Supporting Information

Clustering-triggered Emission of Poly(vinyl) Alcohol

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Experiment Section

Materials.

PVA was purchased from Macklin, (Shanghai, China). Tetrahydrofuran (THF) was obtained from Sinopharm Chemical Reagent Co., Ltd. (Shanghai, China). DMSO, Acetic acid were obtained from Sinopharm Chemical Reagent Co., Ltd. (Shanghai, China). $Al(NO_3)_3$, $NaNO_3$, $Cr(NO_3)_3$, $CuNO_3$, $Mg(NO_3)_2$, KNO_3, $Ca(NO_3)_2$, $Co(NO_3)_2$, $CsNO_3$, $K_2Cr_2O_7$ were all obtained from Sinopharm Chemical Reagent Co., Ltd. (Shanghai, China). The water used in all experiments was distilled water.

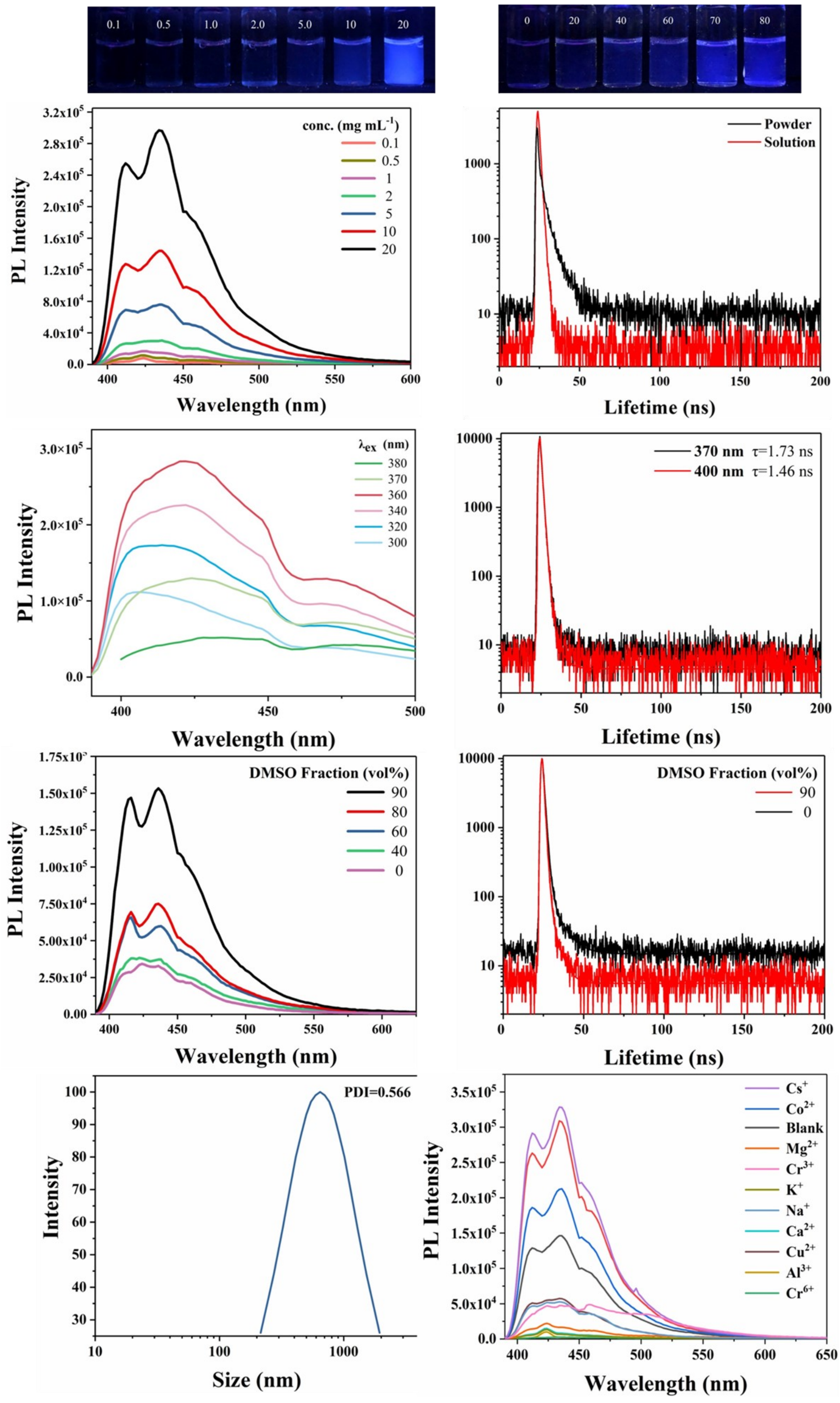
Characterizations.

Fluorescence spectra, fluorescent lifetime, quantum yields of the solutions and solids were all recorded on Steady-state Transient Fluorescence Spectrometer using an FLS920 fluorescence spectrophotometer (Edinburgh Instrument Ltd., Livingston, UK). The average particle size and size distribution of the gelatin were characterized on a Brookhaven Zeta Plus potential analyzer (Brookhaven Instruments Corporation, USA) at 25 °C.

PVA solutions were put into PP matrix and dried in vacuum drying oven in 50 °C one day to producted PVA films. The films were cut into 1.5 cm*1.5 cm squares. The strength of films were tested in CMT-005L Electronic Universal Testing Machine (Liangong Testing Technology Co.Ltd, Jinan). The test spacing is 60 mm, tensile speed is 100 mm/min.

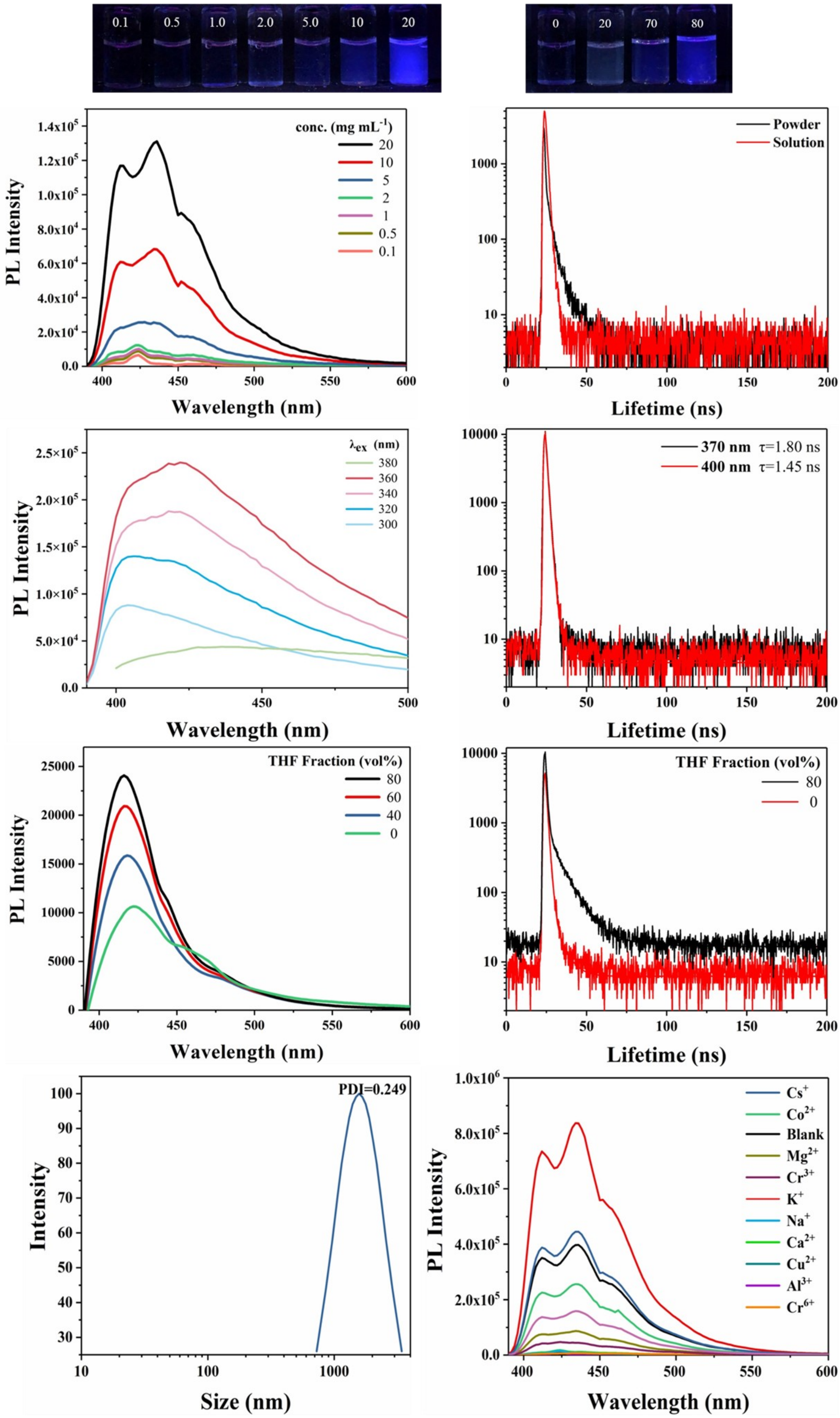
Purification and Preparation of PVA

The distilled water was heated to 70°C in water bath magnetic stirrer for 20 minutes, then PVA powder was put into hot water in the stirring process and heated to 90°C. The solution was stirred for 2 hours to produced PVA aqueous solutions. Then THF (water/THF, 1/10, v/v) is added as a non-solvent to precipitate PVA. The precipitate was collected after centrifuging. After centrifuging, the collected powder was dried in a freeze dryer for 24 hours, and then refrigerated for later use. Next, preparing PVA solutions of different concentrations to measure fluorescence property.



Results and Discussion

Figure S1. PVA_{0588LV} A) solution with different concentration and B) water/DMSO mixtures with different DMSO fraction photos taken under 365 nm UV light. C) PL spectra of PVA_{0588LV} solutions in different concentration. λ_{ex}=370 nm. D) Fluorescence lifetime of PVA_{0588LV} powders and solution. E) PL spectra of PVA_{0588LV} solution with different λ_{ex}. F) Fluorescence lifetime of 20 mg mL^{-1} PVA_{0588LV} solutions monitored at 370 nm and 400 nm. G) PL spectra of PVA_{0588LV} water/DMSO mixtures. H) Fluorescence lifetime of PVA_{0588LV} water/DMSO mixtures. I) DLS result of PVA_{0588LV} in mixtures (10/90) of water and DMSO. J) PL spectra of PVA_{0588LV} aqueous solutions (10 mg mL^{-1}) added with different metal ions of same concentration (1 mg mL^{-1}).



0.1
0.5
1.0
2.0
5.0
10
20
0
20
70
80
PL Intensity
Wavelength (nm)
conc. (mg mL-1)
20
10
5
2
1
0.5
0.1
Powder
Solution
Lifetime (ns)
λex (nm)
380
360
340
320
300
370 nm τ=1.80 ns
400 nm τ=1.45 ns
THF Fraction (vol%)
80
60
40
0
PDI=0.249
Intensity
Size (nm)
Cs+
Co2+
Blank
Mg2+
Cr3+
K+
Na+
Ca2+
Cu2+
Al3+
Cr6+

Figure S2. PVA_{1788} A) solution with different concentration and B) water/THF mixtures with different THF fraction photos taken under 365 nm UV light. C) PL spectra of PVA_{1788} solutions in different concentration. λ_{ex}=370 nm. D) Fluorescence lifetime of PVA_{1788} powders and solution. E) PL spectra of PVA_{1788} solution with different λ_{ex}. F) Fluorescence lifetime of 20 mg mL^{-1} PVA_{1788} solutions monitored at 370 nm and 400 nm. G) PL spectra of PVA_{1788} water/THF mixtures. H) Fluorescence lifetime of PVA_{1788} water/THF mixtures. I) DLS result of PVA_{1788} in mixtures (20/80) of water and THF. J) PL spectra of PVA_{1788} aqueous solutions (10 mg mL^{-1}) added with different metal ions of same concentration (1 mg mL^{-1}).

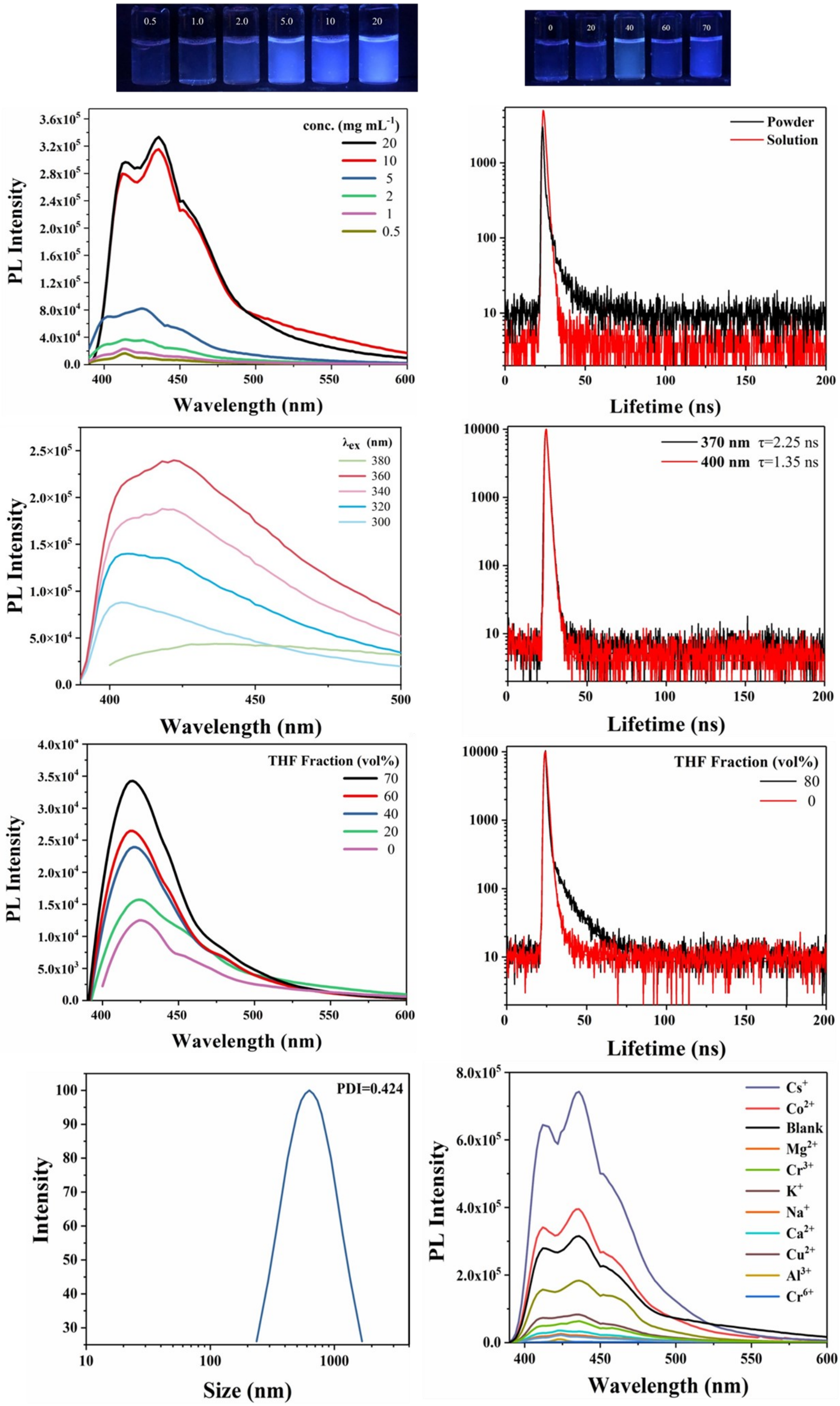
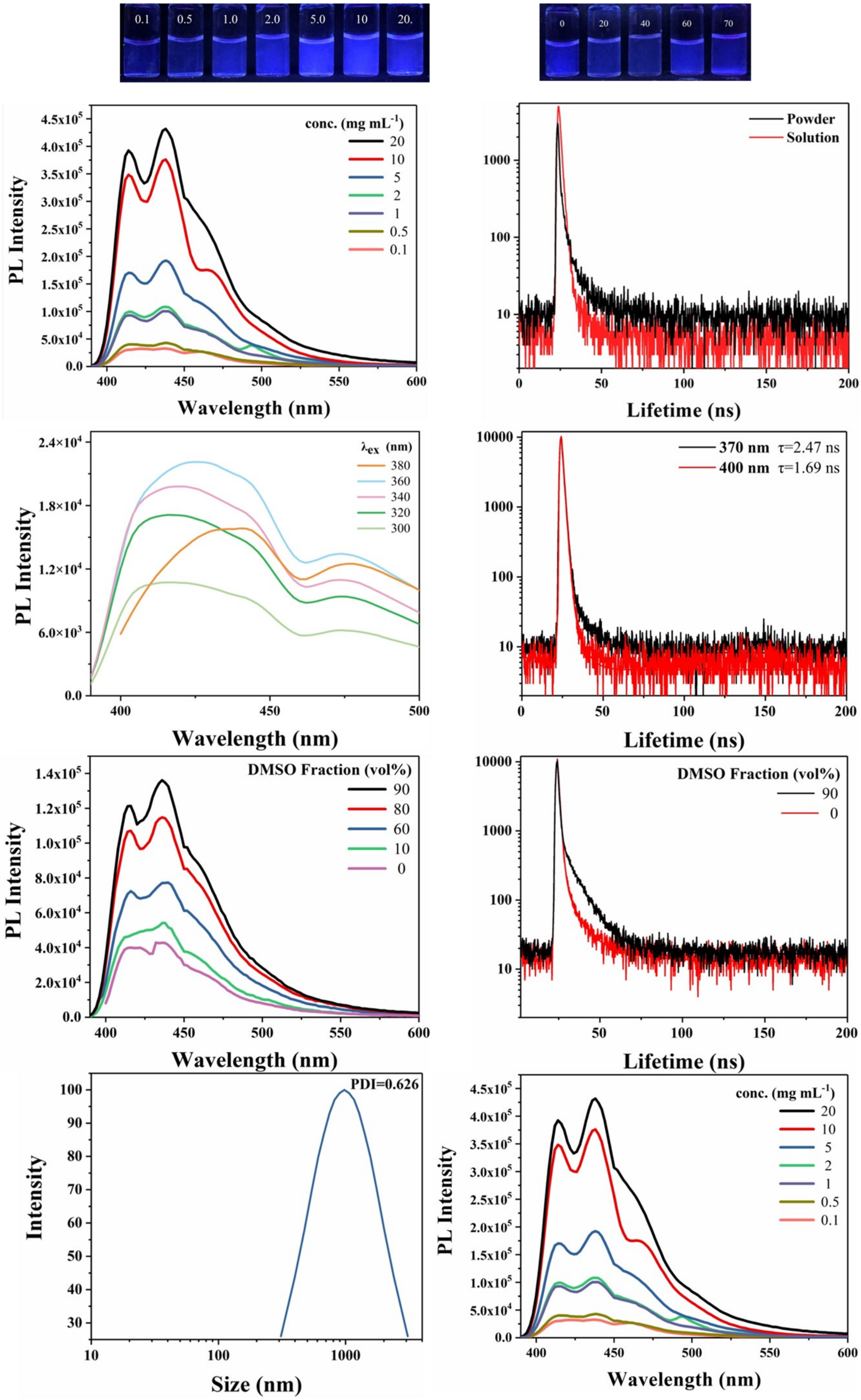

0.5
1.0
2.0
5.0
10
20
0
20
40
60
70
conc. (mg mL-1)
20
10
5
2
1
0.5
PL Intensity
Wavelength (nm)
Powder
Solution
Lifetime (ns)
λex (nm)
380
360
340
320
300
PL Intensity
Wavelength (nm)
370 nm τ=2.25 ns
400 nm τ=1.35 ns
Lifetime (ns)
THF Fraction (vol%)
70
60
40
20
0
PL Intensity
Wavelength (nm)
THF Fraction (vol%)
80
0
Lifetime (ns)
PDI=0.424
Intensity
Size (nm)
Cs+
Co2+
Blank
Mg2+
Cr3+
K+
Na+
Ca2+
Cu2+
Al3+
Cr6+
PL Intensity
Wavelength (nm)

Figure S3. PVA_{1788LV} A) solution with different concentration and B) water/THF mixtures with different THF fraction photos taken under 365 nm UV light. C) PL spectra of PVA_{1788} solutions in different concentration. λ_{ex}=370 nm. D) Fluorescence lifetime of PVA_{1788LV} powders and solution. E) PL spectra of $PVA_{1788\ low\text{-}viscosity}$ solution with different λ_{ex}. F) Fluorescence lifetime of 20 mg mL^{-1} PVA_{1788LV} solutions monitored at 370 nm and 400 nm. G) PL spectra of PVA_{1788LV} water/THF mixtures. H) Fluorescence lifetime of PVA_{1788LV} water/THF mixtures. I) DLS result of PVA_{1788LV} in mixtures (20/80) of water and THF. J) PL spectra of PVA_{1788LV} aqueous solutions (10 mg mL^{-1}) added with different metal ions of same concentration (1 mg mL^{-1}).



0.1
0.5
1.0
2.0
5.0
10
20.
0
20
40
60
70
PL Intensity
conc. (mg mL-1)
20
10
5
2
1
0.5
0.1
Wavelength (nm)
Powder
Solution
Lifetime (ns)
λex (nm)
380
360
340
320
300
PL Intensity
Wavelength (nm)
370 nm τ=2.47 ns
400 nm τ=1.69 ns
Lifetime (ns)
DMSO Fraction (vol%)
90
80
60
10
0
PL Intensity
Wavelength (nm)
DMSO Fraction (vol%)
90
0
Lifetime (ns)
PDI=0.626
Intensity
Size (nm)
conc. (mg mL-1)
20
10
5
2
1
0.5
0.1
PL Intensity
Wavelength (nm)

Figure S4. PVA_{1799} A) solution with different concentration and B) water/DMSO mixtures with different DMSO fraction photos taken under 365 nm UV light. C) PL spectra of PVA_{1799} solutions in different concentration. λ_{ex}=370 nm. D) Fluorescence lifetime of PVA_{1799} powders and solution. E) PL spectra of PVA_{1799} solution with different λ_{ex}. F) Fluorescence lifetime of 20 mg mL^{-1} PVA_{1799} solutions monitored at 370 nm and 400 nm. G) PL spectra of PVA_{1799} water/DMSO mixtures. H) Fluorescence lifetime of PVA_{1799} water/DMSO mixtures. I) DLS result of PVA_{1799} in mixtures (10/90) of water and DMSO. J) PL spectra of PVA_{1799} aqueous solutions (10 mg mL^{-1}) added with different metal ions of same concentration (1 mg mL^{-1}).

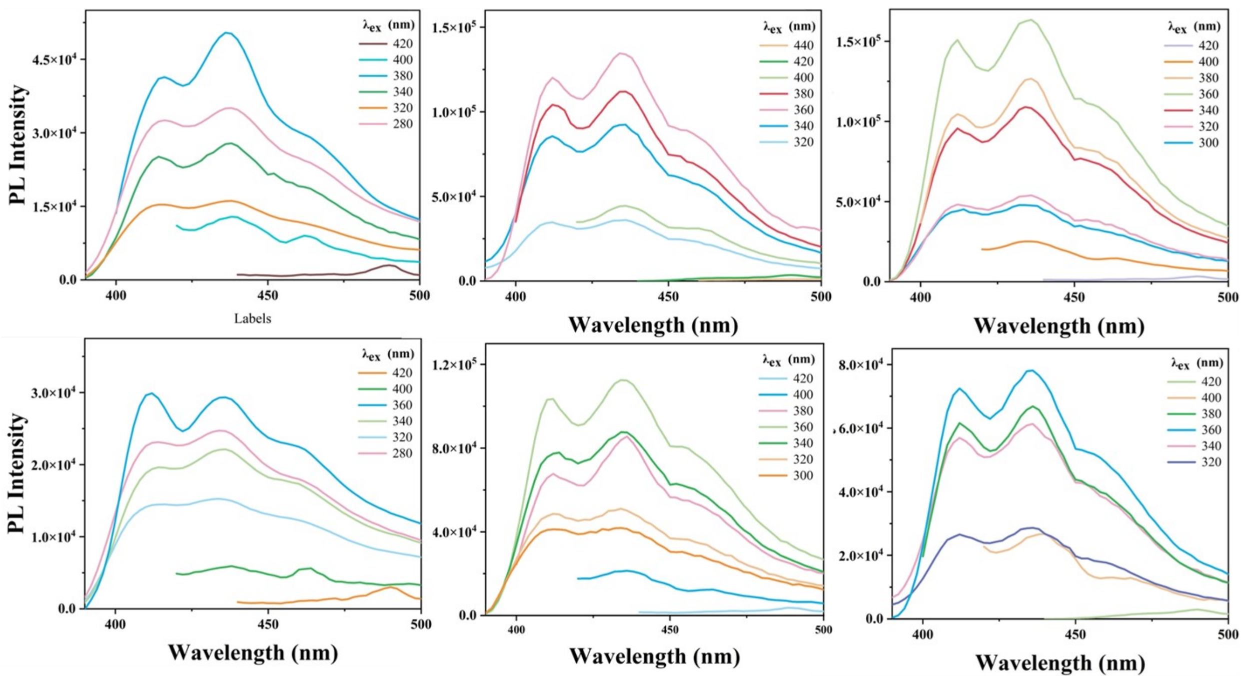


Figure S5. PL spectrum of PVA solutions (20 mg mL^{-1}) under different λ_{ex}.

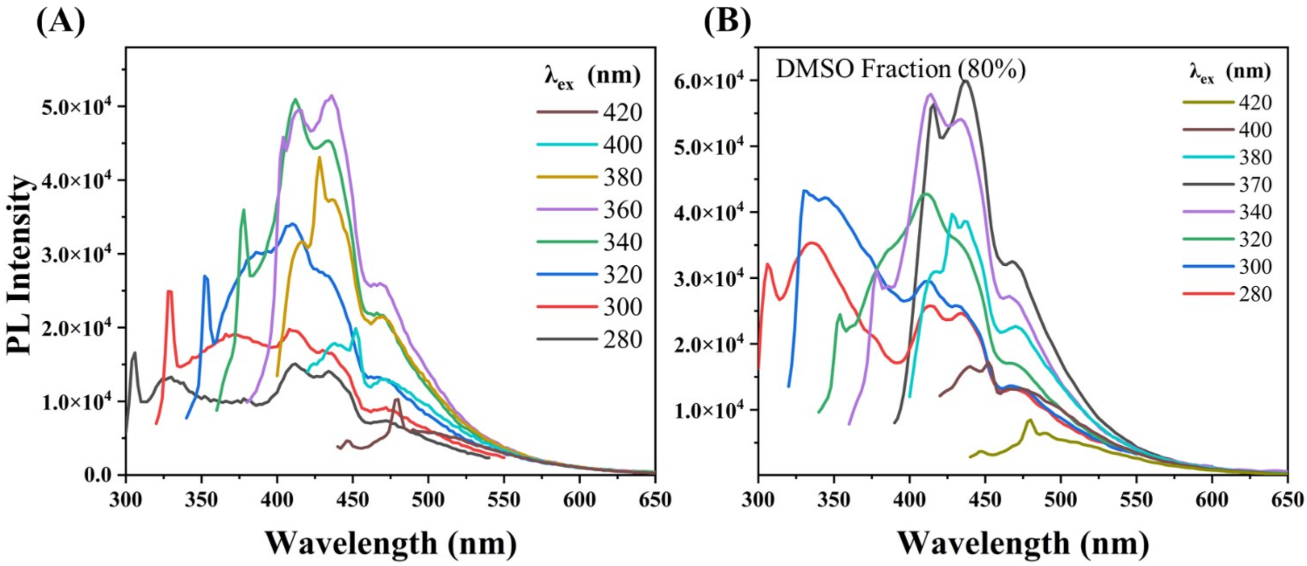


Figure S6. (A) PL spectrum of DMSO under different λ_{ex}. (B) PL spectra of PVA_{105} in mixtures (20/80) of water and DMSO solution with different λ_{ex}.

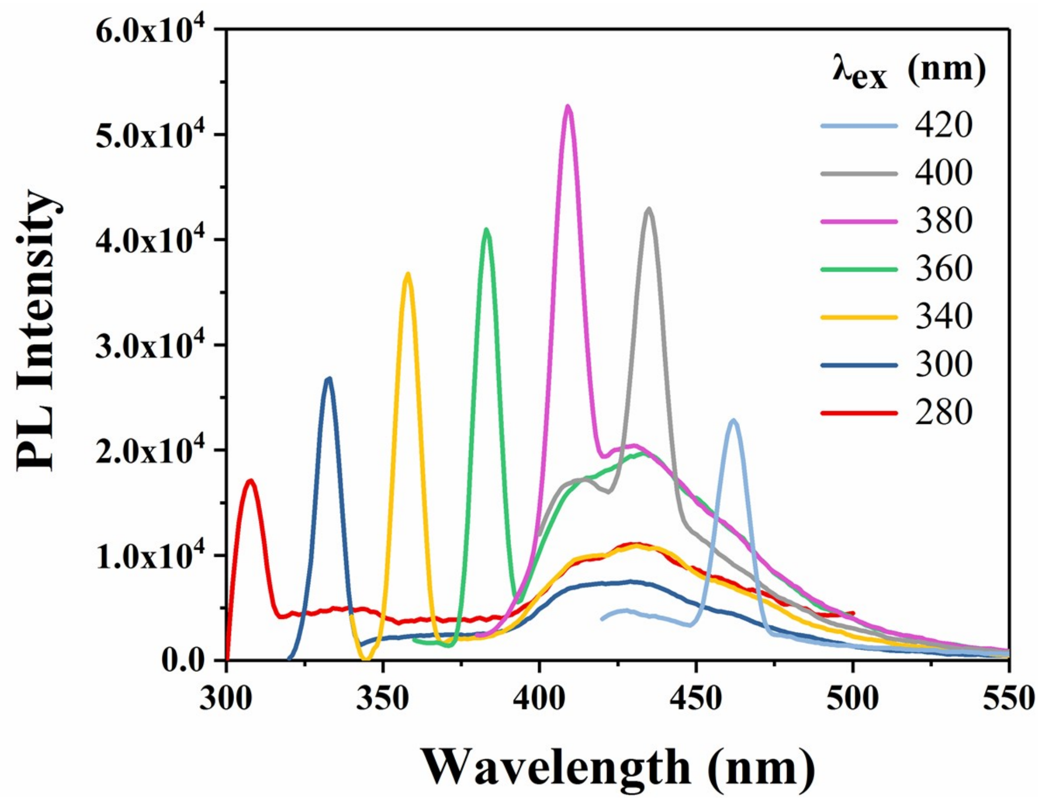


Figure S7. PL spectrum of pure solvent (deionized water) under different λ_{ex}

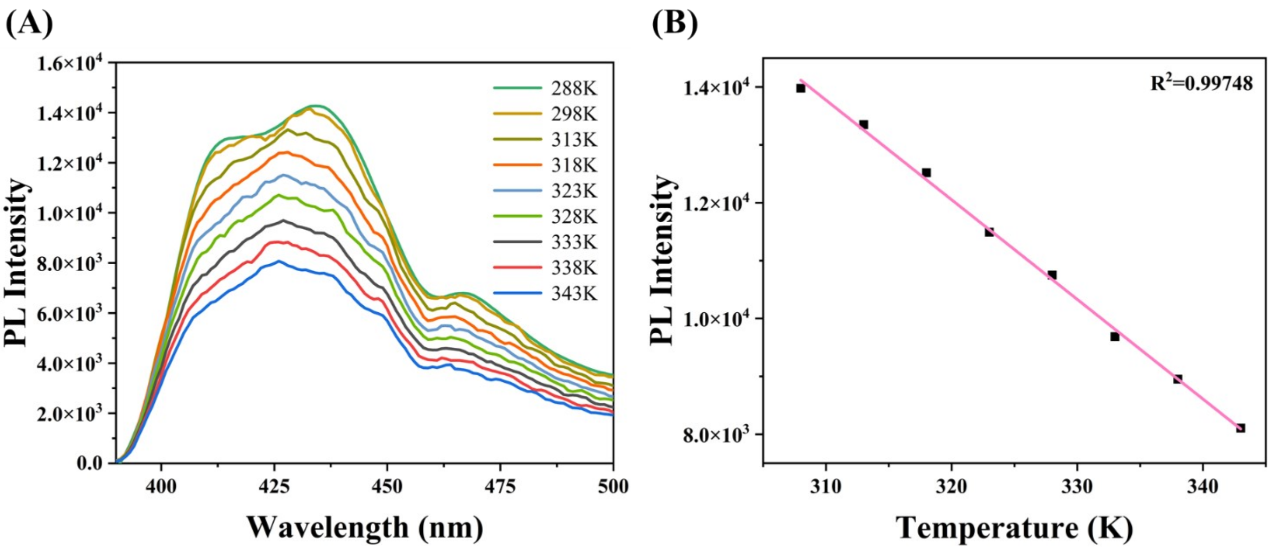


Figure S8. (A) Temperature dependence of PVA_{105}'s fluorescence spectra under the excitation of 370 nm. (B) Plots of PL intensity of PVA_{105} solution (20 mg mL^{-1}) in different temperature.

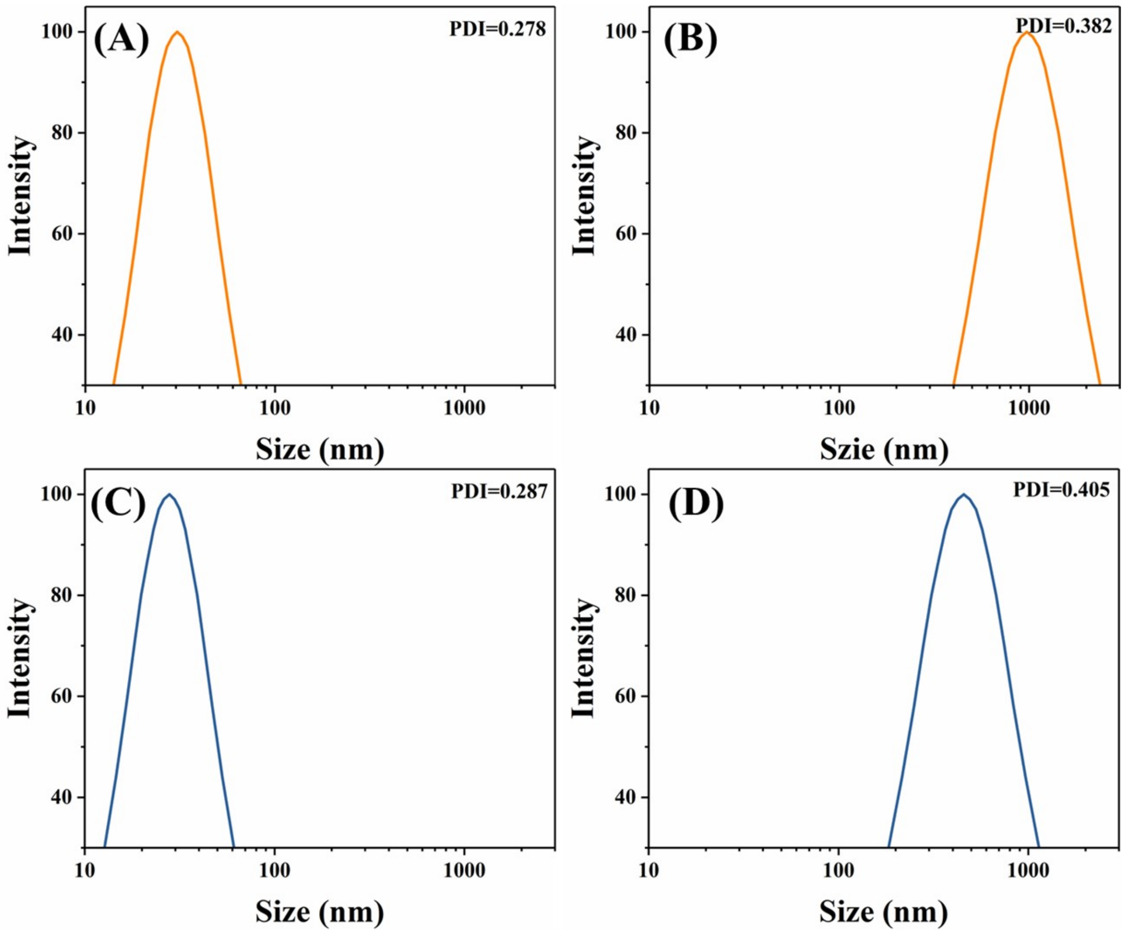


Figure S9. DLS results of (A) 10 mg mL^{-1} and (B) 20 mg mL^{-1} PVA$_{1788}$, (C) 10 mg mL^{-1} and (D) 20 mg mL^{-1} PVA$_{1788LV}$.

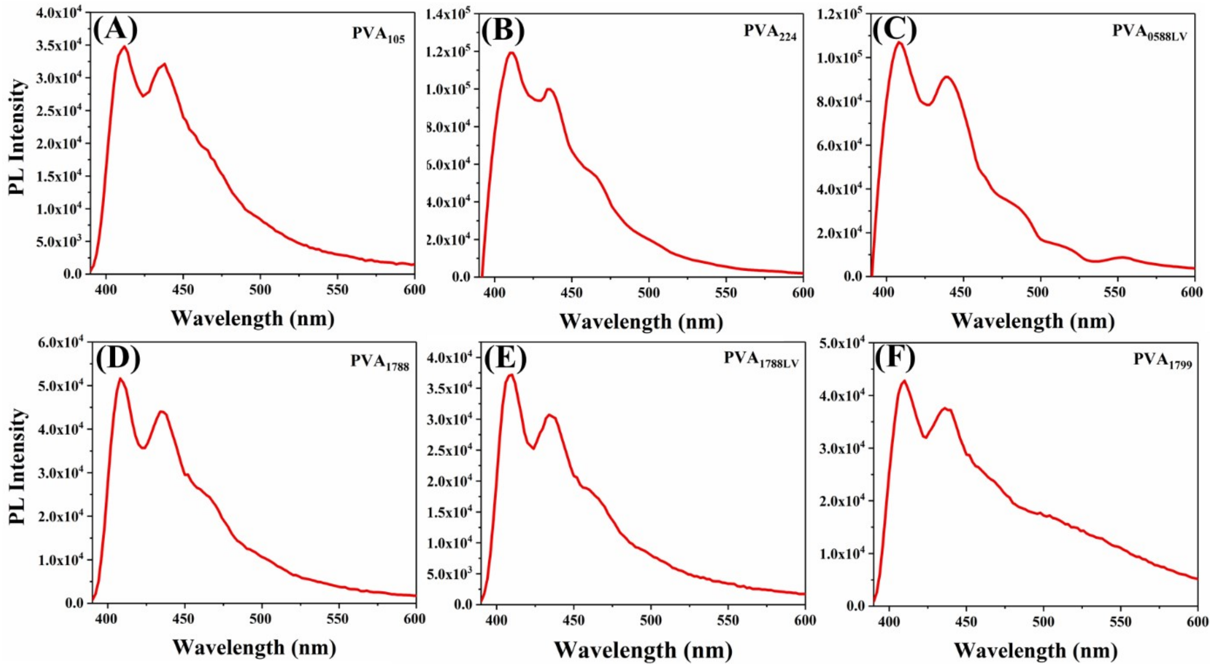


Figure S10. PL spectra of A) PVA_{105}, B) PVA_{224}, C) PVA_{0588LV}, D) PVA_{1788}, E) PVA_{1788LV} and F) PVA_{1799} films.

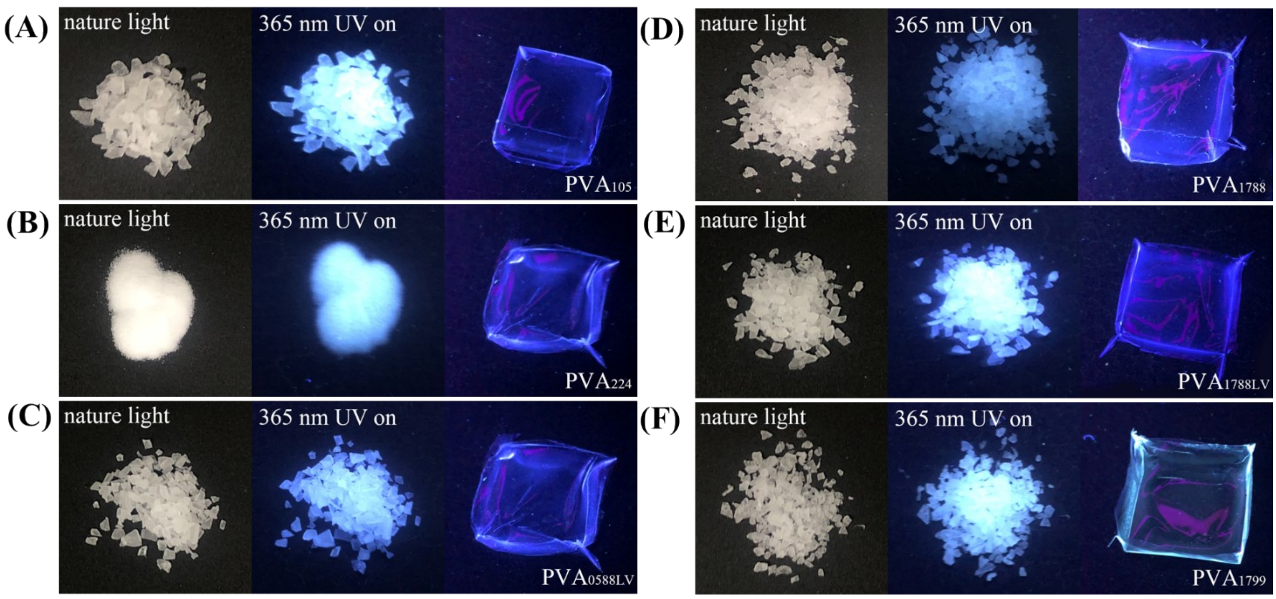


Figure S11. Photos taken under nature and 365 nm UV light of A) PVA_{105}, B) PVA_{224}, C) PVA_{0588LV}, D) PVA_{1788}, E) PVA_{1788LV} and F) PVA_{1799} powders and films

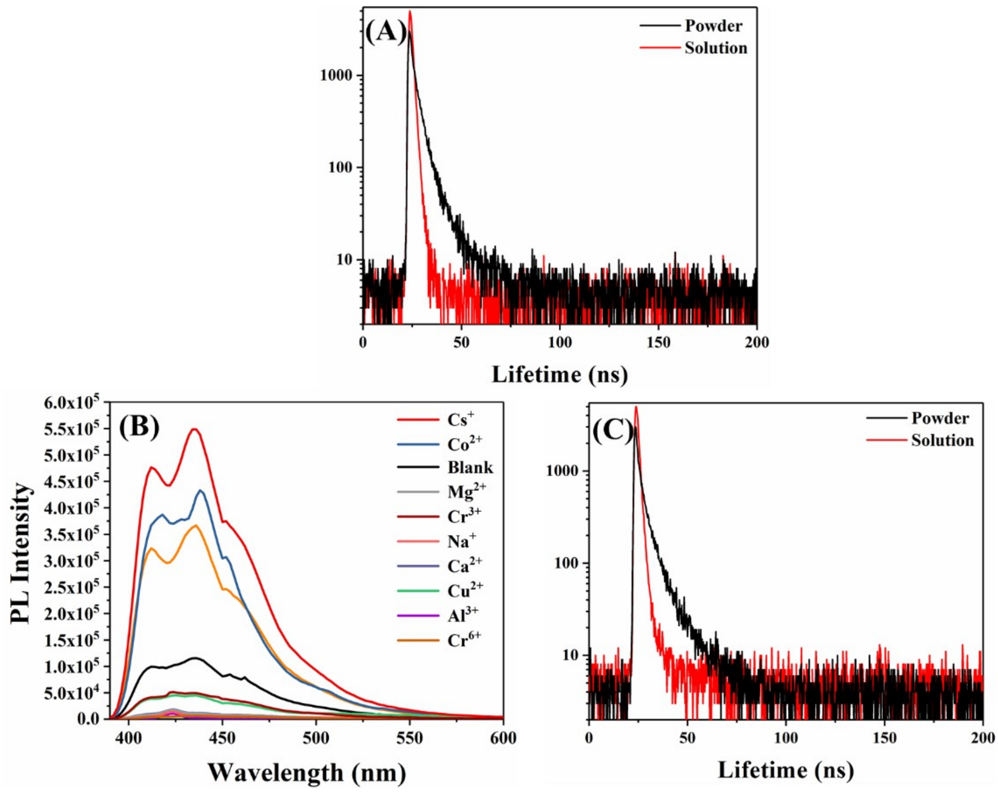


Figure S12. A) Fluorescence lifetime of PVA_{105} powders and solution. B) PL spectra of PVA_{224} aqueous solutions (10 mg mL^{-1}) added with different metal ions of same concentration (1 mg mL^{-1}). C) Fluorescence lifetime of PVA_{224} powders and solution.

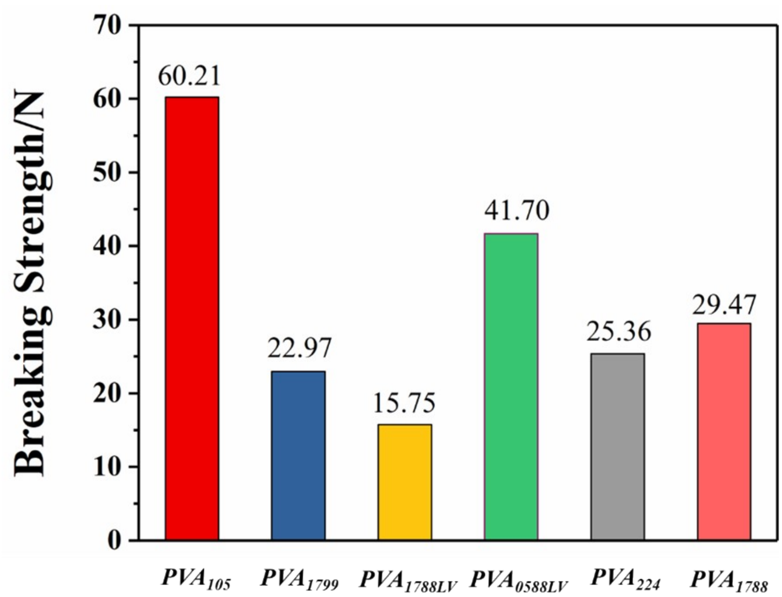


Figure S13. Breaking strength of different PVA films.

The breaking strength of PVA film was affected by DP and viscosity. For PVA_{105} and PVA_{0588LV}, films with low DP and viscosity show high level breaking strength. PVA with high viscosity show good tenacity and difficult to break.

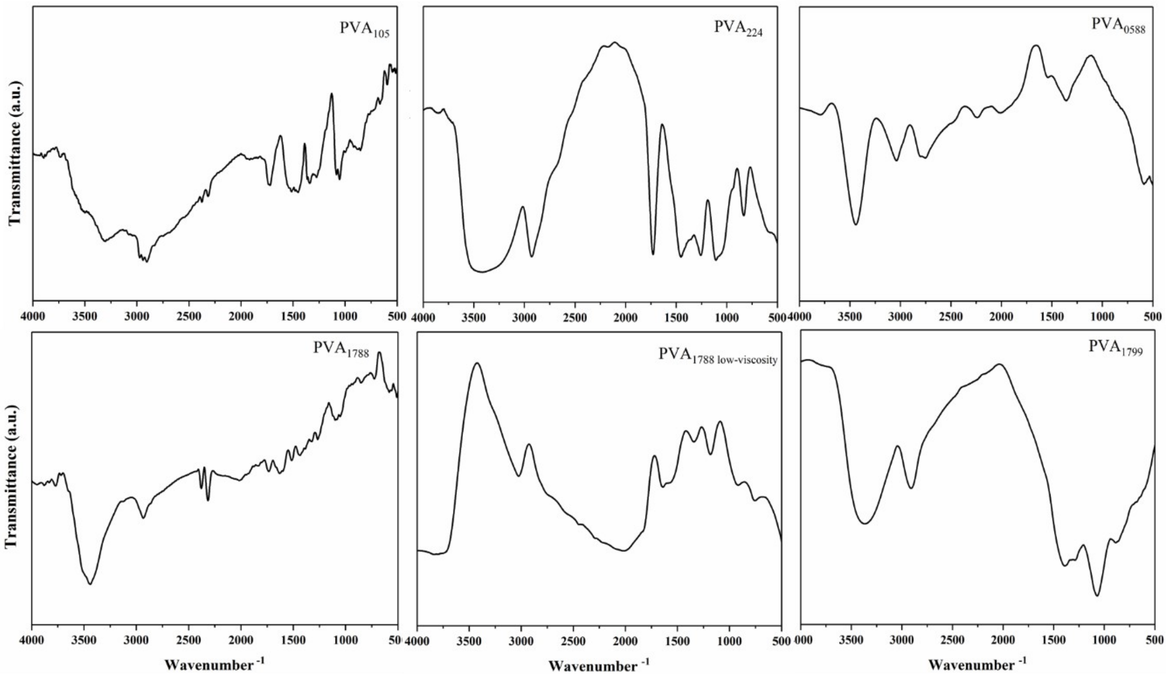


Figure S14. FT-IR spectra of different PVA.

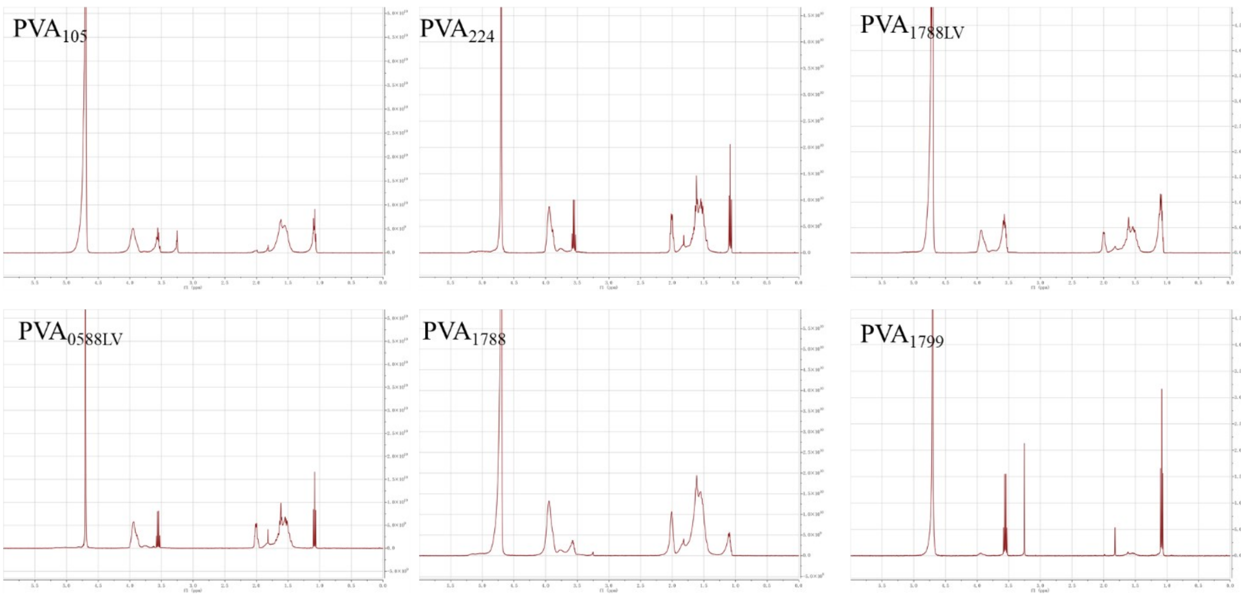


Figure S15. ^{1}H NMR Spectrum of PVA in D_2O at 400 MHz.

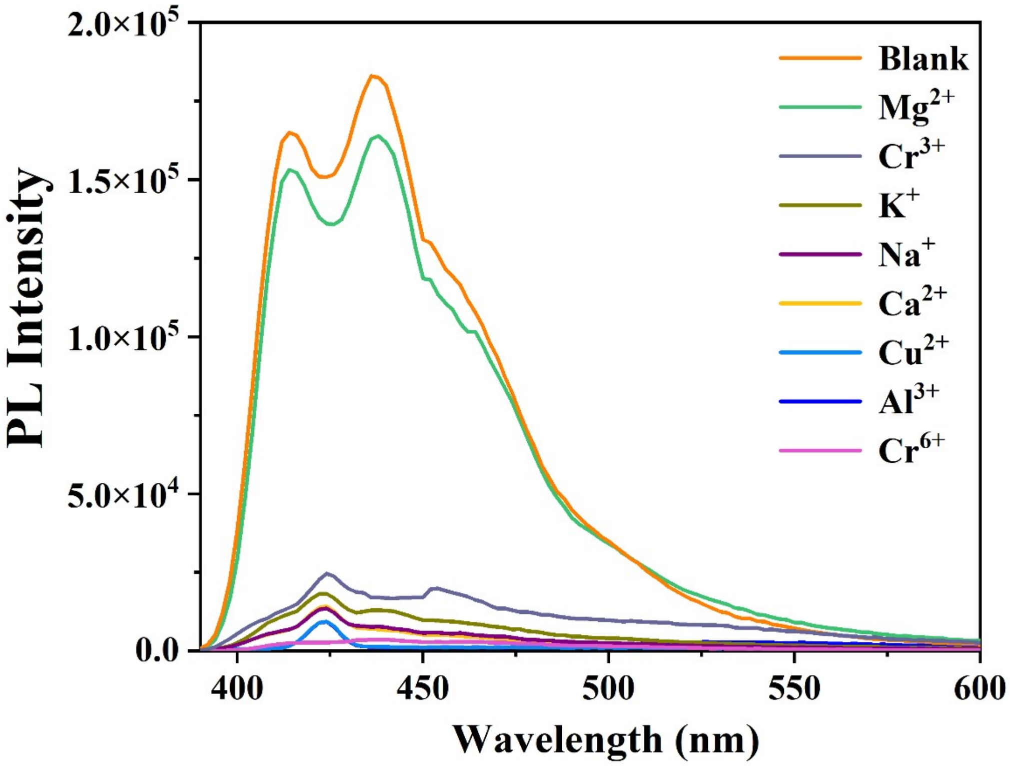


Figure S16. PL spectra of PVA_{105} aqueous solutions (10 mg mL^{-1}) added with different metal ions of same concentration (1 mg mL^{-1}).