Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Supporting Information

Achieving long carrier lifetime and high optical gain in all-inorganic CsPbBr3 perovskite films through top and bottom surface modification

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Supplementary Note 1

The grain size of perovskite films could be estimated by Debye-Scherrer equation: $D=k\lambda / B\cos\theta$, where $k = 0.89$ is the Scherrer constant, $\lambda=0.15406$ nm is X-ray wavelength and B is the FWHM of diffraction peak. In our films, the B values of 15 °and 30.5° peaks are 0.18 ° and 0.22 ° respectively. The grain size of films is thus determined to be roughly 47 nm.

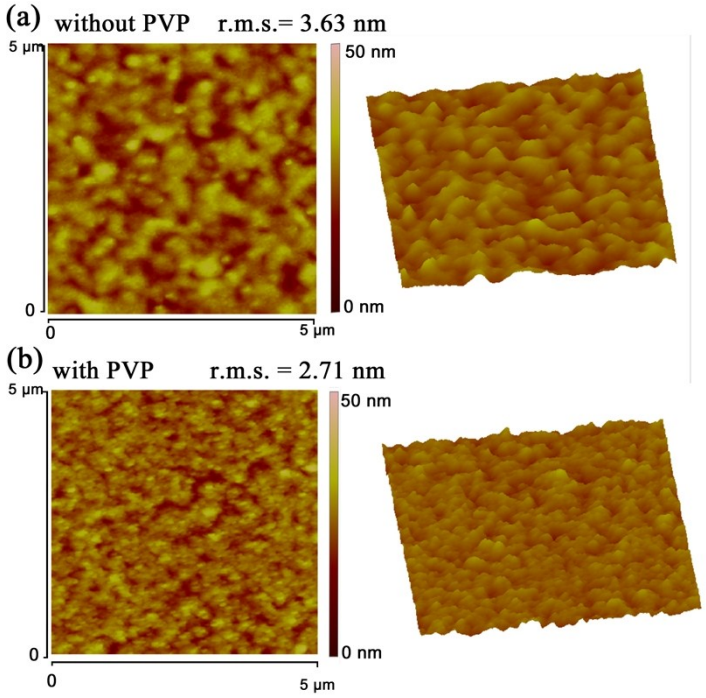

Figure S1. AFM images from perovskite film (a) without a PVP layer and (b) with a PVP layer on the substrate.

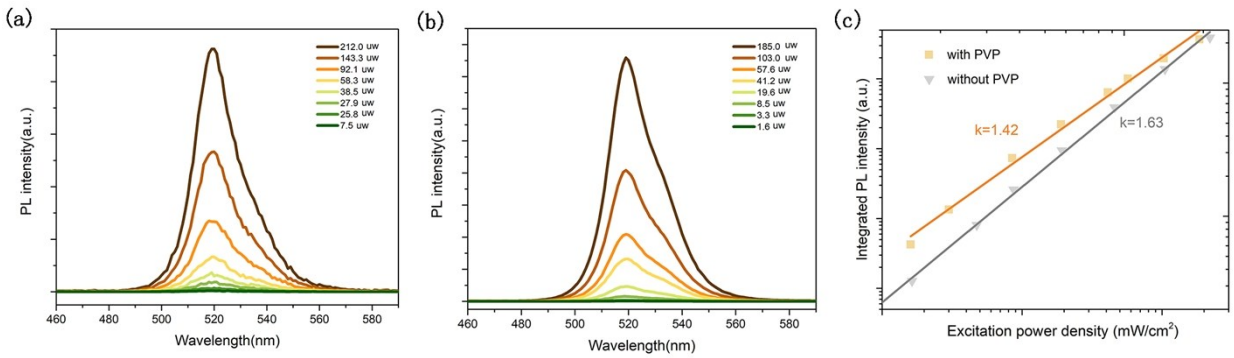

Figure S2. Excitation density-dependent PL measurements from perovskite film (a) without a PVP layer or (b) with a PVP layer. (c) Fitting result of excitation density-dependent PL measurements.

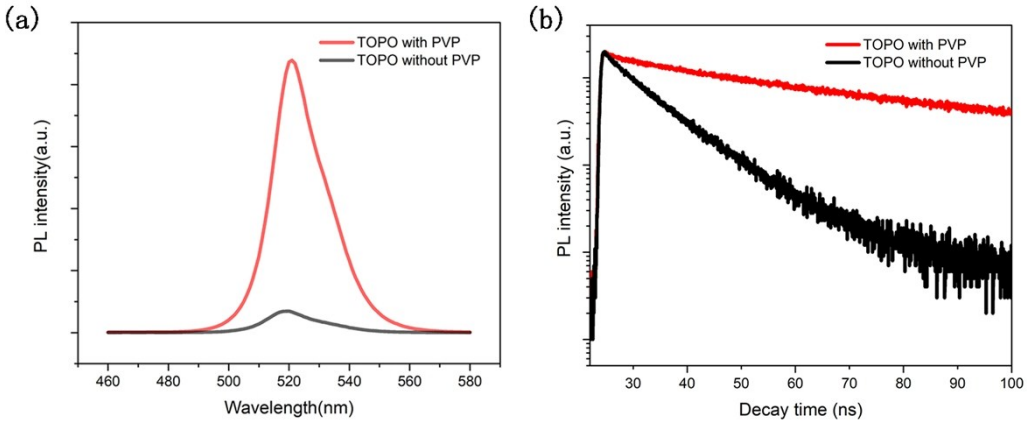

Figure S3. (a) Steady-state PL spectra measurements (b) Transient PL decay measurements from TOPO-treated perovskite films with or without a PVP layer.

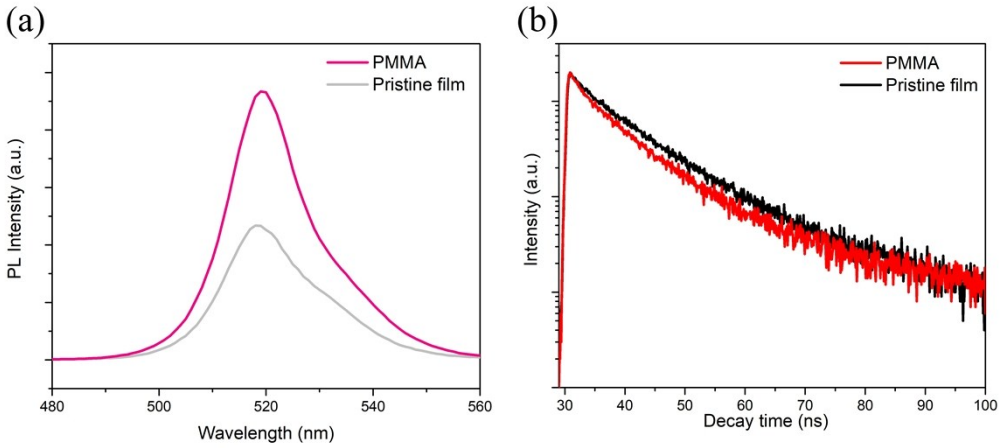

Figure S4. (a) Steady-state PL spectra (b) Transient PL decay from PMMA-treated perovskite film and pristine film.

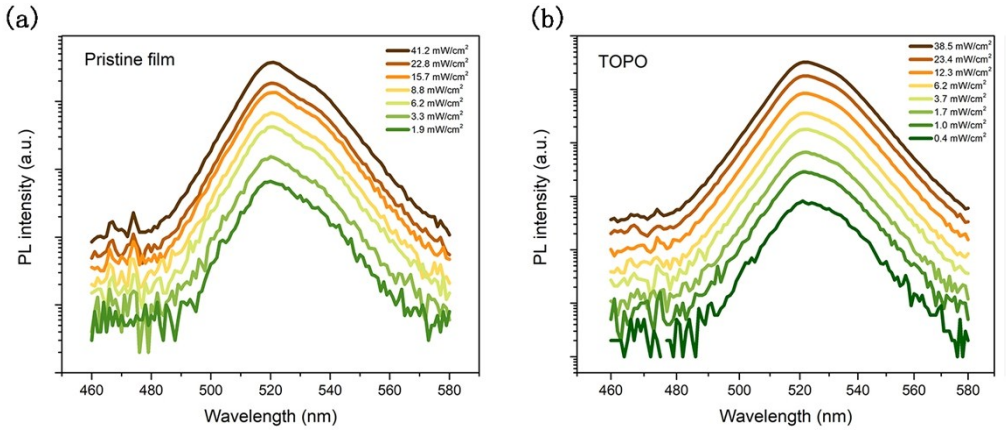

Figure S5. Excitation density-dependent PL measurements from (a) pristine film and (b) TOPO-treated perovskite film.

Table S1. Gain coefficient and carrier lifetime comparison of $CsPbBr_3$ perovskite film as optical gain medium

	Gain (cm^{-1})	Carrier lifetime (ns)	Publish year	Ref.
$CsPbBr_3$ single crystal	38	8	2019	[1]
$CsPbBr_3$ NCs film	450±30	~1.5	2015	[2]
$CsPbBr_3$ NCs film		11	2015	[3]
$CsPbBr_3$ NCs film		~7	2016	[4]
$CsPbBr_3$ NCs film		~8	2016	[5]
$CsPbBr_3$ NCs film	~580	~5	2016	[6]
$CsPbBr_3$ NCs film	98	3.1	2015	[7]
$CsPbBr_3$ NCs film		1.6	2018	[8]
$CsPbBr_3$ NCs film		12.52	2018	[9]
$CsPbBr_3$ NCs film	51	3.64；8.16	2018	[10]
$CsPbBr_3$ NCs film	~502		2018	[11]
$CsPbBr_3$ film		21.99	2017	[12]
$CsPbBr_3$ film		2.01-3.53	2017	[13]
$CsPbBr_3$ film	100（10 K）		2017	[14]
$CsPbBr_3$ film	>300	1-5	2018	[15]
Our work	694	44	2019	

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