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# Supplementary Materials for

## Stimulus-responsive room temperature phosphorescence materials with full-color tunability from pure organic amorphous polymers

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**The PDF file includes:**



**Other Supplementary Material for this manuscript includes the following:**

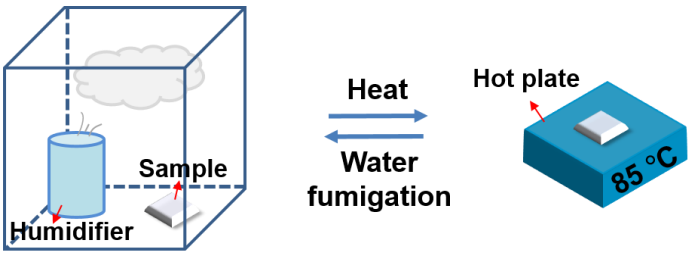


**fig. S1. The schematic diagram of heat/water stimulus-responsive processes.** First, put the prepared film and humidifier in a closed container. Ten minutes after the humidifier was turned on, the film was took out and its RTP performance was studied. Then, heat the water-fumigated film at 85 °C for 10 minutes to desiccate. After the film was cooled to room temperature, its RTP effect was measured again. This process could be repeated for at least five times.

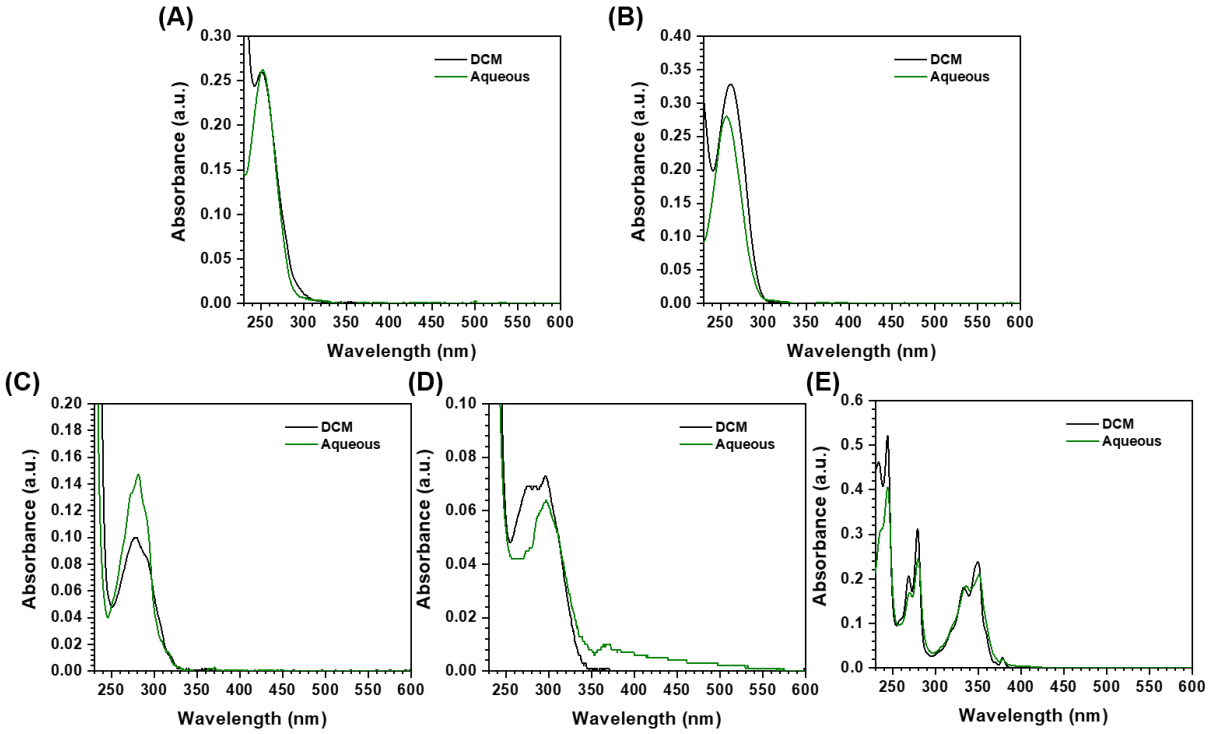


**fig. S2. The UV-vis absorption spectra of target polymers.** The UV-vis absorption spectra of aqueous phase (green line) and dichloromethane (DCM) solution (black line) after extracting (A) ***m*-Bp-BOH-PVA**, (B) ***p*-Bp-BOH-PVA**, (C) **Nap-BOH-PVA**, (D) **BNap-BOH-PVA** and (E) **Py-BOH-PVA** prepared aqueous solutions by dichloromethane (DCM) with the volume ratio of 1:1.

The reaction yield between **PVA** and arylboronic acids was calculated based on following equation:

$A=\lg(1/T)=Kbc$ (a)

Reaction yield = $A_{aqueous}/(A_{aqueous}+ A_{DCM})$

Where A, T, K, b, c, $A_{aqueous}$ and $A_{DCM}$ are absorbance, transmittance, molar absorption coefficient, the distance the light travels in the sample and the concentration of the solution, absorbance in aqueous solution and absorbance in DCM solution.

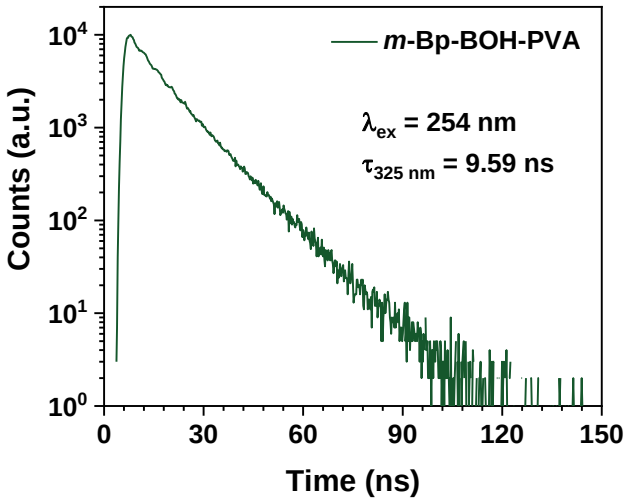


**fig. S3. Fluorescence lifetime of *m*-Bp-BOH-PVA film.** Time-resolved fluorescence-decay profile of ***m*-Bp-BOH-PVA** film.

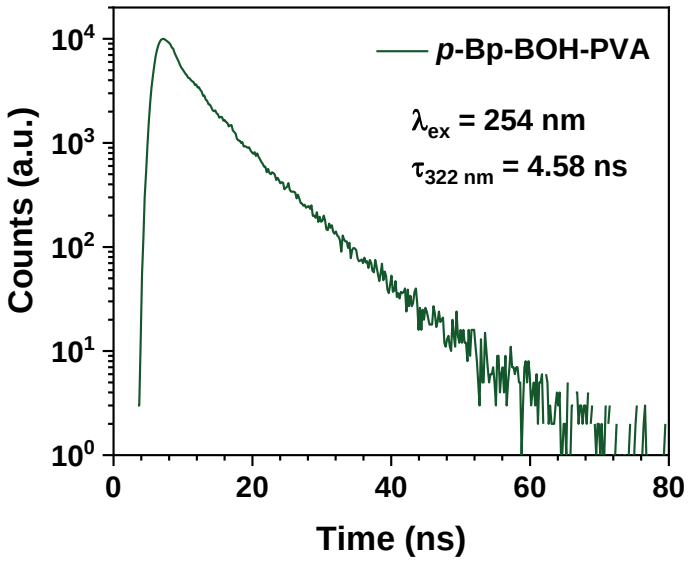


**fig. S4. Fluorescence lifetime of *p*-Bp-BOH-PVA film.** Time-resolved fluorescence-decay profile of ***p*-Bp-BOH-PVA** film.

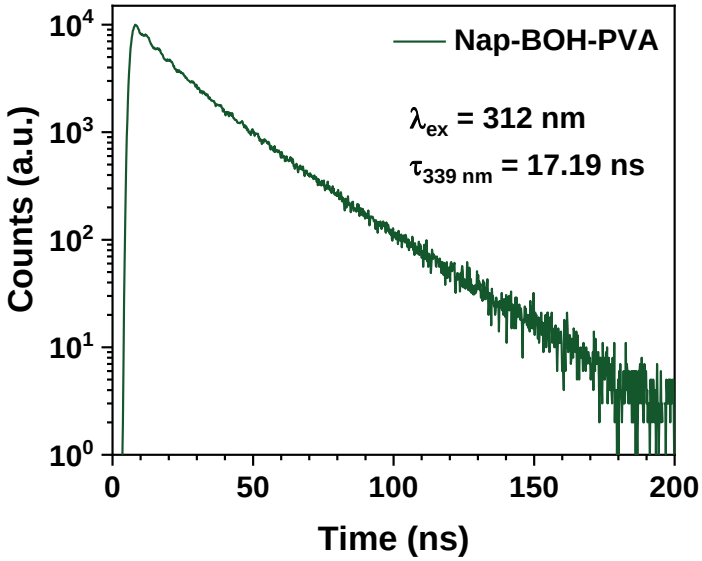


**fig. S5. Fluorescence lifetime of Nap-BOH-PVA film.** Time-resolved fluorescence-decay profile of **Nap-BOH-PVA** film.

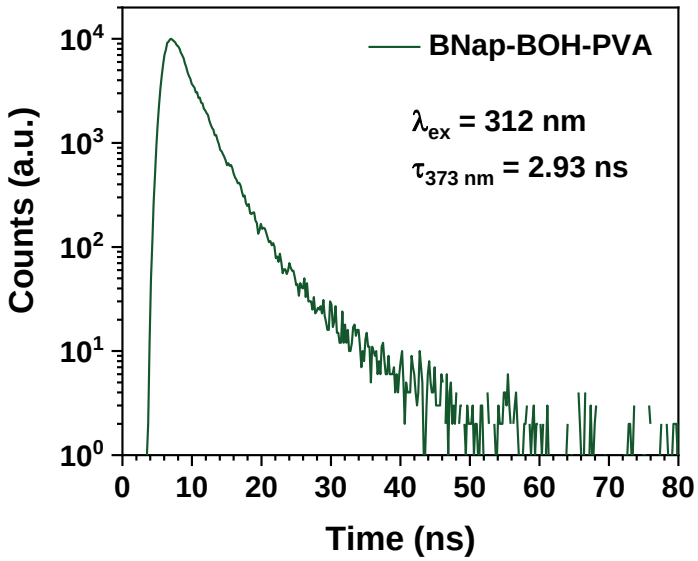


**fig. S6. Fluorescence lifetime of BNap-BOH-PVA film.** Time-resolved fluorescence-decay profile of **BNap-BOH-PVA** film.

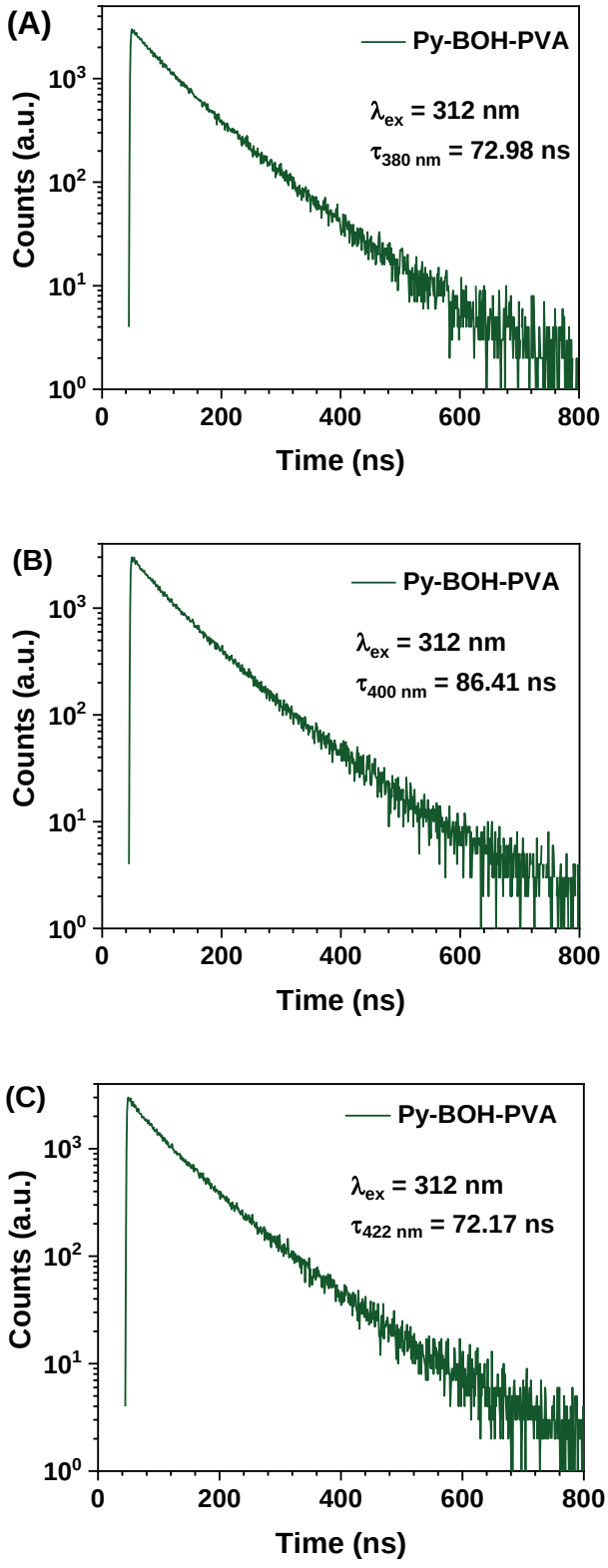


**fig. S7. Fluorescence lifetime of Py-BOH-PVA film.** Time-resolved fluorescence-decay profiles of **Py-BOH-PVA** film at emission peaks of 380 nm (A), 400 nm (B) and 422 nm (C) respectively.

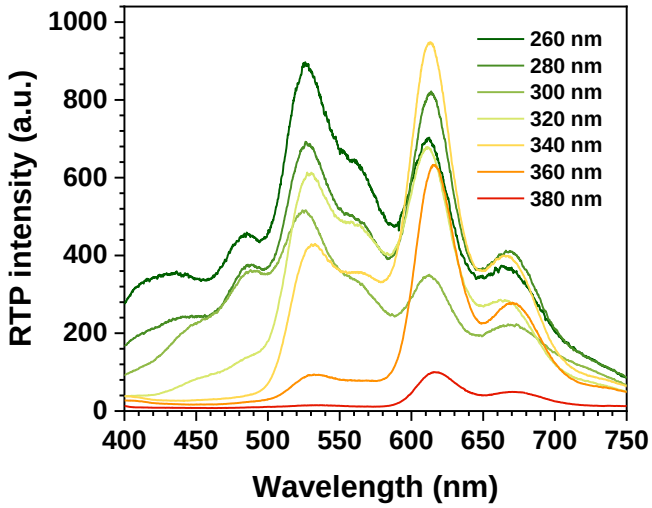


**fig. S8. Excitation-dependent RTP spectra of Py-BOH-PVA.** Phosphorescence spectra of **Py-BOH-PVA** excited by different wavelengths from 260 to 380 nm.

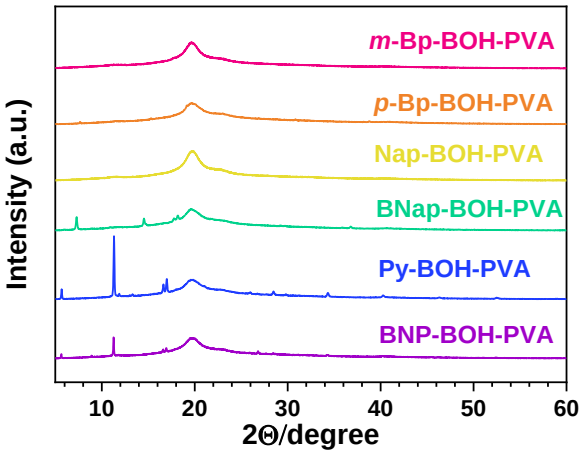


**fig. S9. PXRD patterns of target polymers.** Powder X-ray diffraction (PXRD) patterns of ***m*-Bp-BOH-PVA**, ***p*-Bp-BOH-PVA**, **Nap-BOH-PVA**, **BNap-BOH-PVA**, **Py-BOH-PVA** and **BNP-BOH-PVA** films.

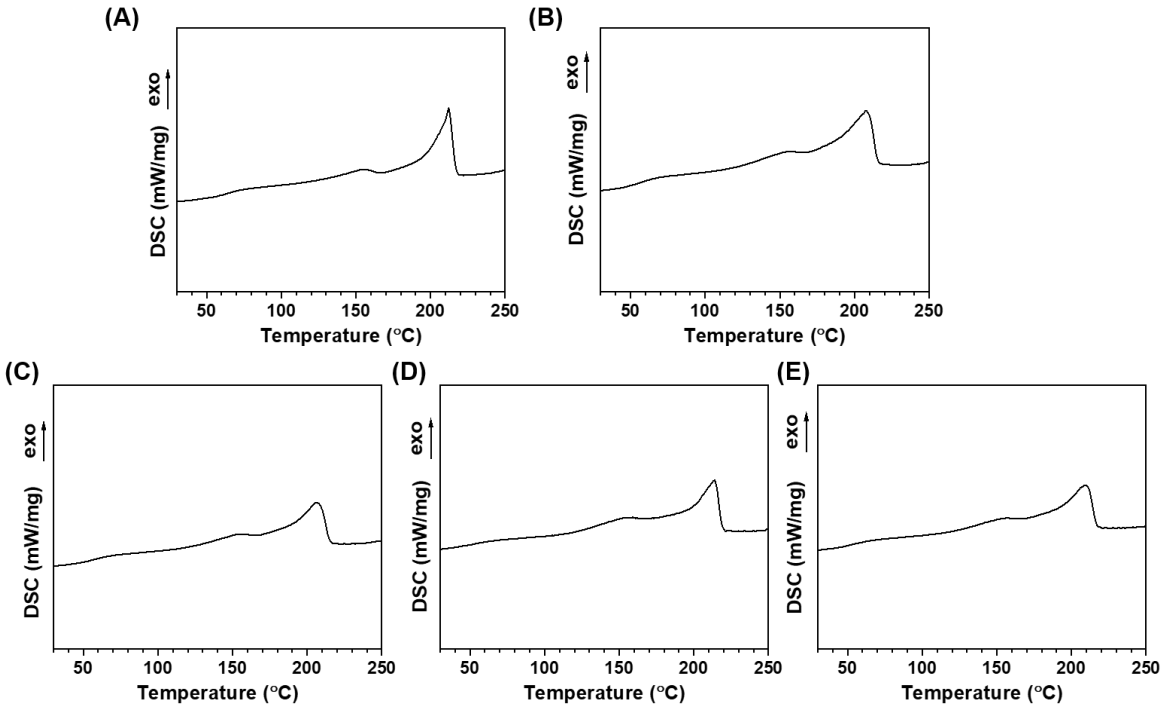


**fig. S10. DSC curves of target polymers.** The differential scanning calorimetry (DSC) curves of (A) ***m*-Bp-BOH-PVA**, (B) ***p*-Bp-BOH-PVA**, (C) **Nap-BOH-PVA**, (D) **BNap-BOH-PVA** and (E) **Py-BOH-PVA** (these data were extracted from the second cycle).

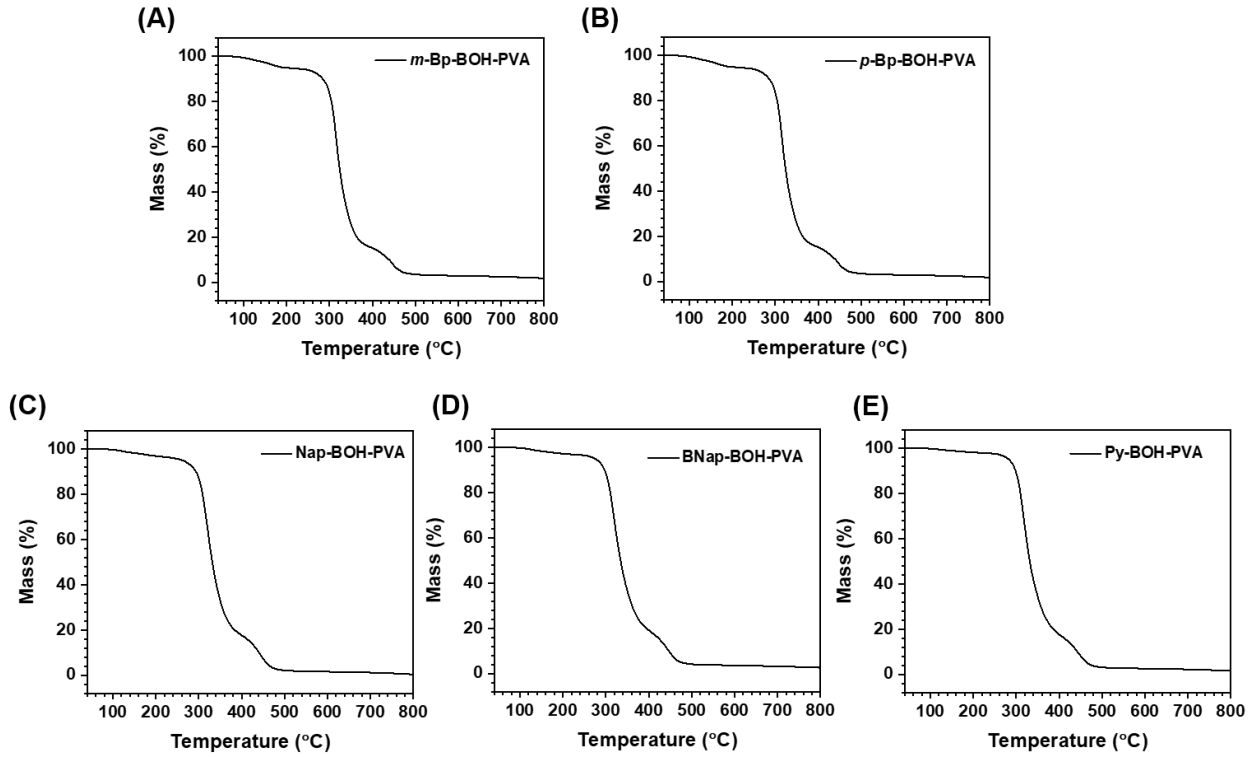


**fig. S11. TGA curves of target polymers.** The thermos-gravimetric analysis (TGA) curves of (A) ***m*-Bp-BOH-PVA**, (B) ***p*-Bp-BOH-PVA**, (C) **Nap-BOH-PVA**, (D) **BNap-BOH-PVA** and (E) **Py-BOH-PVA**.

**table S1. Thermal properties of target polymers.** Glass transition temperature and thermal decomposition temperature of ***m*-Bp-BOH-PVA**, ***p*-Bp-BOH-PVA**, **Nap-BOH-PVA**, **BNap-BOH-PVA** and **Py-BOH-PVA**.

| | Glass transition temperature/°C | Decomposition temperature[a)]/°C |
|---|---|---|
| ***m*-Bp-BOH-PVA** | 52.8 | 315.1 |
| ***p*-Bp-BOH-PVA** | 45.6 | 316.9 |
| **Nap-BOH-PVA** | 42.6 | 321.8 |
| **BNap-BOH-PVA** | 58.9 | 321.3 |
| **Py-BOH-PVA** | 43.5 | 318.9 |

[a)] Decomposition temperatures are based on the decomposition onset temperature.

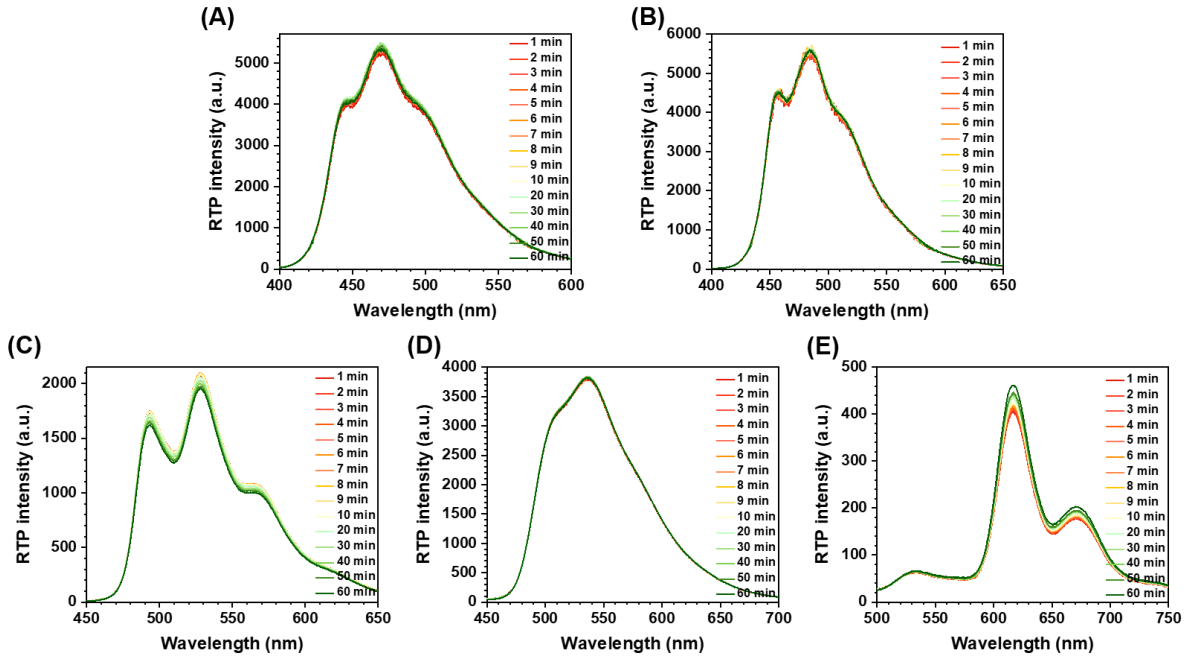


**fig. S12. Photostability of target polymers.** Phosphorescence spectra illuminated by UV lamp for different times (1-60 min) of (A) ***m*-Bp-BOH-PVA**, (B) ***p*-Bp-BOH-PVA**, (C) **Nap-BOH-PVA**, (D) **BNap-BOH-PVA** and (E) **Py-BOH-PVA** films.

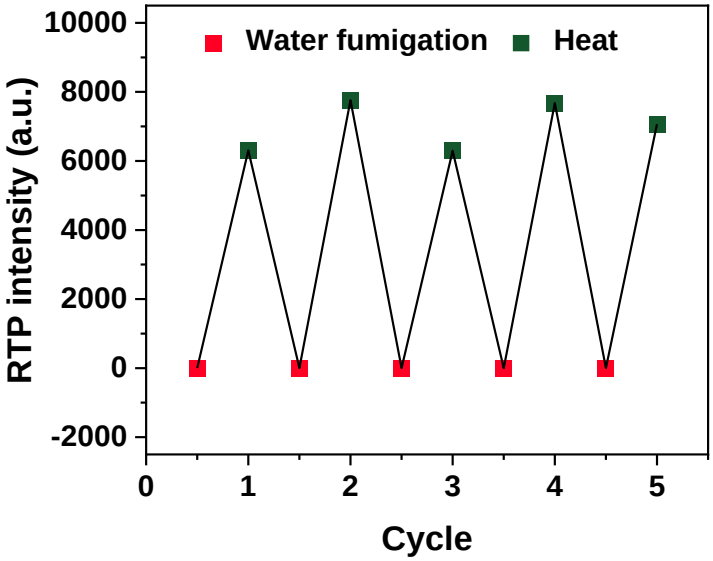


**fig. S13. Cycles of stimulus-responsive RTP effect for *m*-Bp-BOH-PVA.** Repeated cycles of the heating/water fuming processes of ***m*-Bp-BOH-PVA** film. The RTP intensity represents the phosphorescence emission intensity at 470 nm at room temperature.

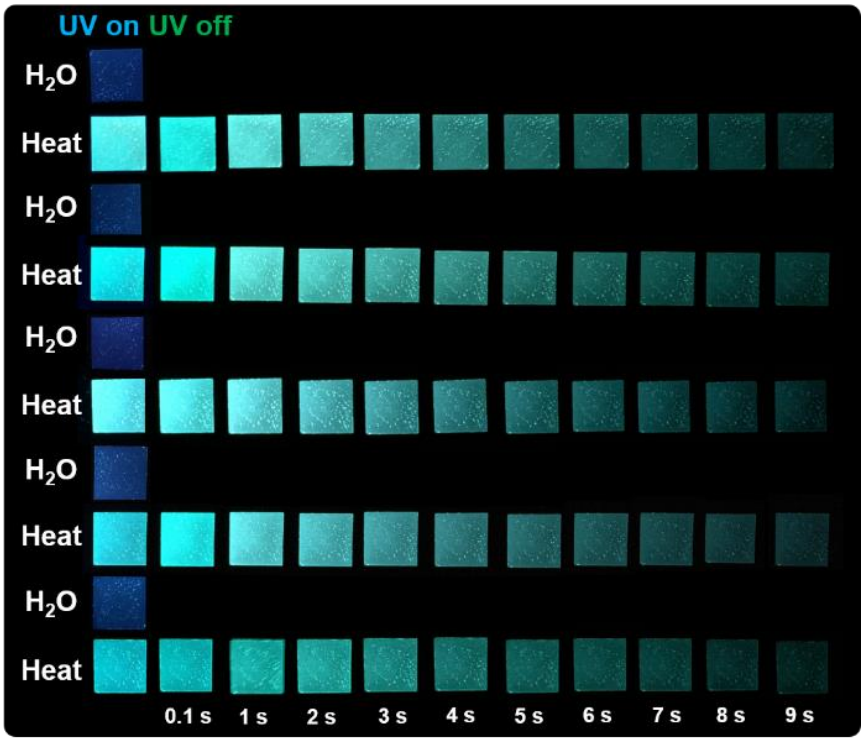


**fig. S14. Photographs of repeated stimulus-responsive RTP effect for *m*-Bp-BOH-PVA.** Photographs of repeated cycles of the heating/water fuming processes of ***m*-Bp-BOH-PVA** film.

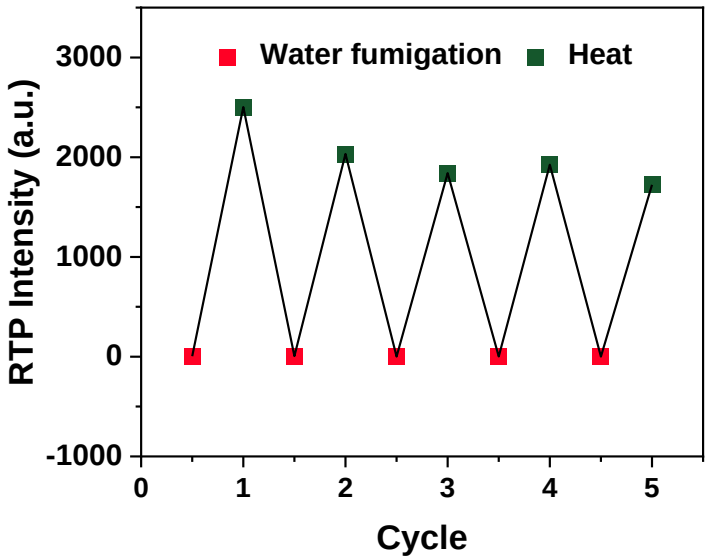


**fig. S15. Cycles of stimulus-responsive RTP effect for *p*-Bp-BOH-PVA.** Repeated cycles of the heating/water fuming processes of ***p*-Bp-BOH-PVA** film. The RTP intensity represents the phosphorescence emission intensity at 485 nm at room temperature.

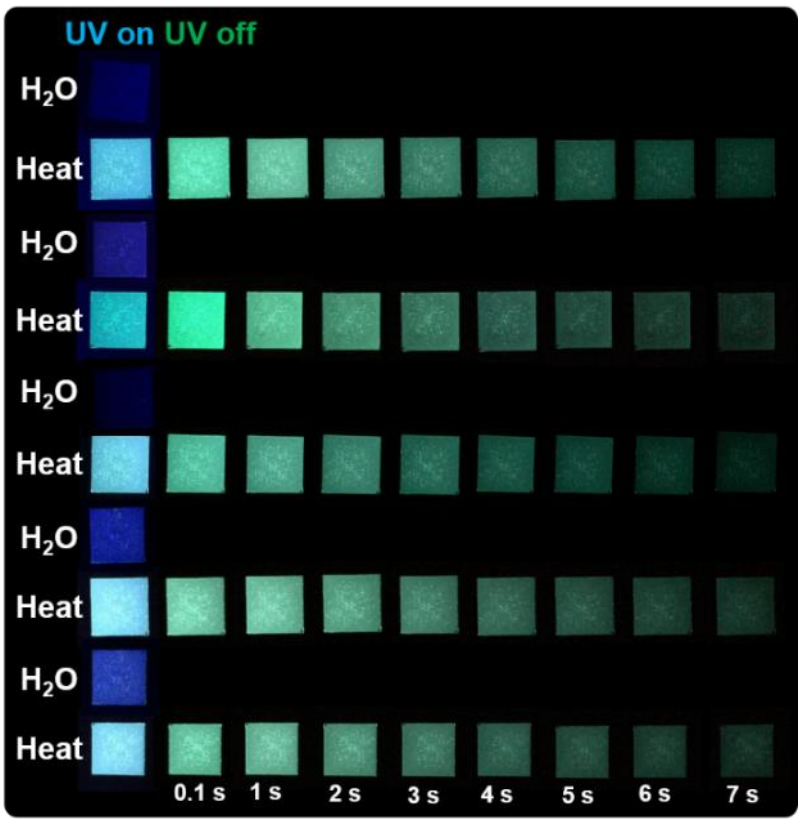


**fig. S16. Photographs of repeated stimulus-responsive RTP effect for *p*-Bp-BOH-PVA.** Photographs of repeated cycles of the heating/water fuming processes of ***p*-Bp-BOH-PVA** film.

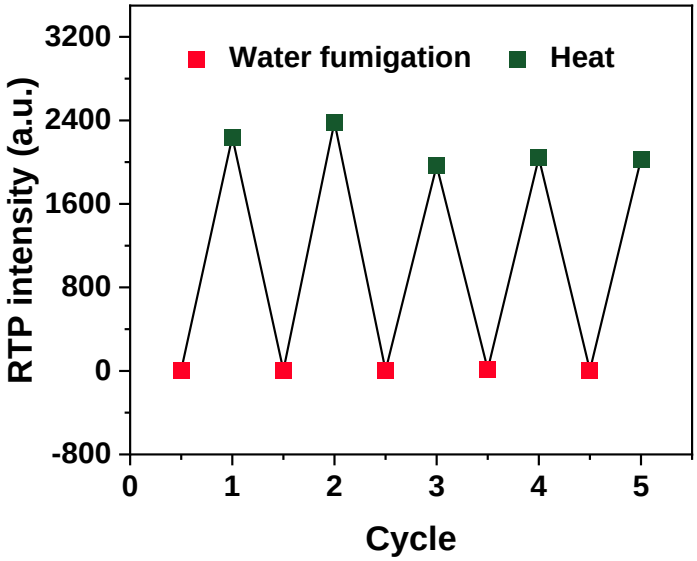


**fig. S17. Cycles of stimulus-responsive RTP effect for Nap-BOH-PVA.** Repeated cycles of the heating/water fuming processes of **Nap-BOH-PVA** film. The RTP intensity represents the phosphorescence emission intensity at 525 nm at room temperature.

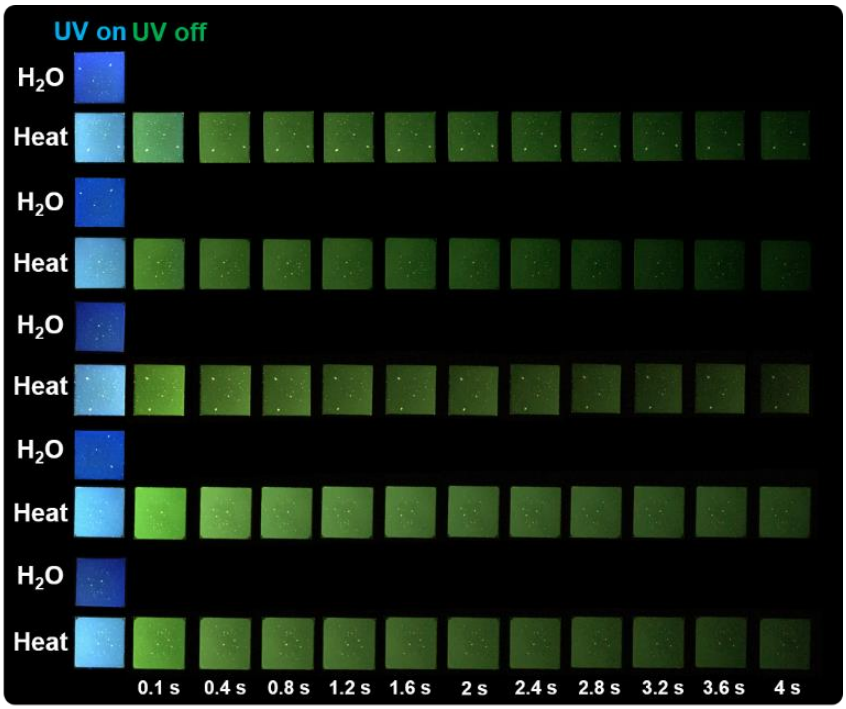


**fig. S18. Photographs of repeated stimulus-responsive RTP effect for Nap-BOH-PVA.** Photographs of repeated cycles of the heating/water fuming processes of **Nap-BOH-PVA** film.

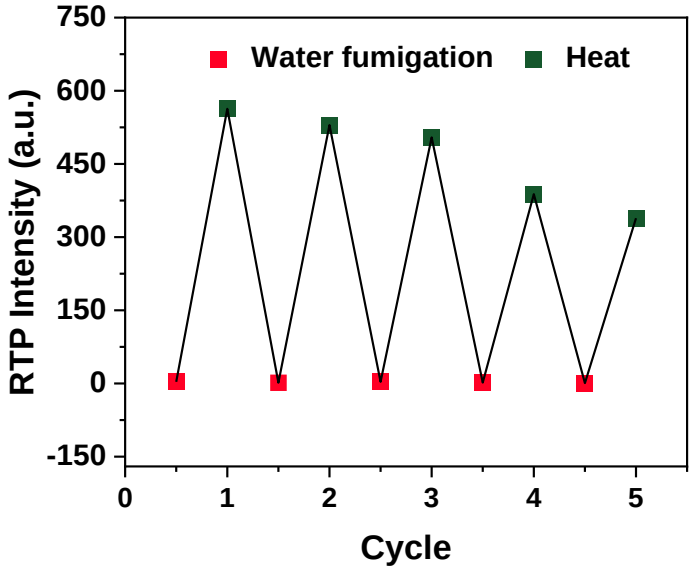


**fig. S19. Cycles of stimulus-responsive RTP effect for BNap-BOH-PVA.** Repeated cycles of the heating/water fuming processes of **BNap-BOH-PVA** film. The RTP intensity represents the phosphorescence emission intensity at 535 nm at room temperature.

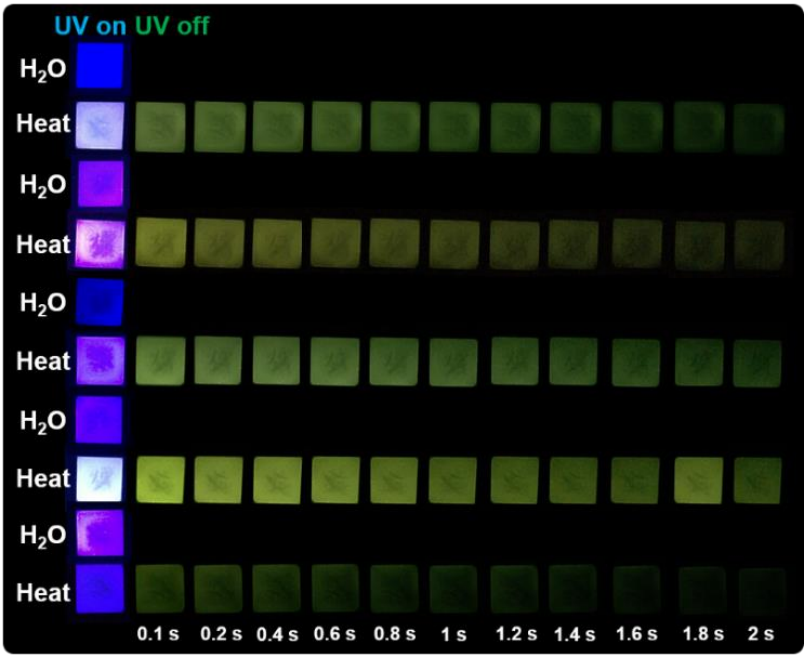


**fig. S20. Photographs of repeated stimulus-responsive RTP effect for BNap-BOH-PVA.** Photographs of repeated cycles of the heating/water fuming processes of **BNap-BOH-PVA** film.

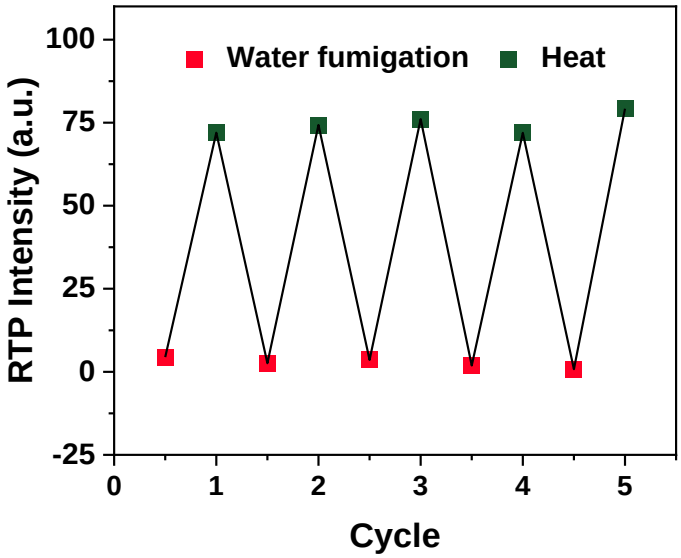


**fig. S21. Cycles of stimulus-responsive RTP effect for Py-BOH-PVA.** Repeated cycles of the heating/water fuming processes of **Py-BOH-PVA** film. The RTP intensity represents the phosphorescence emission intensity at 610 nm at room temperature.

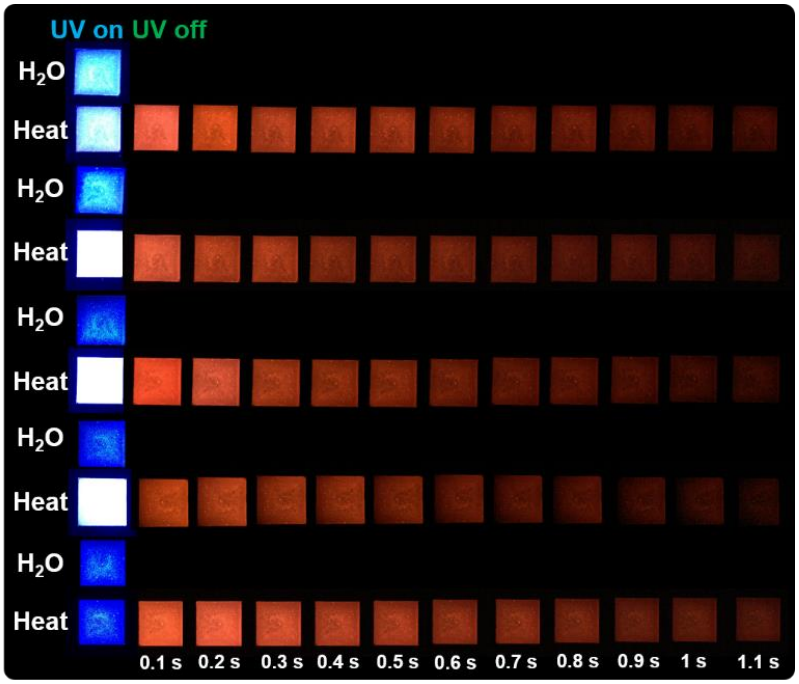


**fig. S22. Photographs of repeated stimulus-responsive RTP effect for Py-BOH-PVA.** Photographs of repeated cycles of the heating/water fuming processes of **Py-BOH-PVA** film.

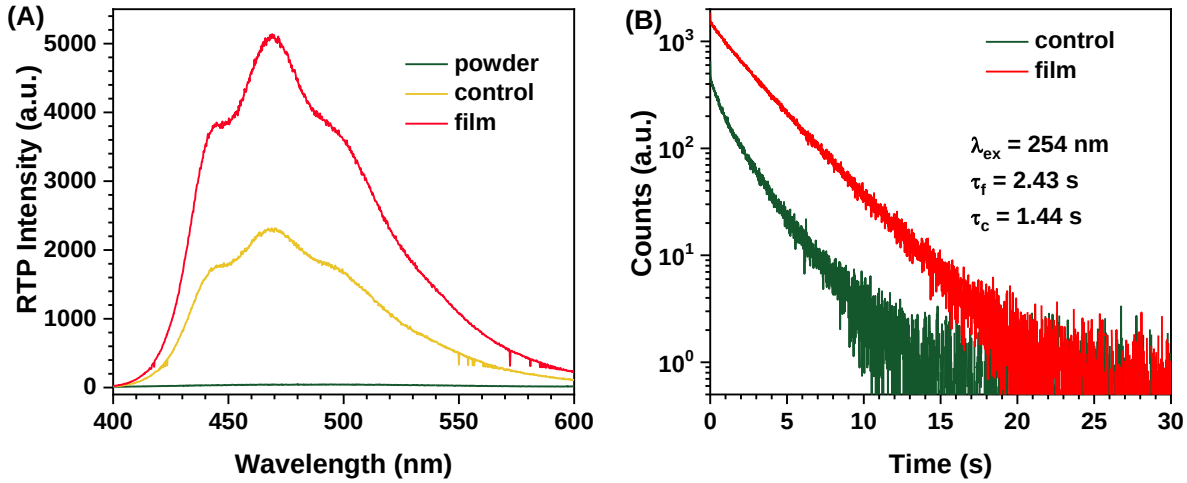


**fig. S23. RTP behaviors of *m*-Bp-BOH in different states.** (A) The RTP spectra and (B) corresponding time resolved phosphoresence-decay profiles of ***m*-Bp-BOH** powder, ***m*-Bp-BOH-PVA-C** film and ***m*-Bp-BOH-PVA** film under ambient condition.

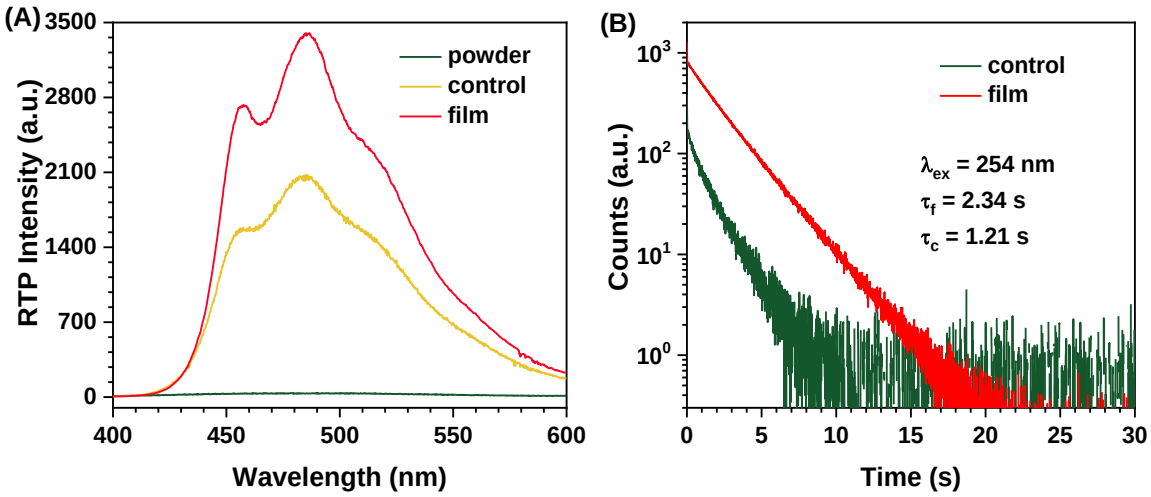


**fig. S24. RTP behaviors of *p*-Bp-BOH in different states.** (A) The RTP spectra and (B) corresponding time resolved phosphoresence-decay profiles of ***p*-Bp-BOH** powder, ***p*-Bp-BOH-PVA-C** film and ***p*-Bp-BOH-PVA** film under ambient condition.

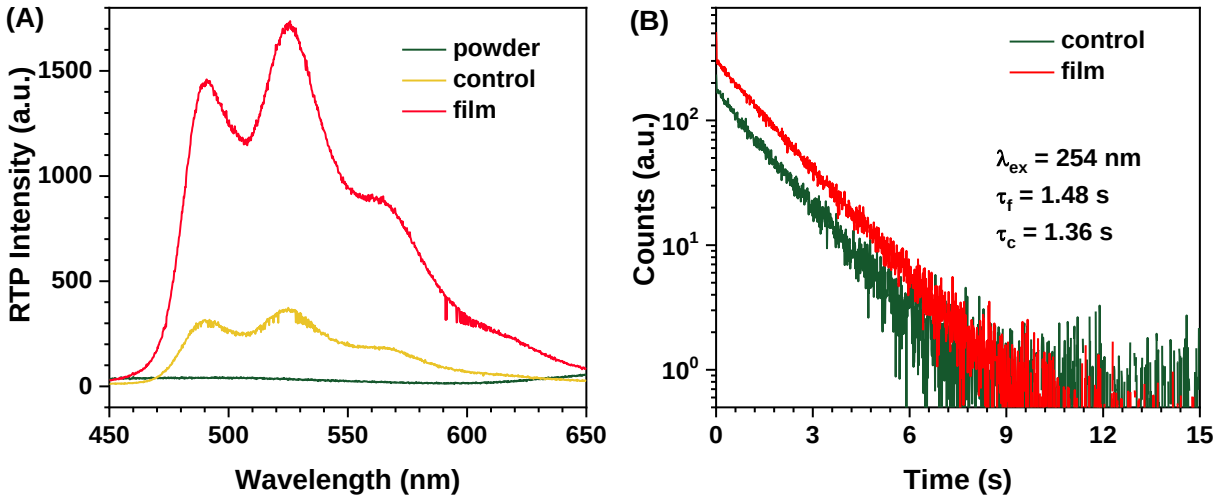


**fig. S25. RTP behaviors of Nap-BOH in different states.** (A) The RTP spectra and (B) corresponding time resolved phosphoresence-decay profiles of **Nap-BOH** powder, **Nap-BOH-PVA-C** film and **Nap-BOH-PVA** film under ambient condition.

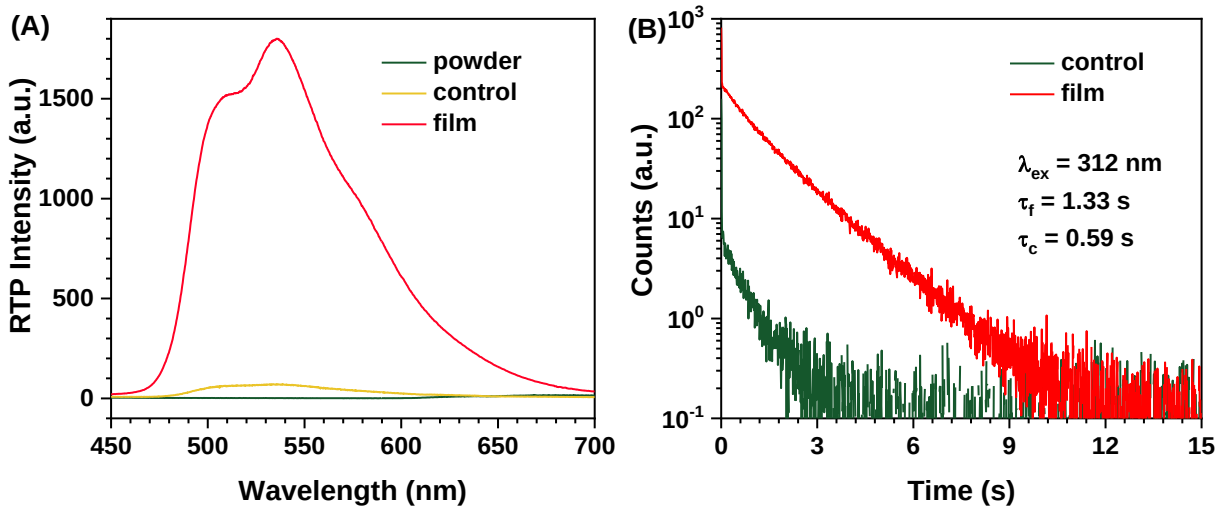


**fig. S26. RTP behaviors of BNap-BOH in different states.** (A) The RTP spectra and (B) corresponding time resolved phosphorescence-decay profiles of **BNap-BOH** powder, **BNap-BOH-PVA-C** film and **BNap-BOH-PVA** film under ambient conditions.

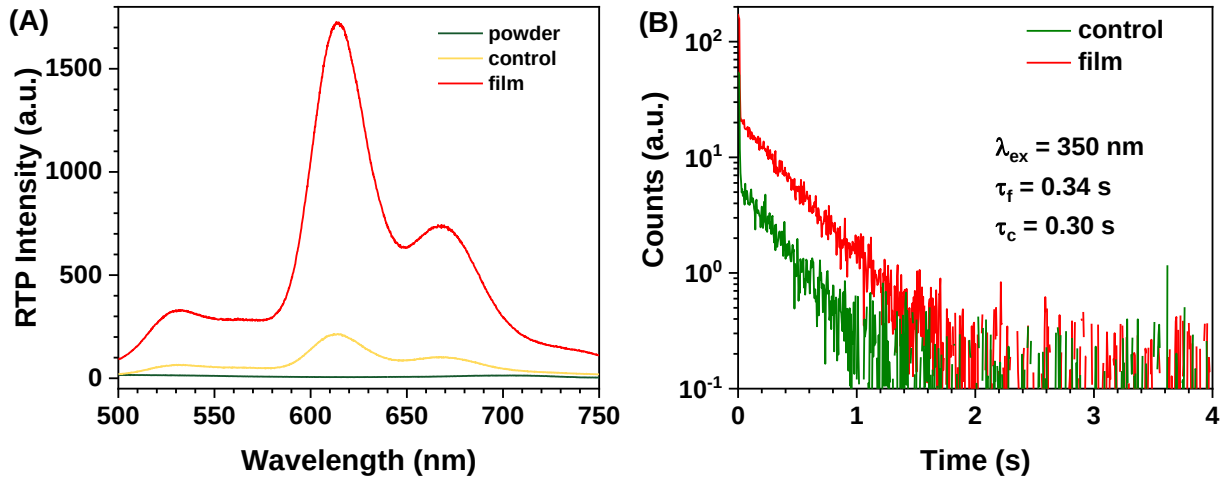


**fig. S27. RTP behaviors of Py-BOH in different states.** (A) The RTP spectra and (B) corresponding time resolved phosphoresence-decay profiles of **Py-BOH** powder, **Py-BOH-PVA-C** film and **Py-BOH-PVA** film under ambient condition.

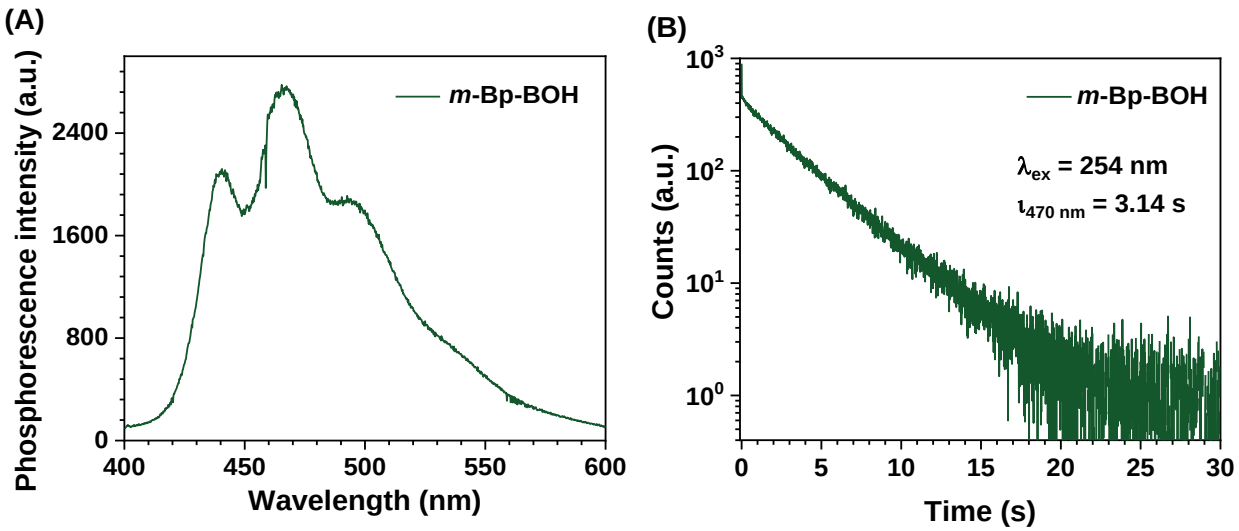


**fig. S28. Low temperature phosphorescence of *m*-Bp-BOH solution.** (A) Phosphorescence spectrum and (B) corresponding time resolved phosphoresence-decay profile of ***m*-Bp-BOH** in tetrahydrofuran (THF) solution ($10^{-5}$ mol/L) at 77 K.

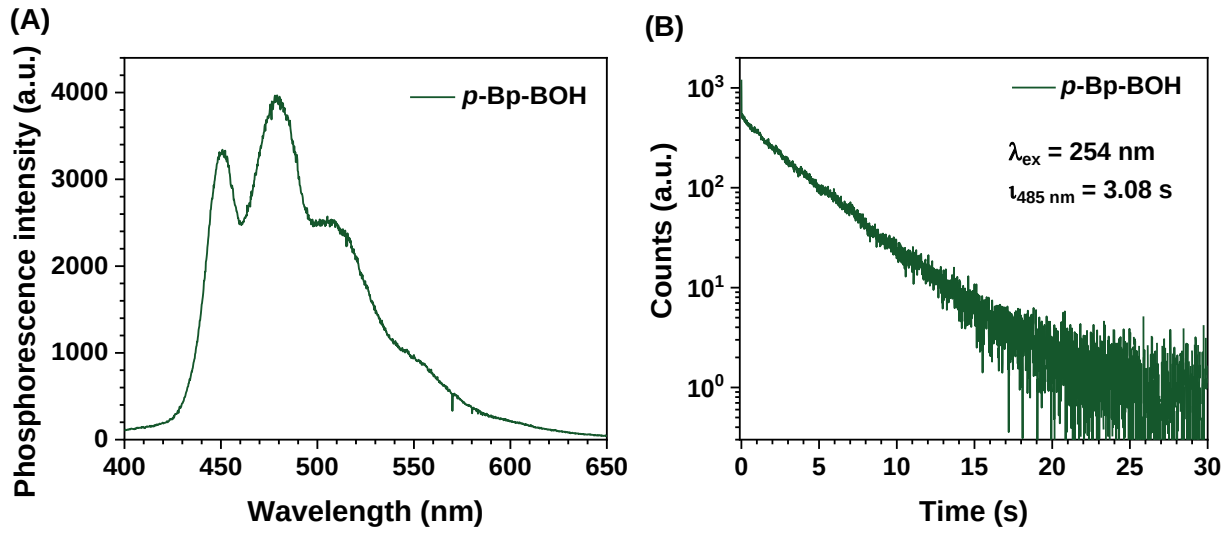


**fig. S29. Low temperature phosphorescence of *p*-Bp-BOH solution.** (A) Phosphorescence spectrum and (B) corresponding time resolved phosphoresence-decay profile of ***p*-Bp-BOH** in tetrahydrofuran (THF) solution ($10^{-5}$ mol/L) at 77 K.

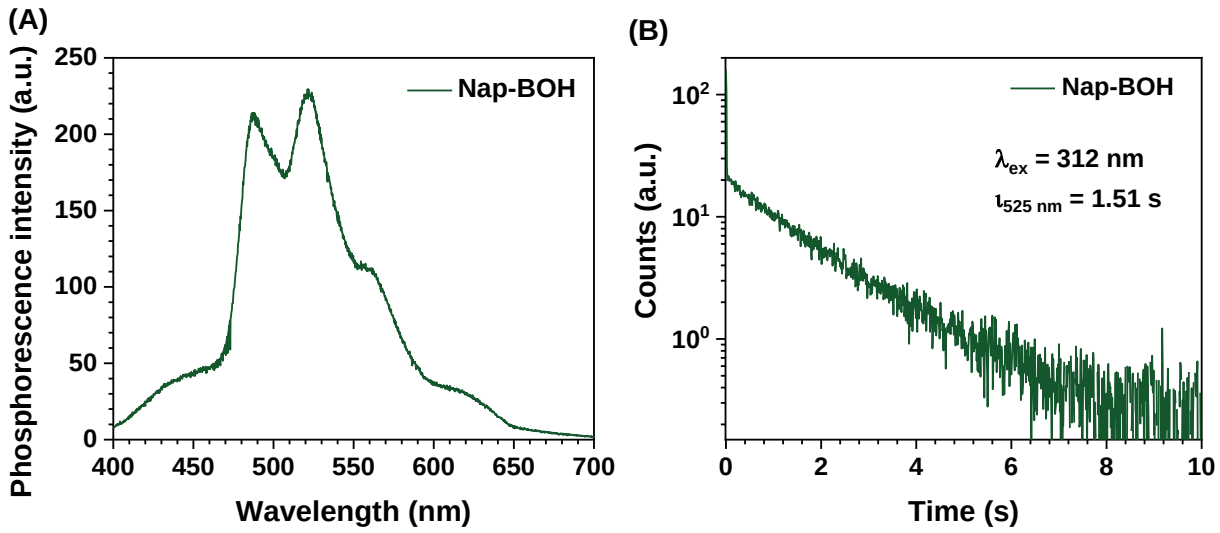


**fig. S30. Low temperature phosphorescence of Nap-BOH solution.** (A) Phosphorescence spectrum and (B) corresponding time resolved phosphoresence-decay profile of **Nap-BOH** in tetrahydrofuran (THF) solution ($10^{-5}$ mol/L) at 77 K.

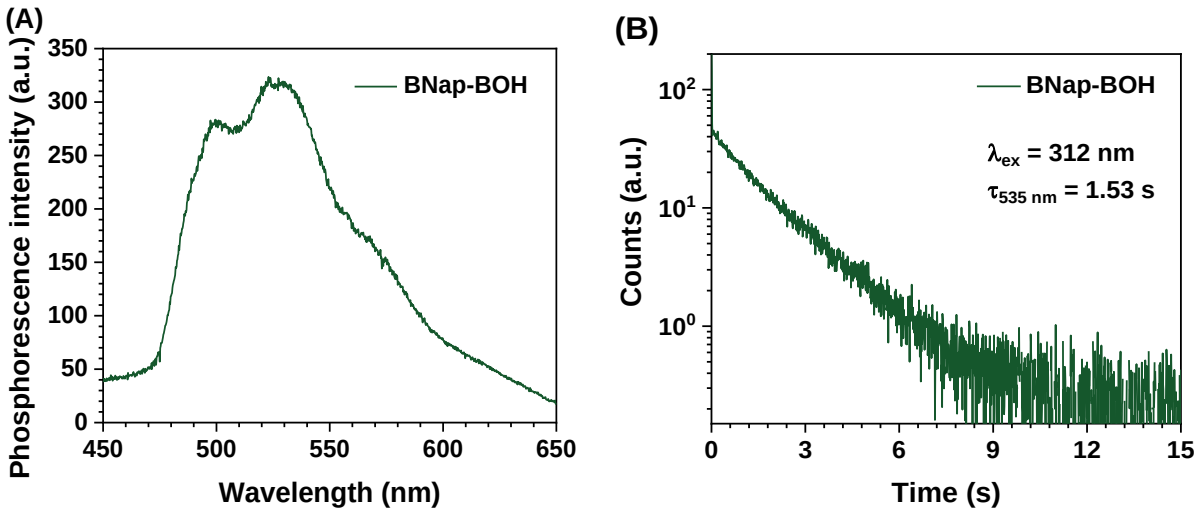


**fig. S31. Low temperature phosphorescence of BNap-BOH solution.** (A) Phosphorescence spectrum and (B) corresponding time resolved phosphoresence-decay profile of **BNap-BOH** in tetrahydrofuran (THF) solution ($10^{-5}$ mol/L) at 77 K.

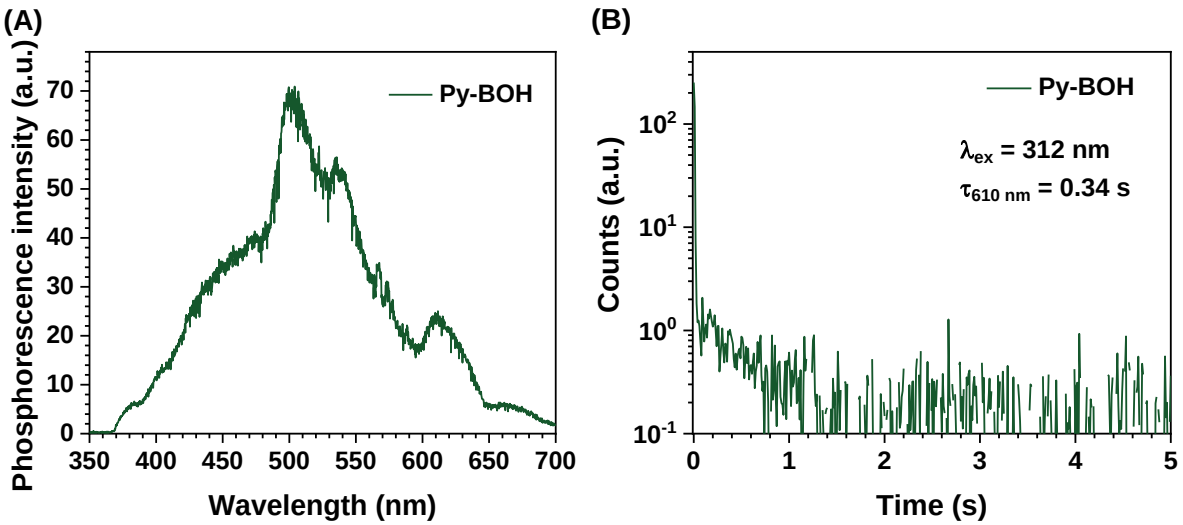


**fig. S32. Low temperature phosphorescence of Py-BOH solution.** (A) Phosphorescence spectrum and (B) corresponding time resolved phosphorescence-decay profile of **Py-BOH** in tetrahydrofuran (THF) solution ($10^{-5}$ mol/L) at 77 K.

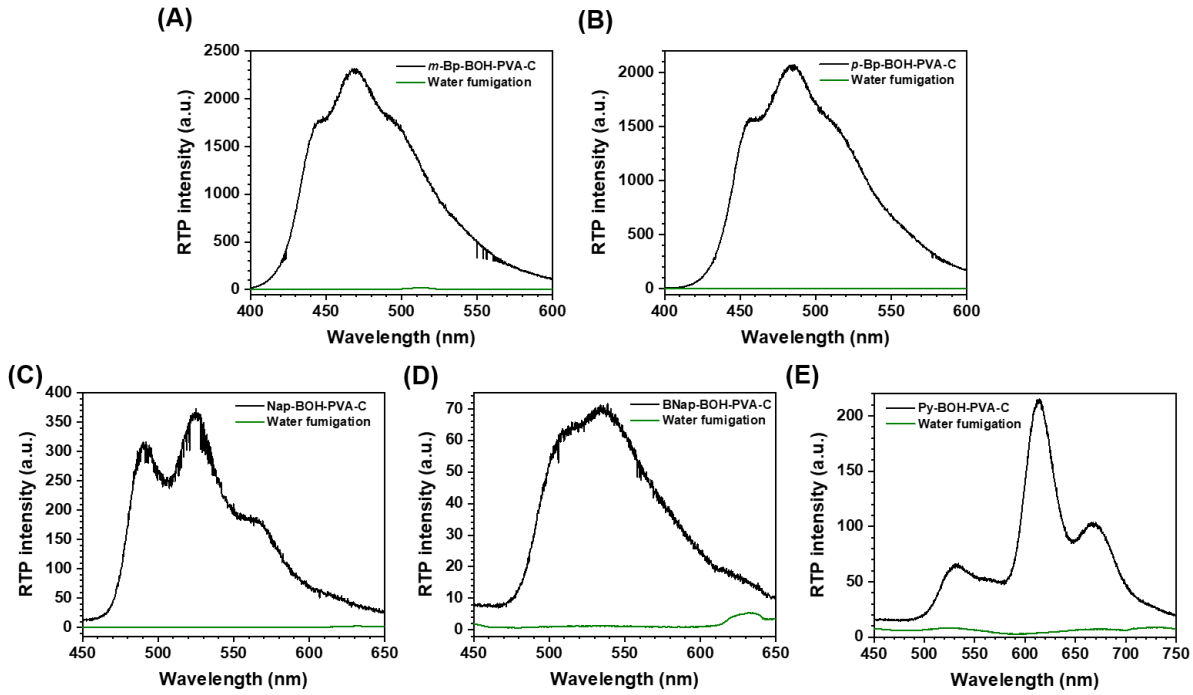


**fig. S33. RTP behaviors of polymers without the addition of ammonia water.** Phosphorescence spectra of (A) ***m*-Bp-BOH-PVA-C**, (B) ***p*-Bp-BOH-PVA-C**, (C) **Nap-BOH-PVA-C**, (D) **BNap-BOH-PVA-C** and (E) **Py-BOH-PVA-C** before (black line) and after (green line) water fumigation.

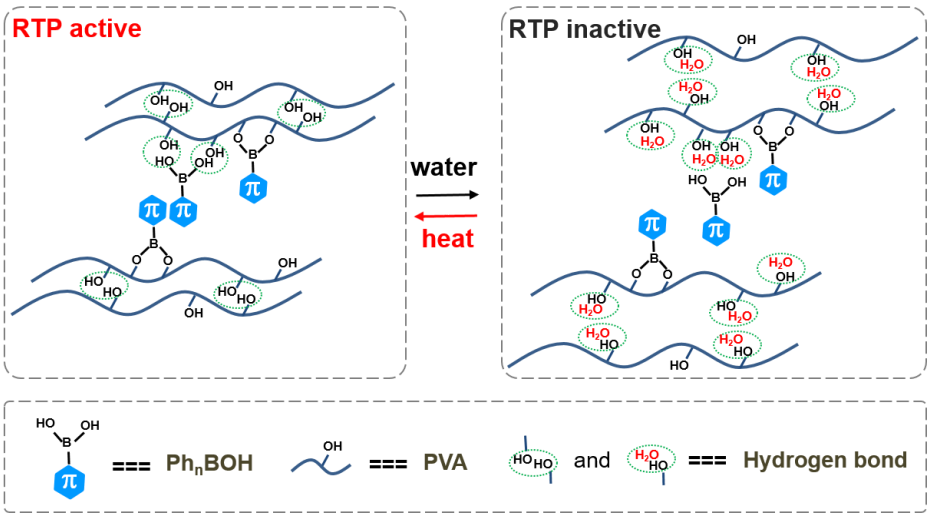


**fig. S34. Stimulus-responsive RTP mechanism.** The illustration about the mechanism of heating/water stimulus-responsive RTP effect.

**table S2. Photophysical data of target polymers.** Dynamic photophysical parameters of five polymer films.

| | $\tau_p$/s | $\Phi_p$/% | $k_{p,r}$/s$^{-1}$ | $k_{p,nr}$/s$^{-1}$ |
|---|---|---|---|---|
| ***m*-Bp-BOH-PVA** | 2.43 | 5.40 | 0.0222 | 0.3893 |
| ***p*-Bp-BOH-PVA** | 2.34 | 12.33 | 0.0527 | 0.3747 |
| **Nap-BOH-PVA** | 1.48 | 5.69 | 0.0384 | 0.6371 |
| **BNap-BOH-PVA** | 1.33 | 5.84 | 0.0439 | 0.7080 |
| **Py-BOH-PVA** | 0.34 | 13.10 | 0.3853 | 2.5559 |

The dynamic photophysical parameters were calculated based on the equations below:

$\tau_p = 1/(k_{p,r} + k_{p,nr})$

$\Phi_p = k_{p,r}/(k_{p,r} + k_{p,nr})$

Where, $\tau_p$, $\Phi_p$, $k_{p,r}$ and $k_{p,nr}$ are the phosphorescence lifetime, phosphorescence quantum yield, radiative rate constant of phosphorescence and non-radiative rate constant of phosphorescence.

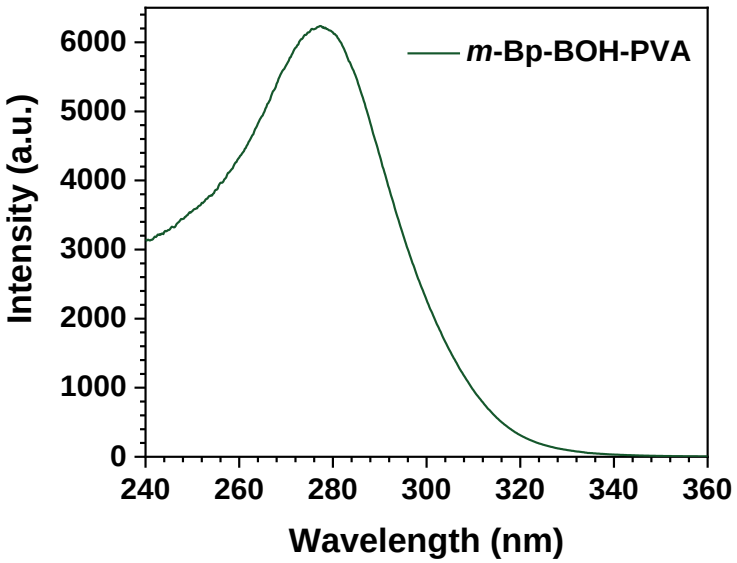


**fig. S35. Phosphorescence excitation spectrum of *m*-Bp-BOH-PVA.** Phosphorescence excitation spectrum of ***m*-Bp-BOH-PVA** film at the emission wavelength of 470 nm.

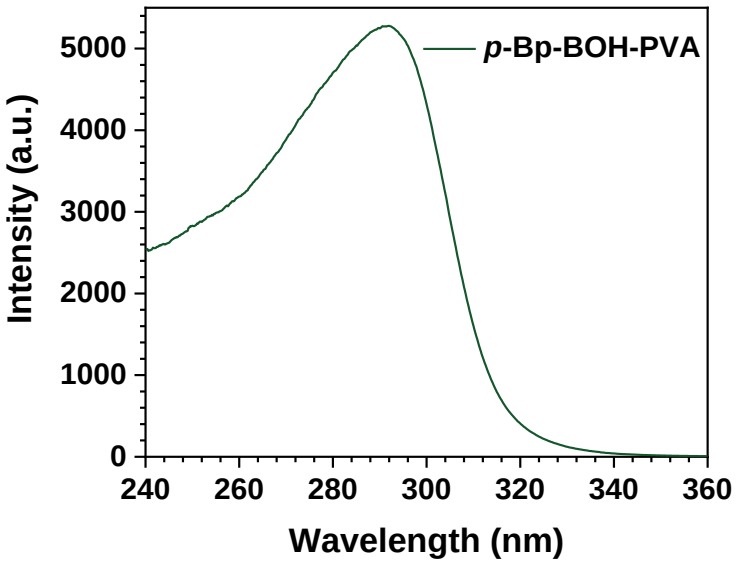


**fig. S36. Phosphorescence excitation spectrum of *p*-Bp-BOH-PVA.** Phosphorescence excitation spectrum of ***p*-Bp-BOH-PVA** film at the emission wavelength of 485 nm.

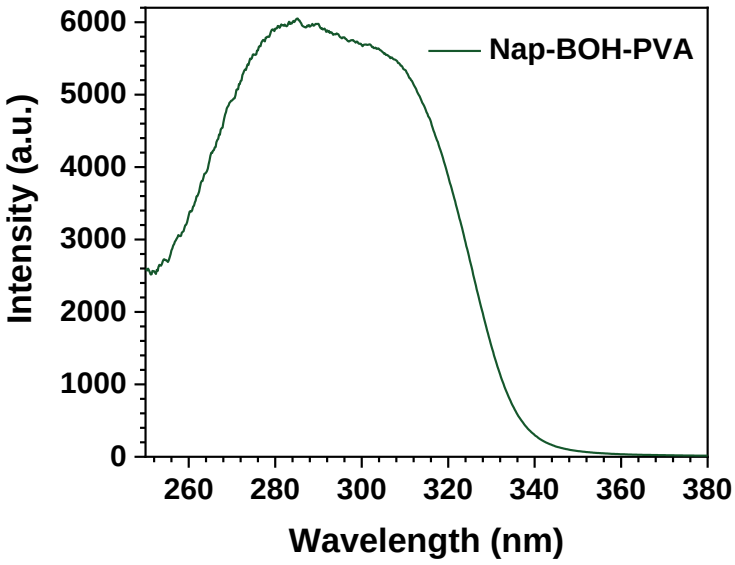


**fig. S37. Phosphorescence excitation spectrum of Nap-BOH-PVA.** Phosphorescence excitation spectrum of **Nap-BOH-PVA** film at the emission wavelength of 525 nm.

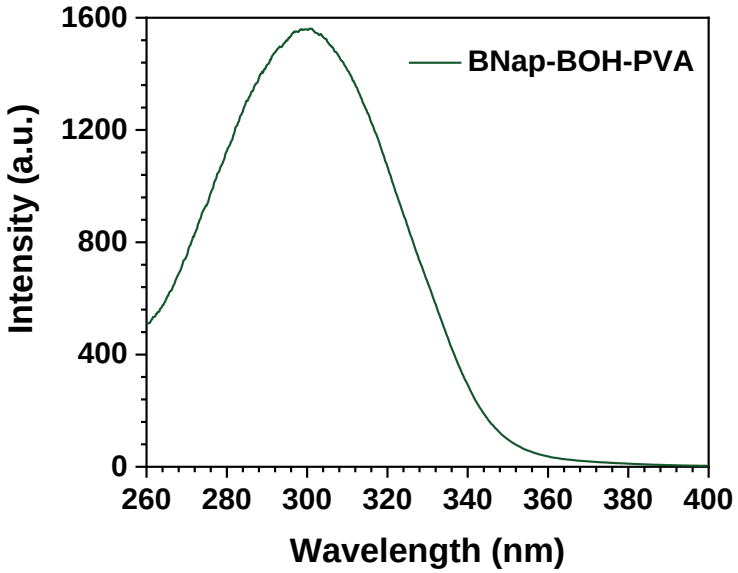


**fig. S38. Phosphorescence excitation spectrum of BNap-BOH-PVA.** Phosphorescence excitation spectrum of **BNap-BOH-PVA** film at the emission wavelength of 535 nm.

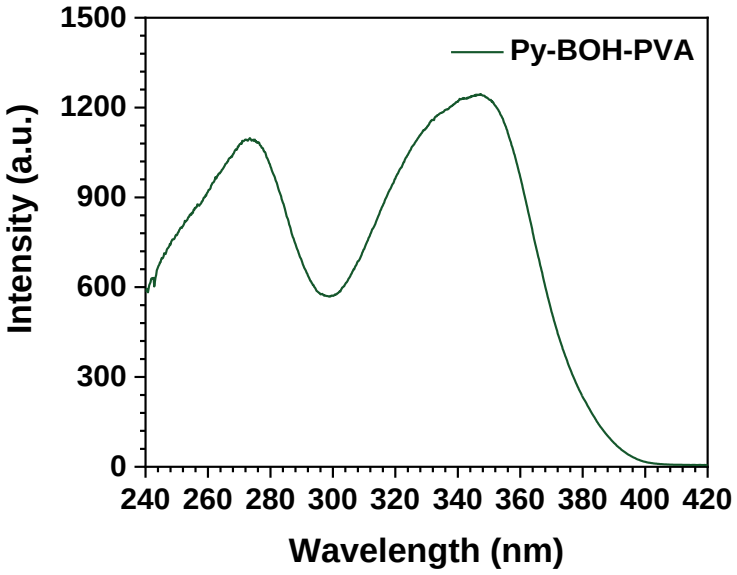


**fig. S39. Phosphorescence excitation spectrum of Py-BOH-PVA.** Phosphorescence excitation spectrum of **Py-BOH-PVA** film at the emission wavelength of 610 nm.

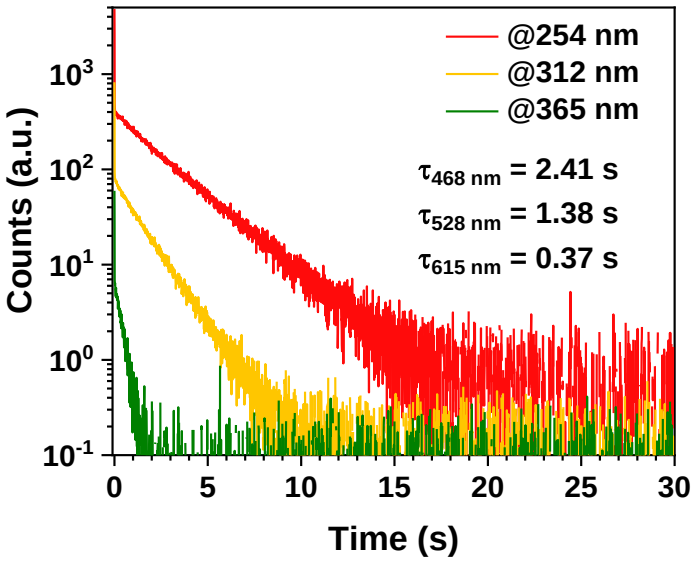


**fig. S40. RTP lifetimes of BNP-BOH-PVA.** Time resolved phosphorescence-decay profiles of **BNP-BOH-PVA** film at different excitation wavelengths under ambient condition.

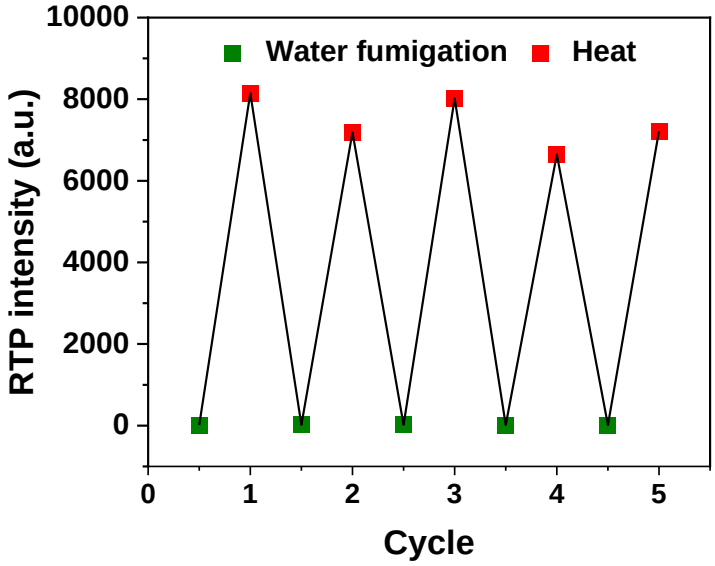


**fig. S41. Cycles of stimulus-responsive RTP effect of BNP-BOH-PVA upon the excitation of 254 nm.** Repeated cycles of the heating/water fuming processes of **BNP-BOH-PVA** film at the excitation wavelength of 254 nm. The RTP intensity represents the phosphorescence emission intensity at 468 nm at room temperature.

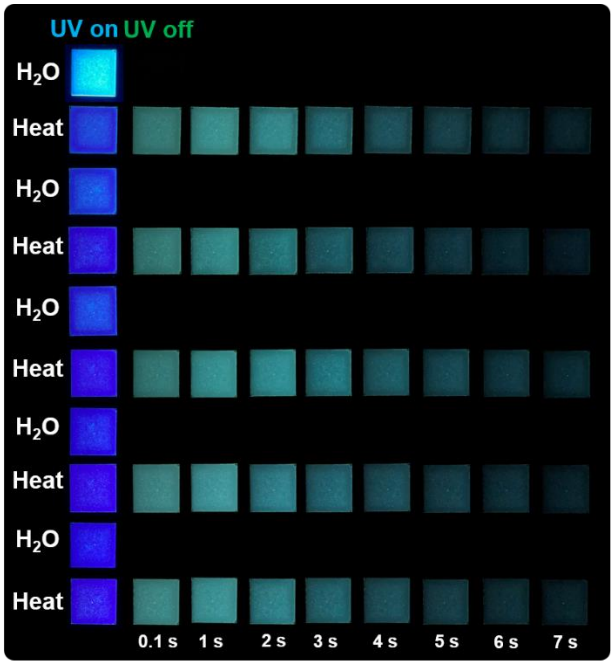


**fig. S42. Photographs of repeated stimulus-responsive RTP effect of BNP-BOH-PVA upon the excitation of 254 nm.** Photographs of repeated cycles of the heating/water fuming processes of **BNP-BOH-PVA** film at the excitation wavelength of 254 nm.

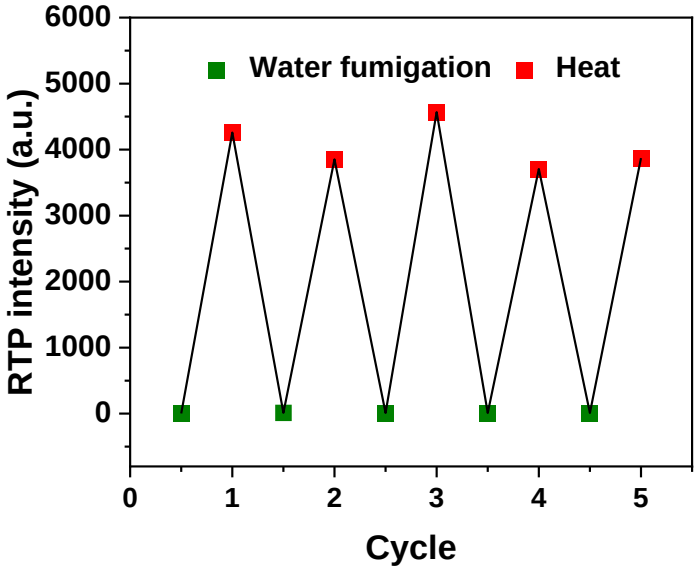


**fig. S43. Cycles of stimulus-responsive RTP effect of BNP-BOH-PVA upon the excitation of 312 nm.** Repeated cycles of the heating/water fuming processes of **BNP-BOH-PVA** film at the excitation wavelength of 312 nm. The RTP intensity represents the phosphorescence emission intensity at 528 nm at room temperature.

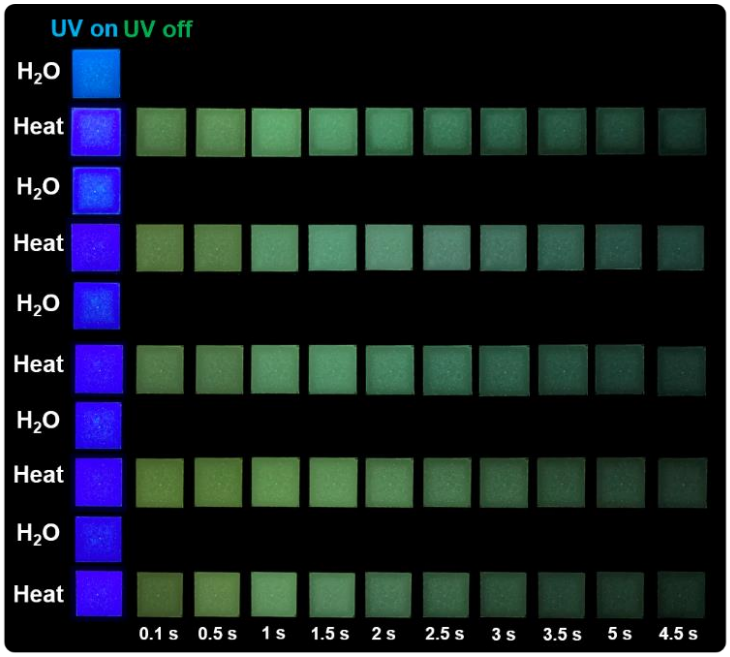


**fig. S44. Photographs of repeated stimulus-responsive RTP effect of BNP-BOH-PVA upon the excitation of 312 nm.** Photographs of repeated cycles of the heating/water fuming processes of **BNP-BOH-PVA** film at the excitation wavelength of 312 nm.

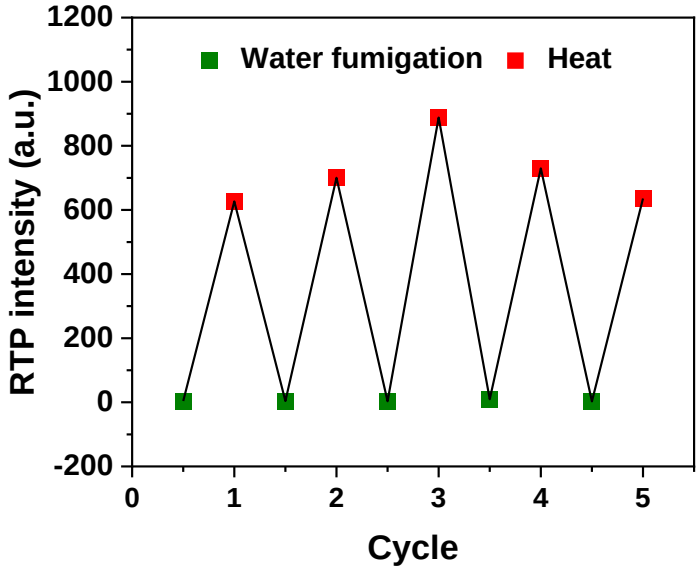


**fig. S45. Cycles of stimulus-responsive RTP effect of BNP-BOH-PVA upon the excitation of 365 nm.** Repeated cycles of the heating/water fuming processes of **BNP-BOH-PVA** film at the excitation wavelength of 365 nm. The RTP intensity represents the phosphorescence emission intensity at 615 nm at room temperature.

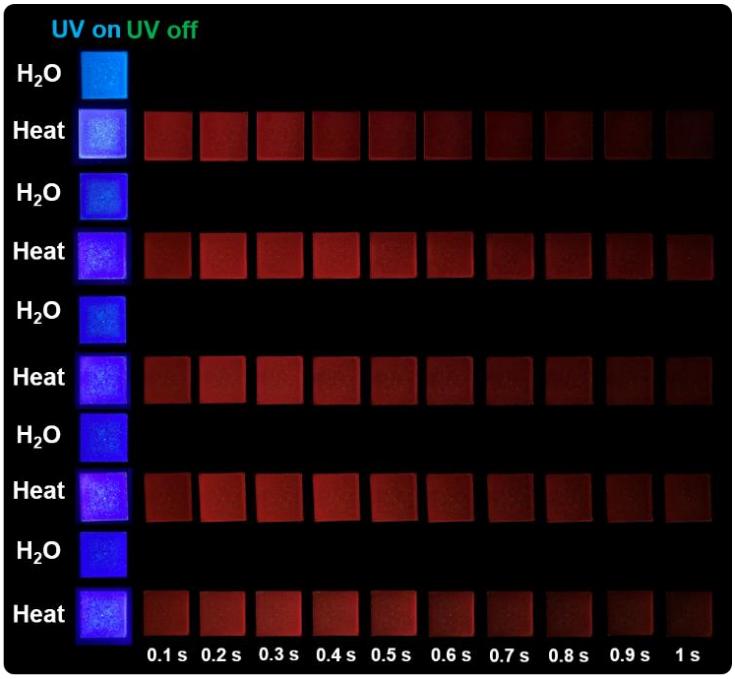


**fig. S46. Photographs of repeated stimulus-responsive RTP effect of BNP-BOH-PVA upon the excitation of 365 nm.** Photographs of repeated cycles of the heating/water fuming processes of **BNP-BOH-PVA** film at the excitation wavelength of 365 nm.

**movie S1.** The video of heated ***m*-Bp-BOH-PVA** film before and after turning off the UV lamp with the 254 nm excitation.

**movie S2.** The video of heated ***p*-Bp-BOH-PVA** film before and after turning off the UV lamp with the 254 nm excitation.

**movie S3.** The video of heated **Nap-BOH-PVA** film before and after turning off the UV lamp with the 312 nm excitation.

**movie S4.** The video of heated **BNap-BOH-PVA** film before and after turning off the UV lamp with the 312 nm excitation.

**movie S5.** The video of heated **Py-BOH-PVA** film before and after turning off the UV lamp with the 365 nm excitation.