Supporting Information

Solvent Atmosphere-Assisted Crystallization of Perovskites for Room-Temperature Continuous-Wave Amplified Spontaneous Emission

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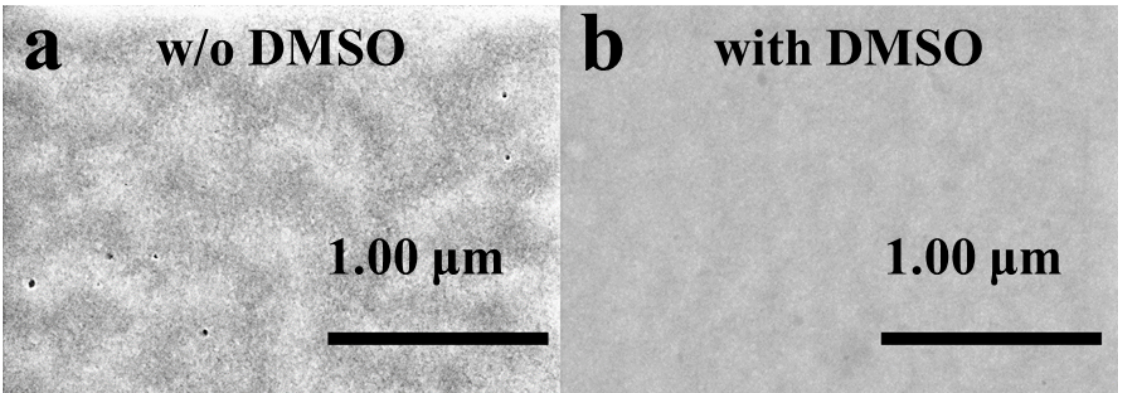

Figure S1. SEM images of P2F6 films (a) w/o and (b) with DMSO atmosphere treatment.

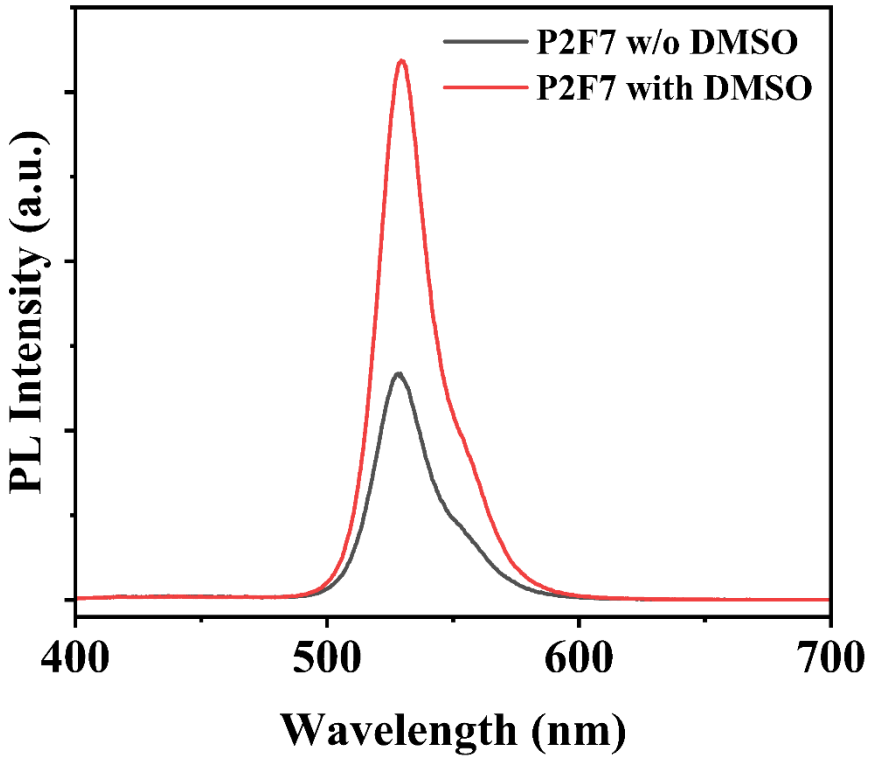

Figure S2. PL spectra of P2F7 films with and w/o DMSO treatment**.**

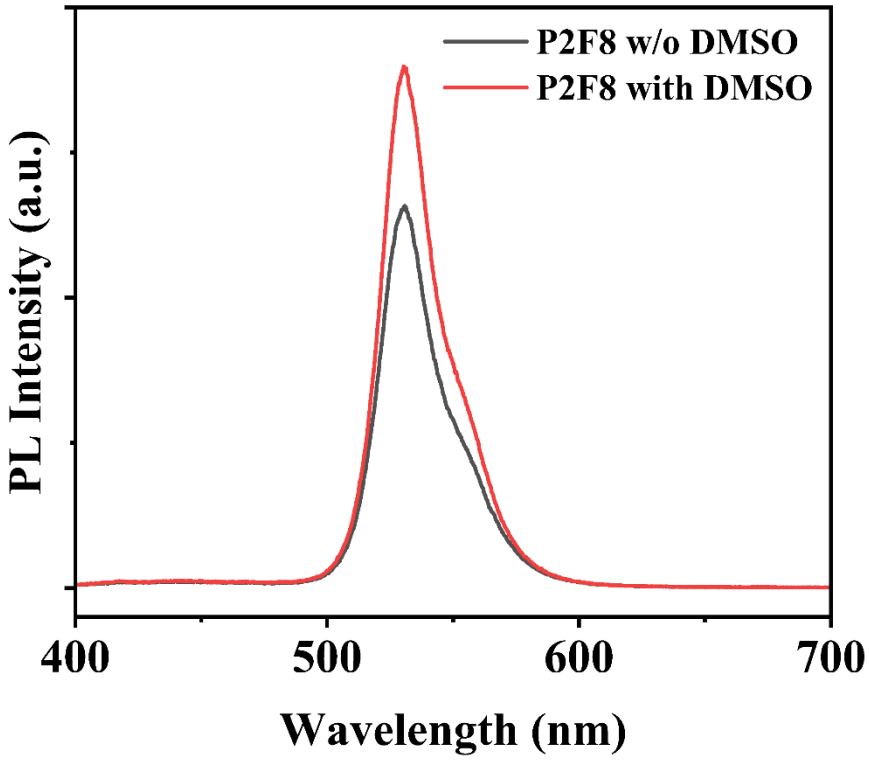

Figure S3. PL spectra of P2F8 films with and w/o DMSO treatment**.**

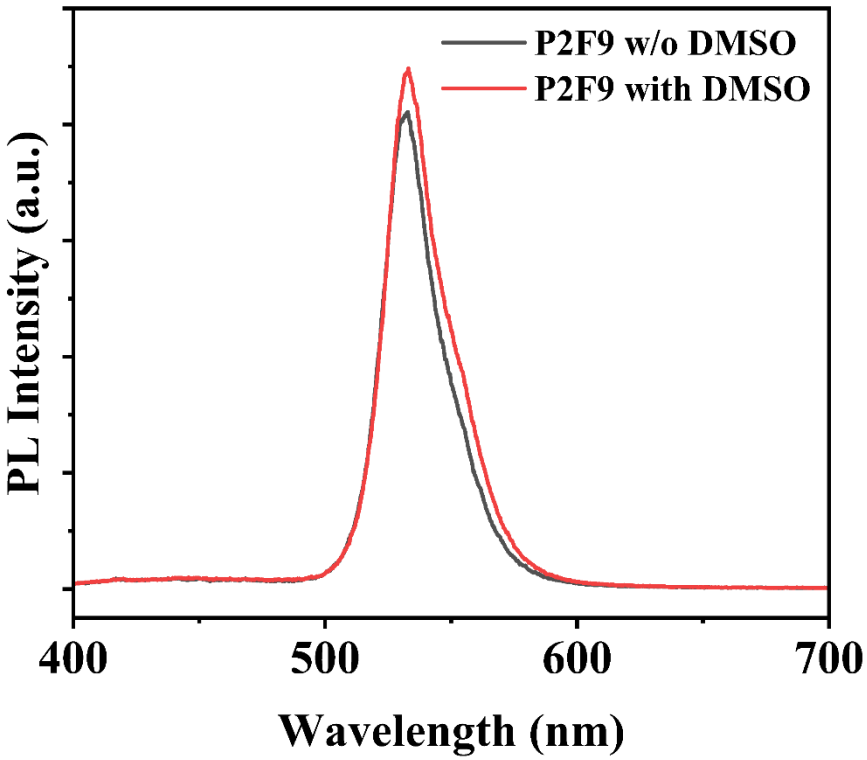

Figure S4. PL spectra of P2F9 films with and w/o DMSO treatment**.**

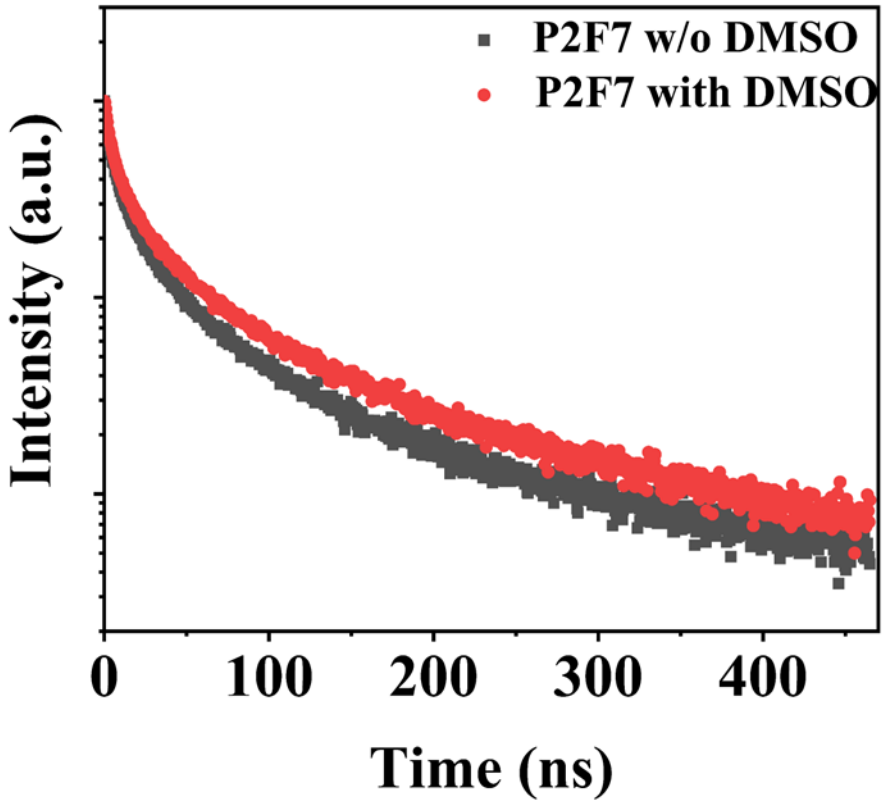

Figure S5. Fluorescence lifetime of P2F7 films with and w/o DMSO treatment.

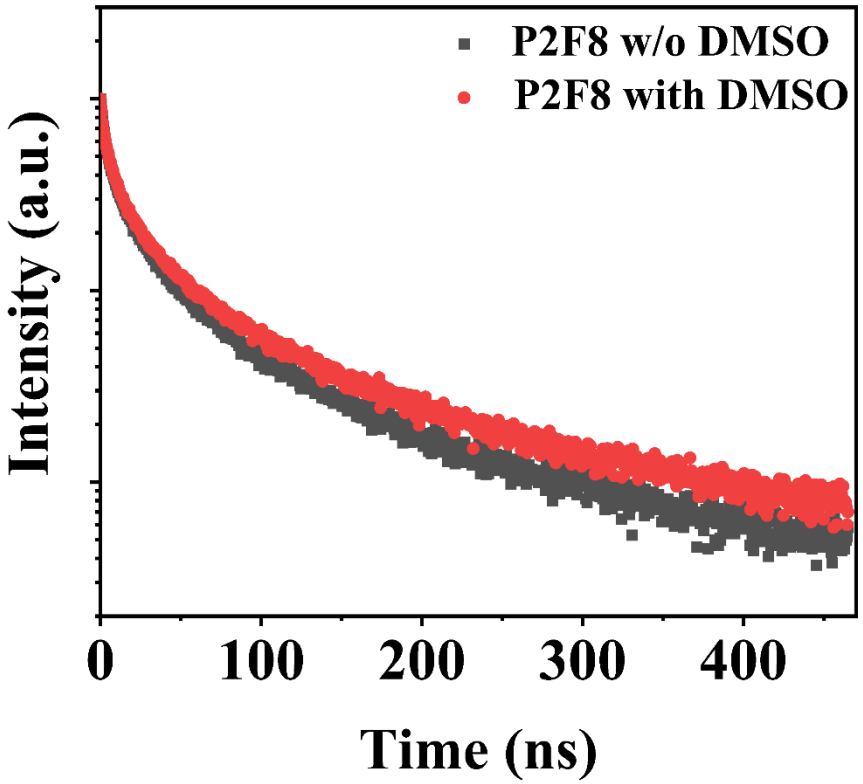

Figure S6. Fluorescence lifetime of P2F8 films with and w/o DMSO treatment.

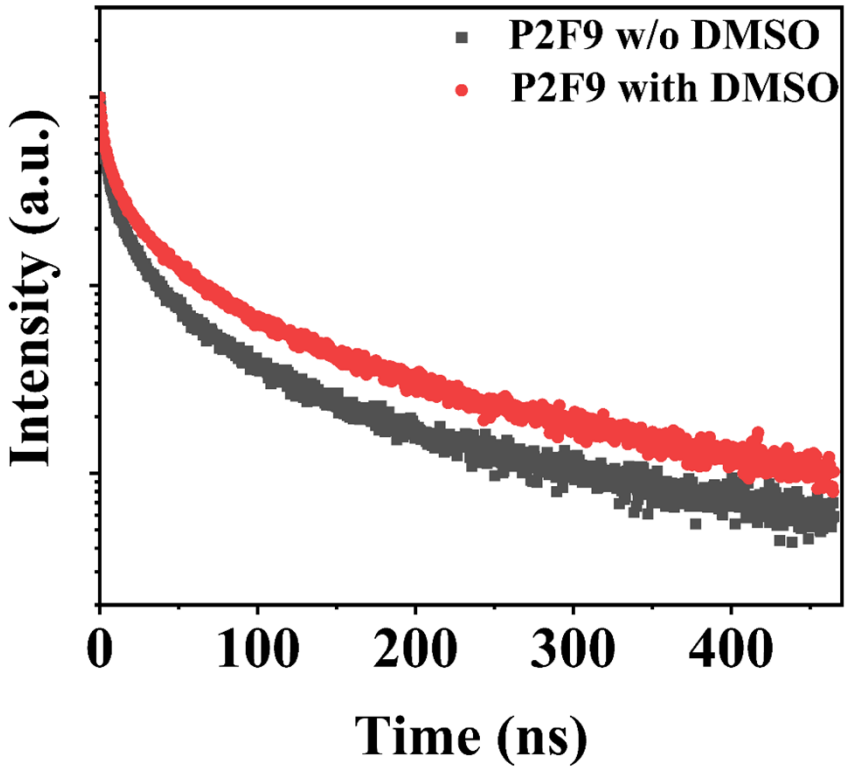

Figure S7. Fluorescence lifetime of P2F9 films with and w/o DMSO treatment.

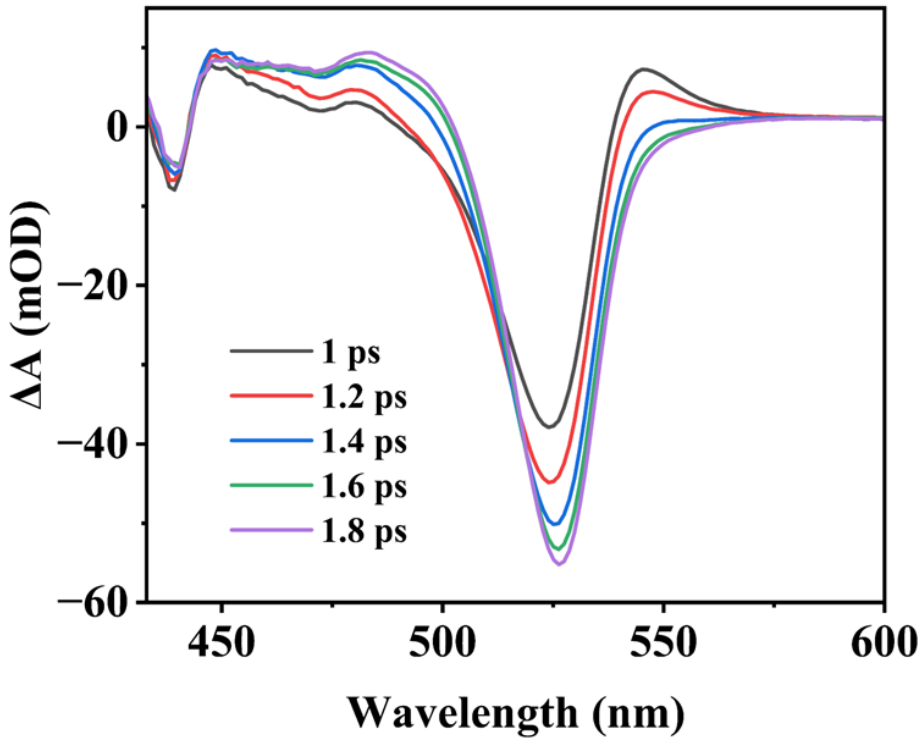

Figure S8. TA spectra of the quasi-2D perovskite P2F6 film w/o DMSO treatment at selected time scales.

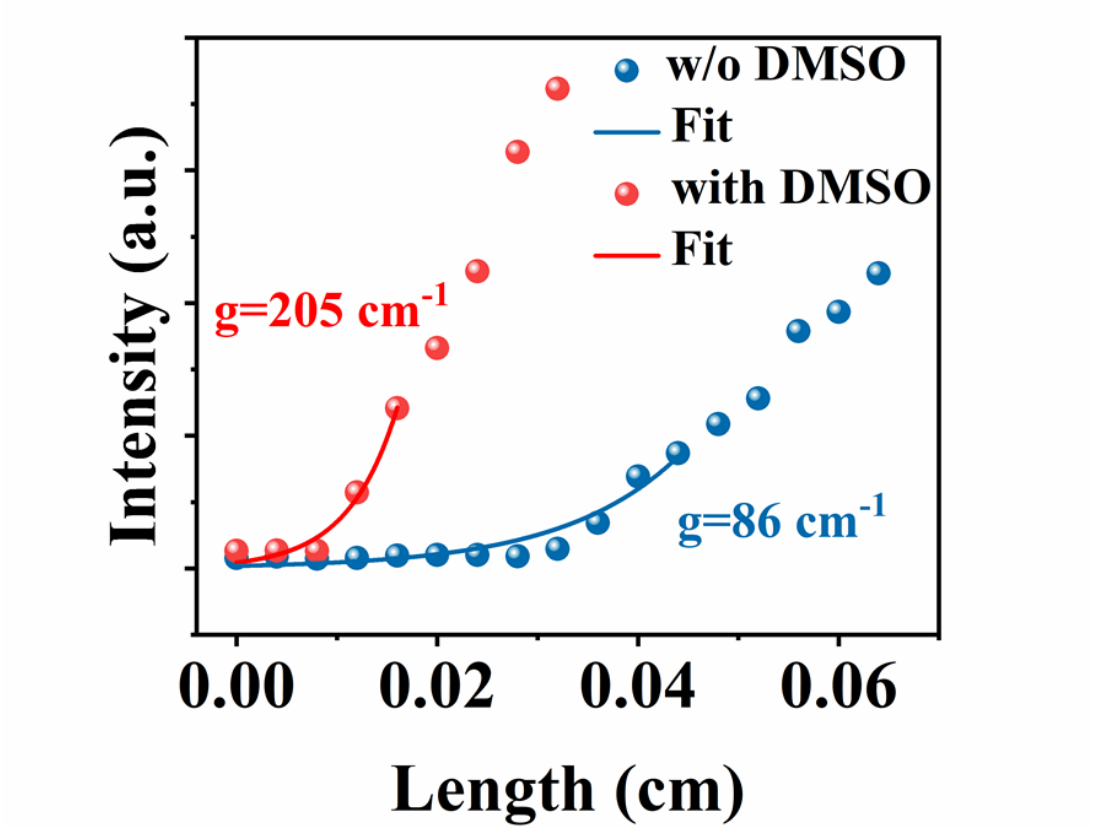

Figure S9. PL intensity of the perovskite films with and w/o DMSO treatment as a function of stripe length under the energy densities of 10 P_{th} of the two films.

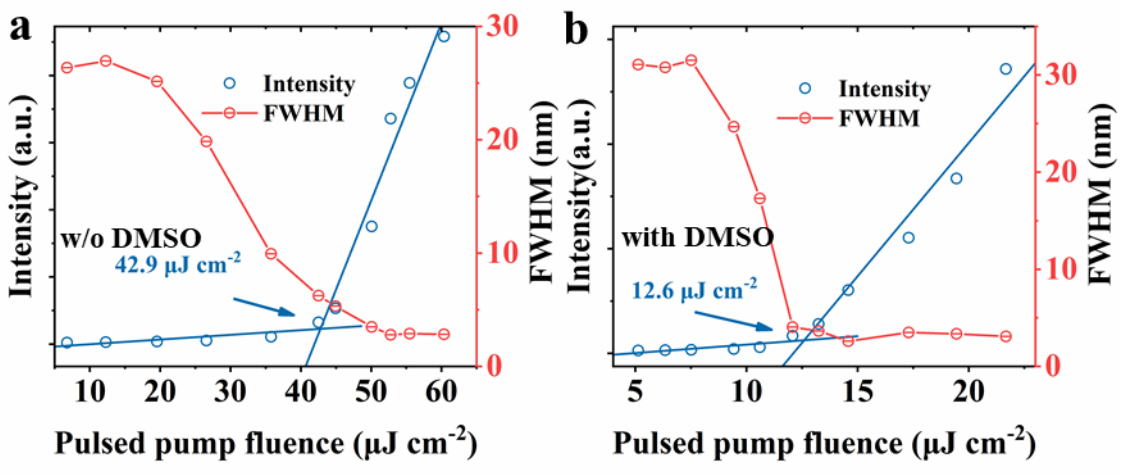

Figure S10. The output intensity and FWHM of the P2F7 films (a) w/o DMSO and (b) with DMSO treatment as a function of the pump fluence.

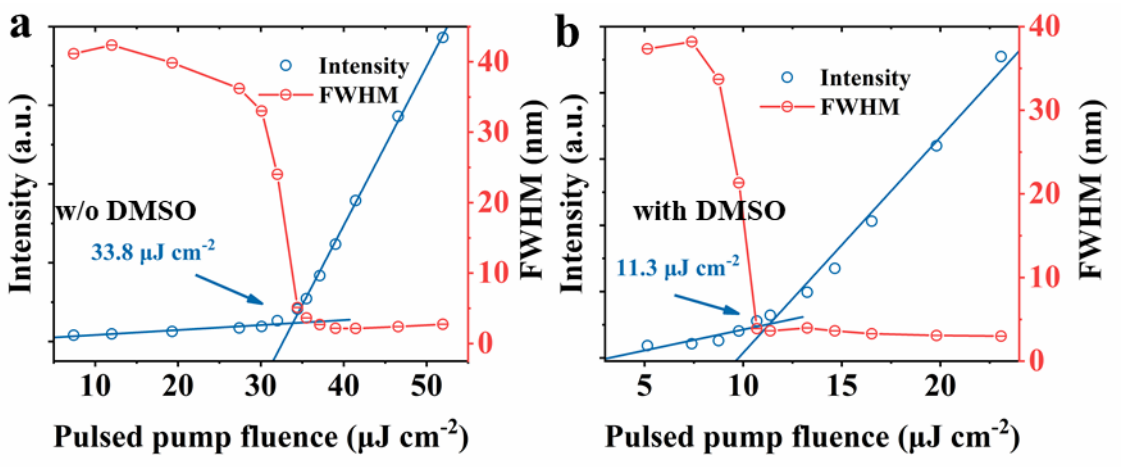

Figure S11. The output intensity and FWHM of the P2F8 films (a) w/o DMSO and (b) with DMSO treatment as a function of the pump fluence.

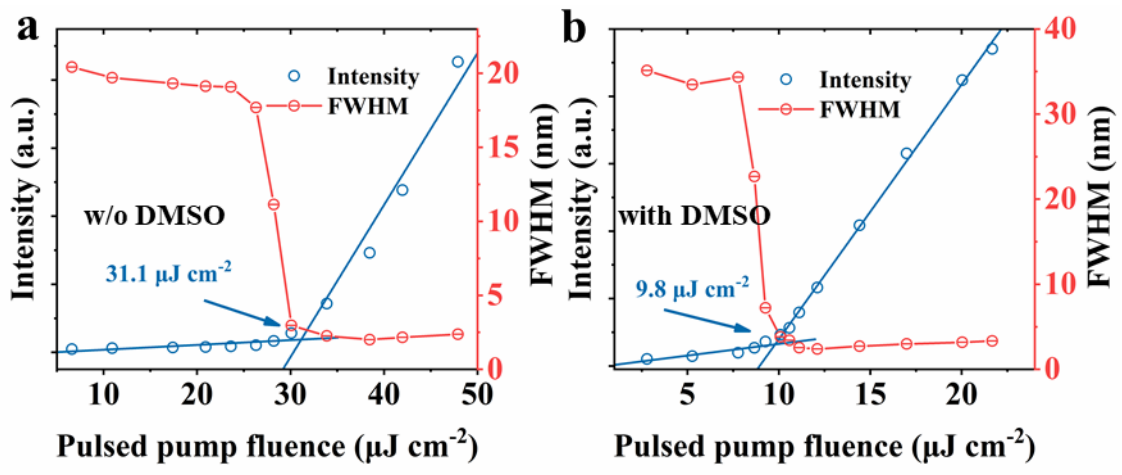

Figure S12. The output intensity and FWHM of the P2F9 films (a) w/o DMSO and (b) with DMSO treatment as a function of the pump fluence.

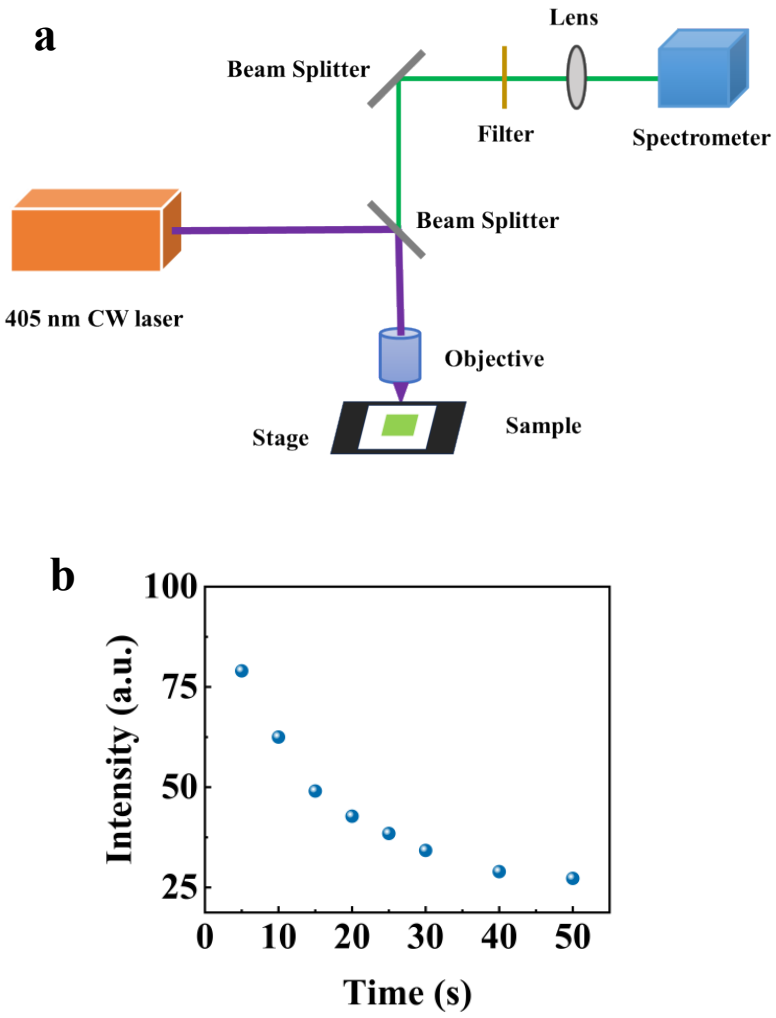

Figure S13. (a) Experimental set-up for emission stability of perovskite films under optical pumping; (b) The luminescence intensity of the perovskite film varies with time at a constant optical pumping power of 2 mW/cm^2.

Table S1. Fluorescence lifetime, non-radiative recombination rates (K_{nr}), and optical pumping ASE threshold of different perovskite films with and w/o DMSO treatment.

	P2F6	P2F7	P2F8	P2F9
τ_{avg} (w/o) (ns)	47.09	57.55	59.13	63.04
τ_{avg} (with) (ns)	65.66	72.94	75.71	84.18
K_{nr} (w/o) ($10^7 s^{-1}$)	1.6	1.4	1.5	1.4
K_{nr} (with) ($10^7 s^{-1}$)	1.1	1.0	1.2	1.0
P_{th} (w/o) ($\mu J\ cm^{-2}$)	46.7	42.9	33.8	31.1
P_{th} (with) ($\mu J\ cm^{-2}$)	12.9	12.6	11.3	9.8

Table S2. The fitted time constant for transient absorption spectra of different quasi-2D perovskite films probed at different wavelength.

	Wavelength (nm)	τ_{rise} (ps)	τ_{decay} (ps)	$\tau_{decay'}$ (ps)	τ_1 (ps)	τ_2 (ps)
w/o DMSO	n=2 (439)	0.73	0.27	14.96		
	n>5 (524)	0.95	2.43		123.81	798.37
with DMSO	n=2 (439)	0.42	0.36	23.02	125.97	
	n=3 (473)	0.44	0.43		254.42	1625.66
	n=4 (494)	0.77	0.32		155.25	966.89
	n>5 (524)	0.54	1.88		99.43	705.79

τ_{rise} is the rise time. τ_{decay}, $\tau_{decay'}$, τ_1, and τ_2 are the relaxation time.