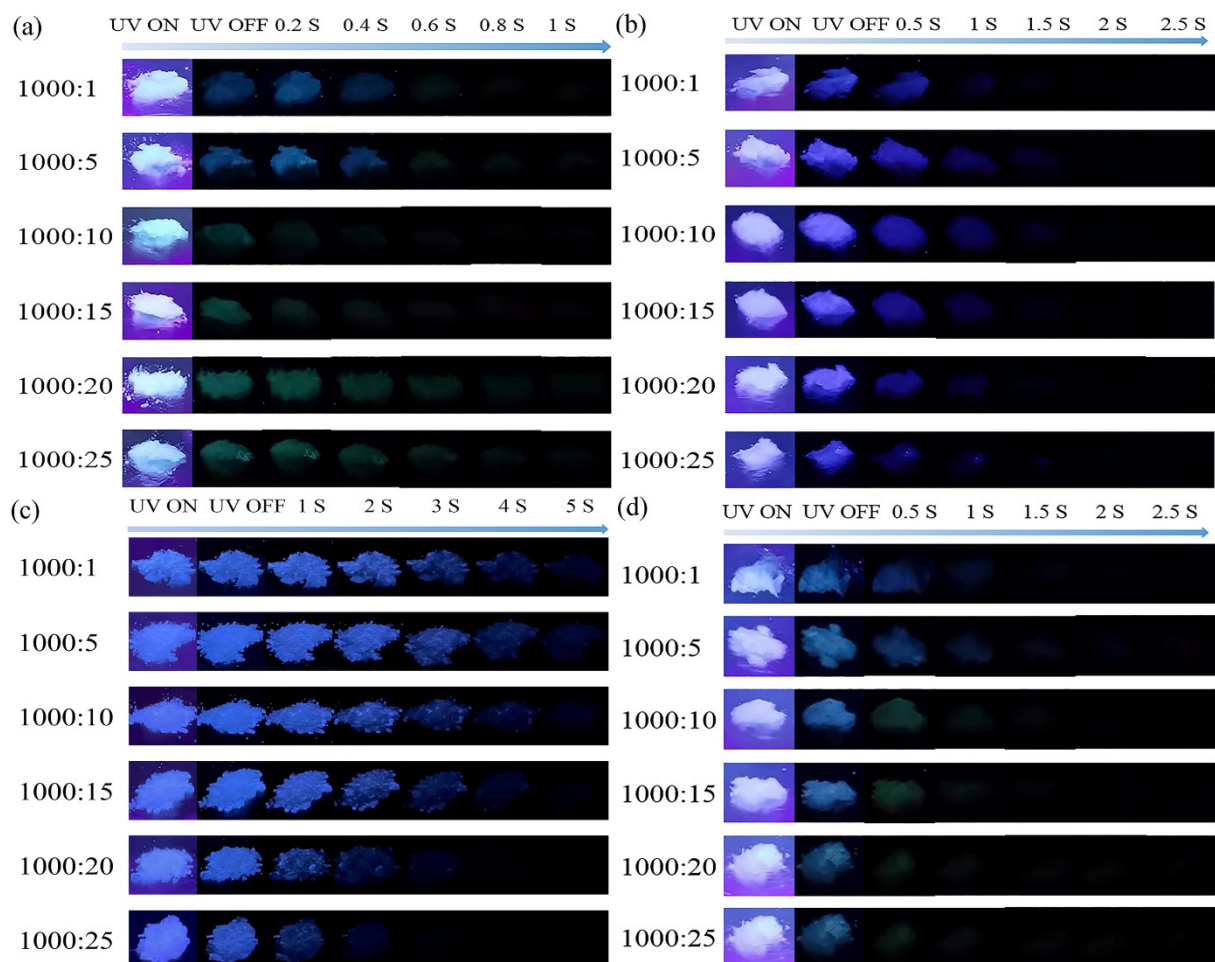


Fig. S8 Photographs of PAA-BDA (a), PAA-BA (b), PAA-TPA (c) and PAA-PBA (d) under 254 nm UV lights and after ceasing the irradiation under ambient conditions.

Table S4. Phosphorescence lifetimes of PAA-CPBA with molar ratio of 1000:15 (AA/CPBA) in air, nitrogen and argon atmospheres.^a

Atmosphere	τ_1 (ms)	A_1 (%)	τ_2 (ms)	A_2 (%)	τ_3 (ms)	A_3 (%)
Air	21.1	3.57	218.7	39.53	789.1	56.91
Nitrogen	44.6	5.42	301.4	43.90	981.1	50.67
Argon	78.0	5.16	497.3	40.55	1373.6	54.29

^a Determined from the fitting function of $I(t) = A_1e^{-t/\tau_1} + A_2e^{-t/\tau_2} + A_3e^{-t/\tau_3}$ according to the time-resolved emission decay curves.

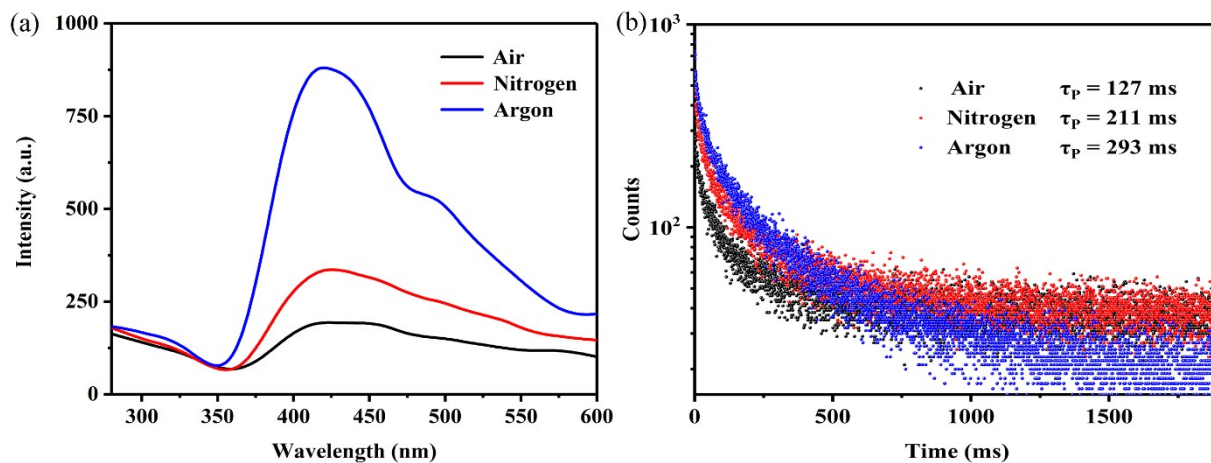


Fig. S9 (a) Phosphorescence spectra of PAA-BDA with AA/BDA molar ratio of 1000:15 in air, nitrogen and argon atmospheres. (b) Time-resolved emission decay curves of PAA-BDA with AA/BDA molar ratio of 1000:15 in air, nitrogen and argon atmospheres.

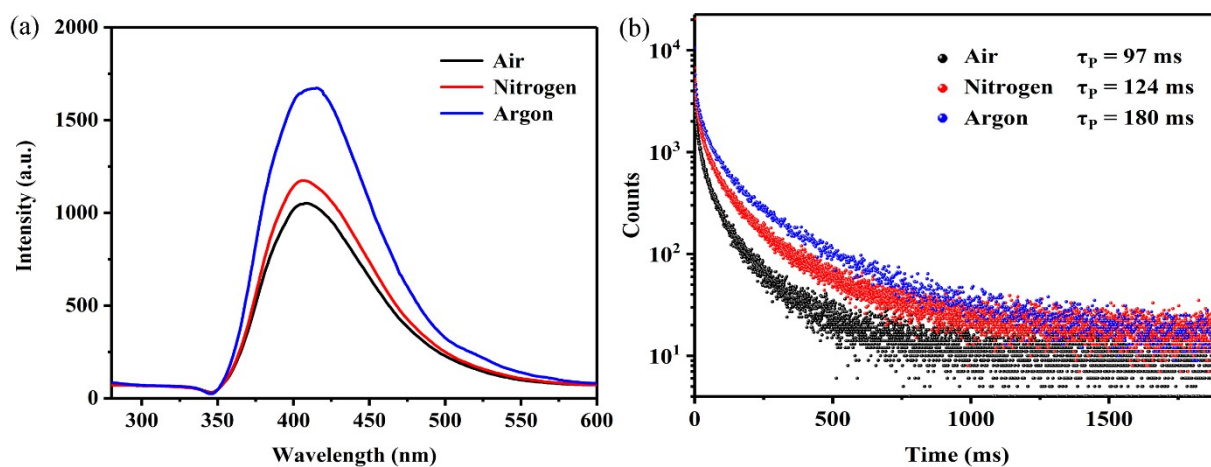


Fig. S10 (a) Phosphorescence spectra of PAA-BA with AA/BA molar ratio of 1000:15 in air, nitrogen and argon atmospheres. (b) Time-resolved emission decay curves of PAA-BA with AA/BA molar ratio of 1000:15 in air, nitrogen and argon atmospheres.

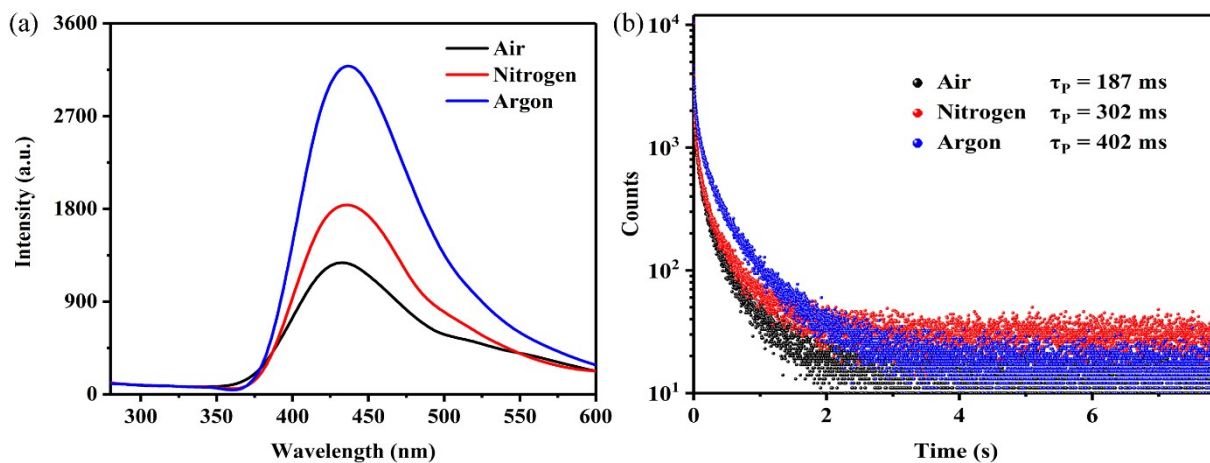


Fig. S11 (a) Phosphorescence spectra of PAA-TPA with AA/TPA molar ratio of 1000:15 in air nitrogen and argon atmospheres. (b) Time-resolved emission decay curves of PAA-TPA with AA/TPA molar ratio of 1000:15 in air, nitrogen and argon atmospheres.

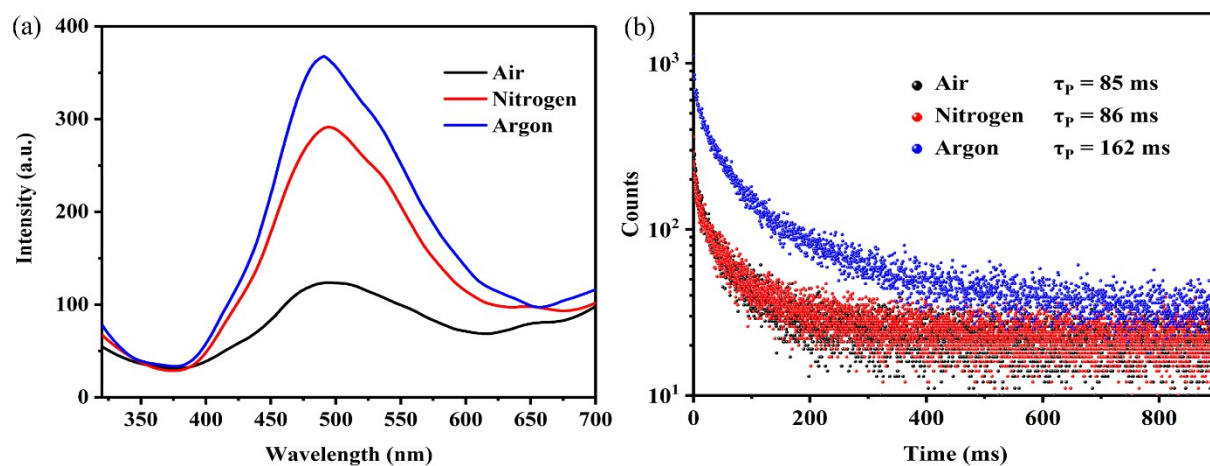


Figure S12 (a) Phosphorescence spectra of PAA-PBA with AA/PBA molar ratio of 1000:15 in air, nitrogen and argon atmospheres. (b) Time-resolved emission decay curves of PAA-PBA with AA/PBA molar ratio of 1000:15 in air, nitrogen and argon atmospheres.

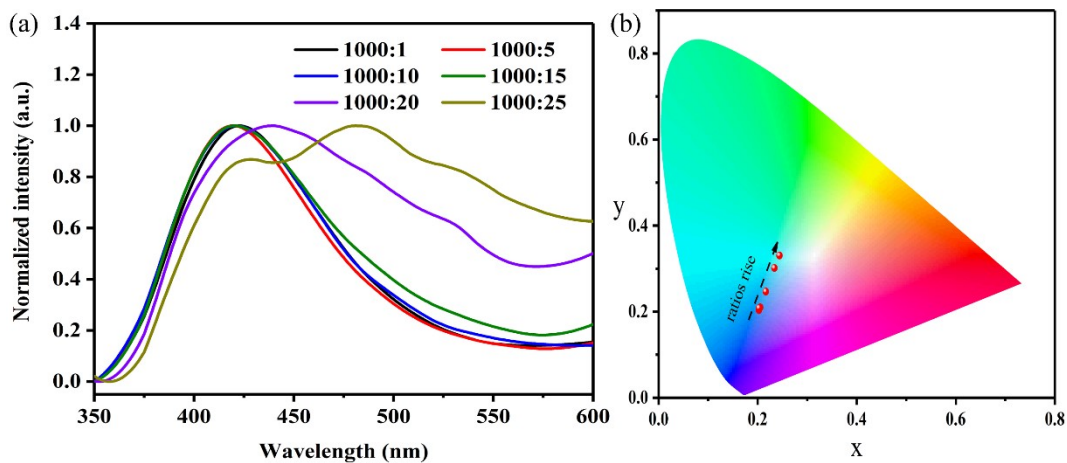


Fig. S13 (a) The normalized phosphorescence spectra of PAA-BDA with different molar ratios of AA to BDA. (b) CIE coordinate diagram for PAA-BDA with different molar ratios of AA to BDA.

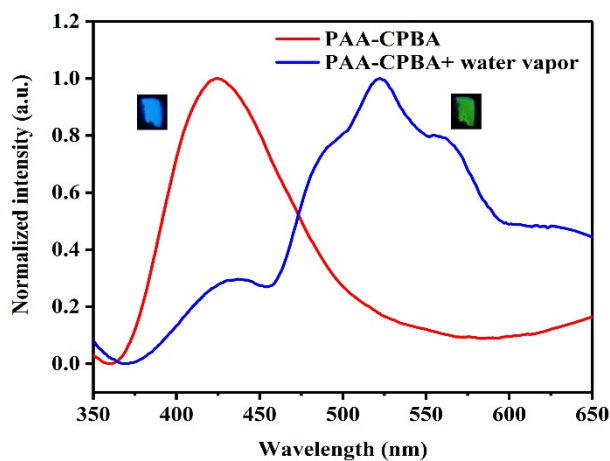


Fig. S14 The normalized phosphorescence emission spectra of PAA-CPBA before and after water vapor fumigation.

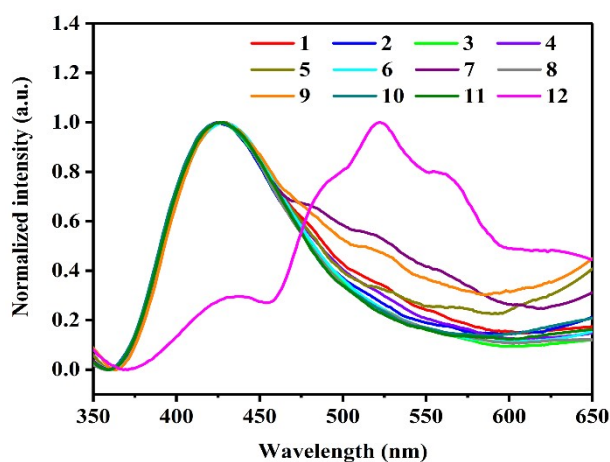


Fig. S15 The normalized phosphorescence spectra of PAA-CPBA after the fumigation of different solvents under 245 nm excitation. (1-acetone, 2-acetonitrile, 3-dichloromethane, 4-diethyl ether, 5-dimethylsulfoxide, 6-ethyl acetate, 7-ethanol, 8-methanol, 9-N, N dimethylformamide, 10-petroleum ether, 11-Tetrahydrofuran, 12-Water).

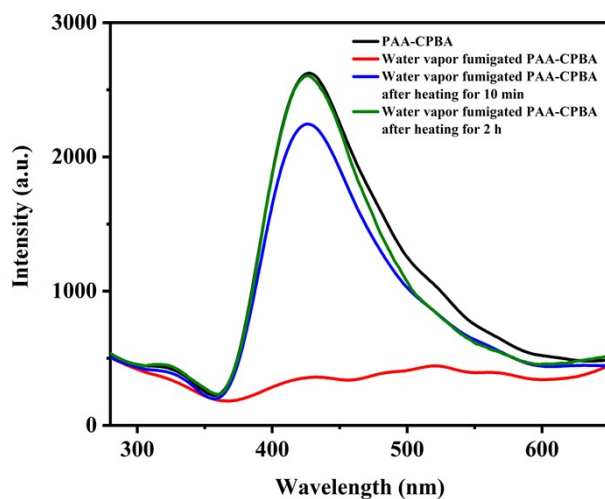


Fig. S16 Phosphorescence spectra of PAA-CPBA, water vapor fumigated PAA-CPBA and water vapor fumigated PAA-CPBA after heating for 10 min and 2 h.

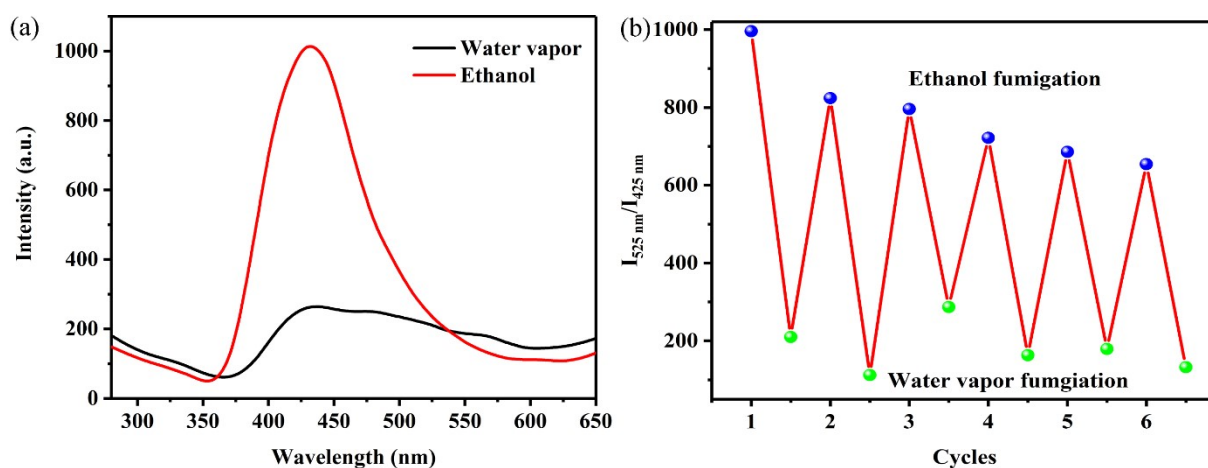


Fig. S17 (a) Phosphorescence spectra of PAA-CPBA with water vapor and ethanol fumigation. (b) The reversible transformation of phosphorescence emission intensity of PAA-CPBA at 525 nm and 425 nm after alternate treatment of water vapor and ethanol fumigation.