Supplementary Information (SI) for New Journal of Chemistry.

Supporting Information

Improving thermal- and photo-stability of $CsPbBr_3$ perovskite films by adding graphene oxide for low threshold amplified spontaneous emission

Ayesha Azeem[1], Xinyang Wang[1], Guochao Lu[1], Meiyi Zhu[1], Xingliang Dai[1], Jing Li[1,2*], Zhizhen Ye[1], Jun Pan[2], Haiping He[1*]

1. School of Materials Science and Engineering, State Key Laboratory of Silicon and Advanced Semiconductor Materials, Zhejiang University, Hangzhou 310027, P. R. China
2. College of Materials Science and Engineering, Zhejiang University of Technology, Hangzhou 310014, P. R. China

E-mail: lijing23@zjut.edu.cn, hphe@zju.edu.cn

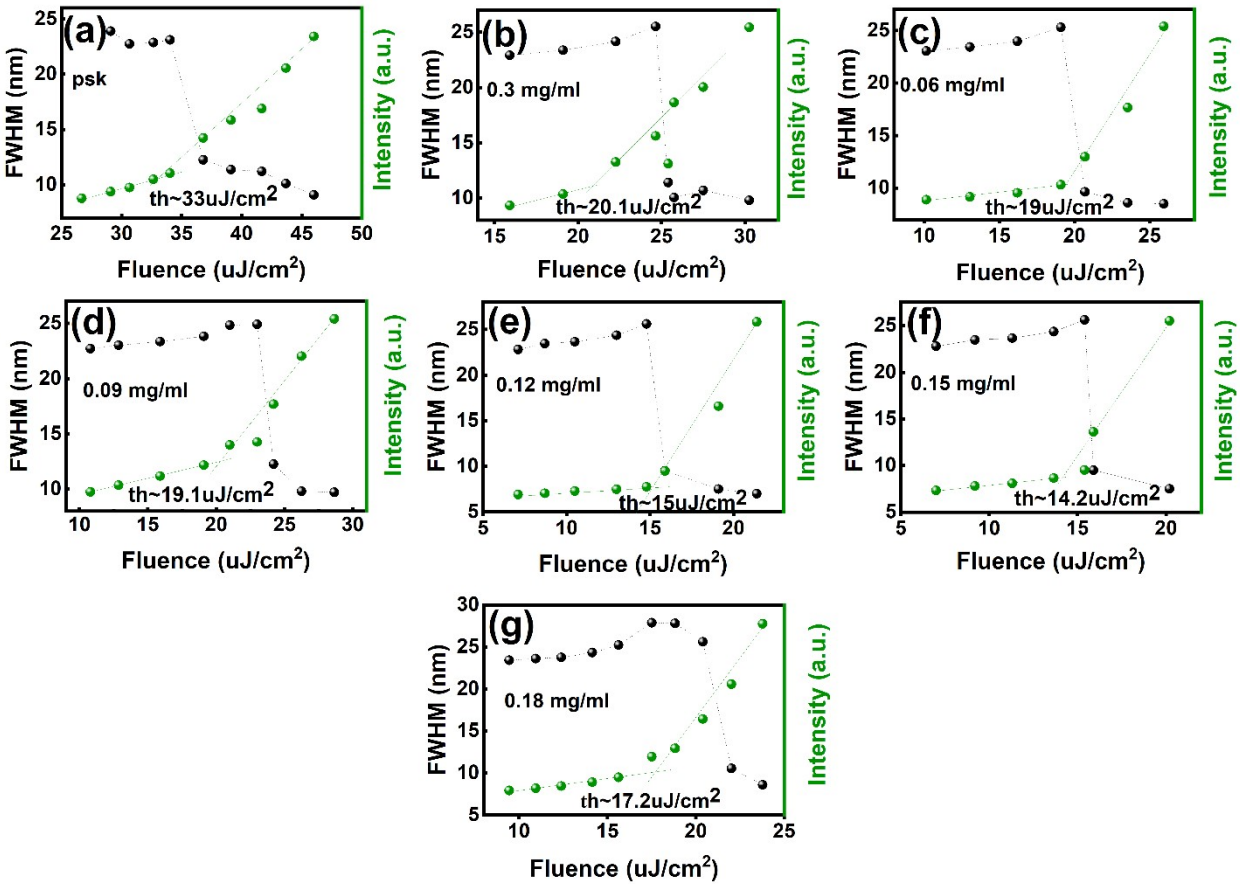

Fig S1. The FWHM and ASE intensity versus excitation fluence of the pure perovskite and different concentrations (0.03-0.18mg/ml GO) of $CsPbBr_3$: GO thin films without annealing (a-g).

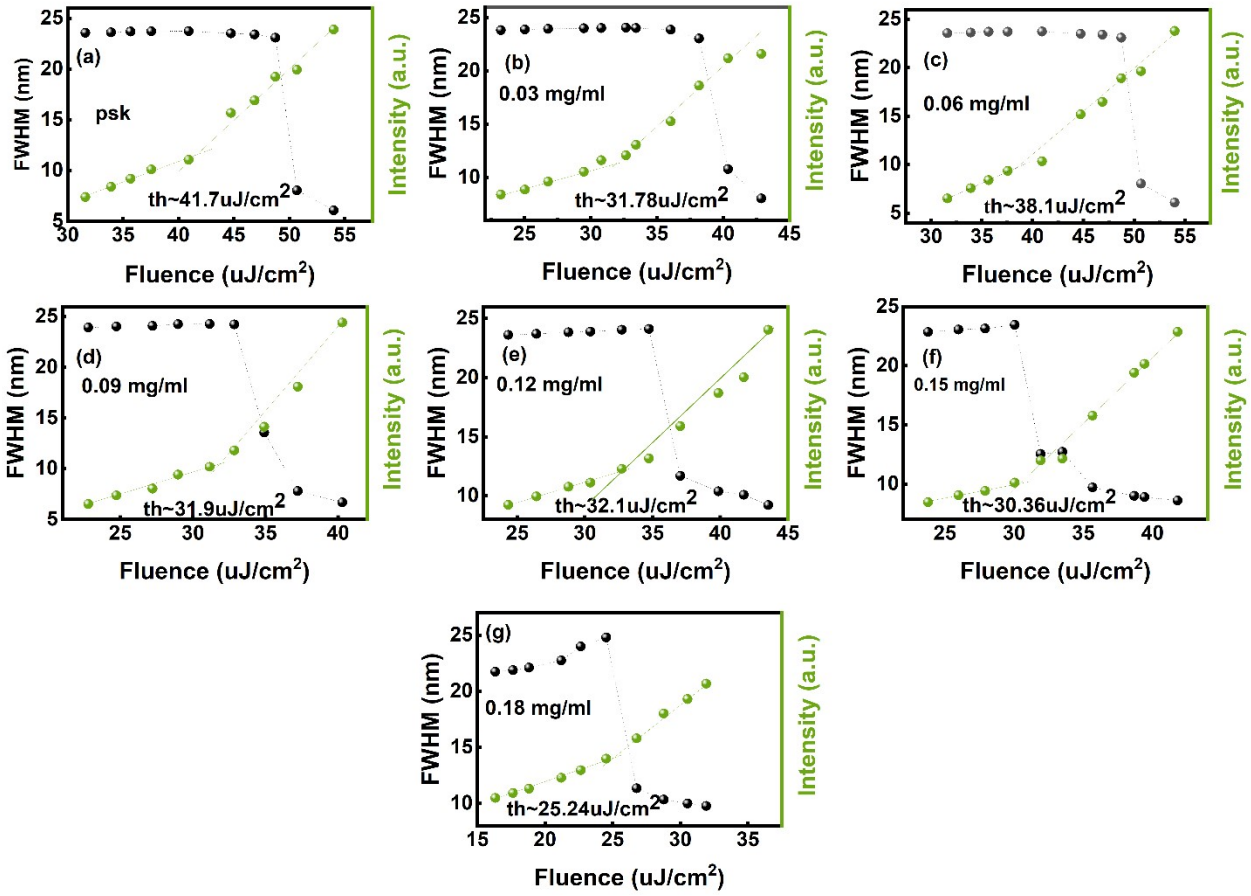

Fig S2. The FWHM and ASE intensity versus excitation fluence of the pure perovskite and different concentrations (0.03-0.18mg/ml GO) of $CsPbBr_3$: GO thin film after annealing at 130 ^oC for 24 hours under nitrogen atmosphere(a-g)

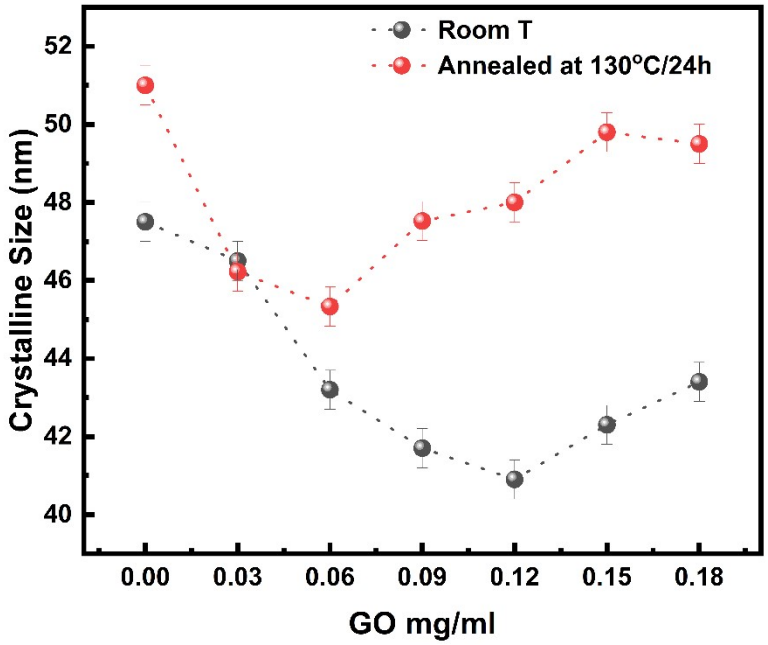

Fig S3. Change in crystal sizes of $CsPbBr_3$: GO thin films at 0.03mg/ml, 0.06mg/ml, 0.09mg/ml, 0.12mg/ml,0.15mg/ml, and 0.18mg/ml GO, respectively.

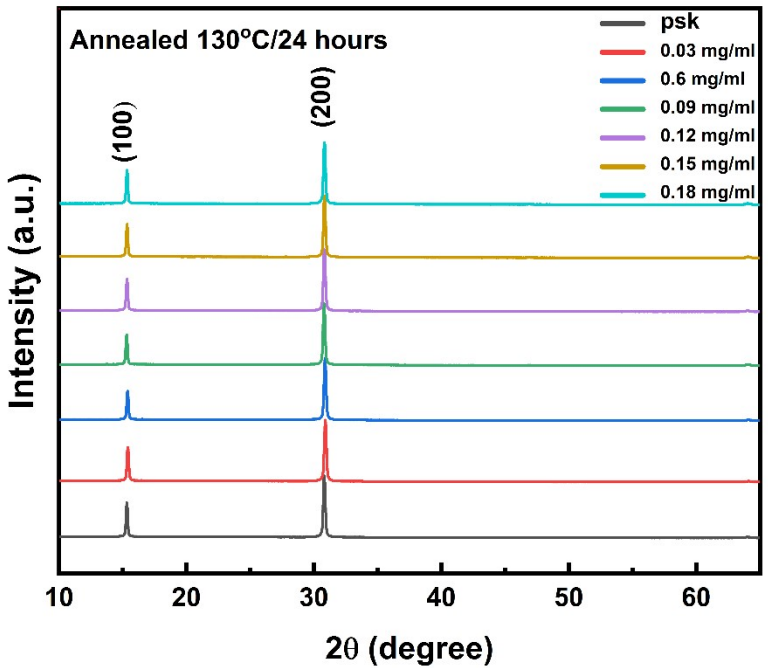

Fig S4. XRD patterns of the parent spectra of the pure $CsPbBr_3$ thin film and various concentrations of $CsPbBr_3$: GO polycrystalline thin films (0.03mg/ml GO-0.18mg/ml) deposited on a glass substrate after annealing at 130 °C for 24 hours.

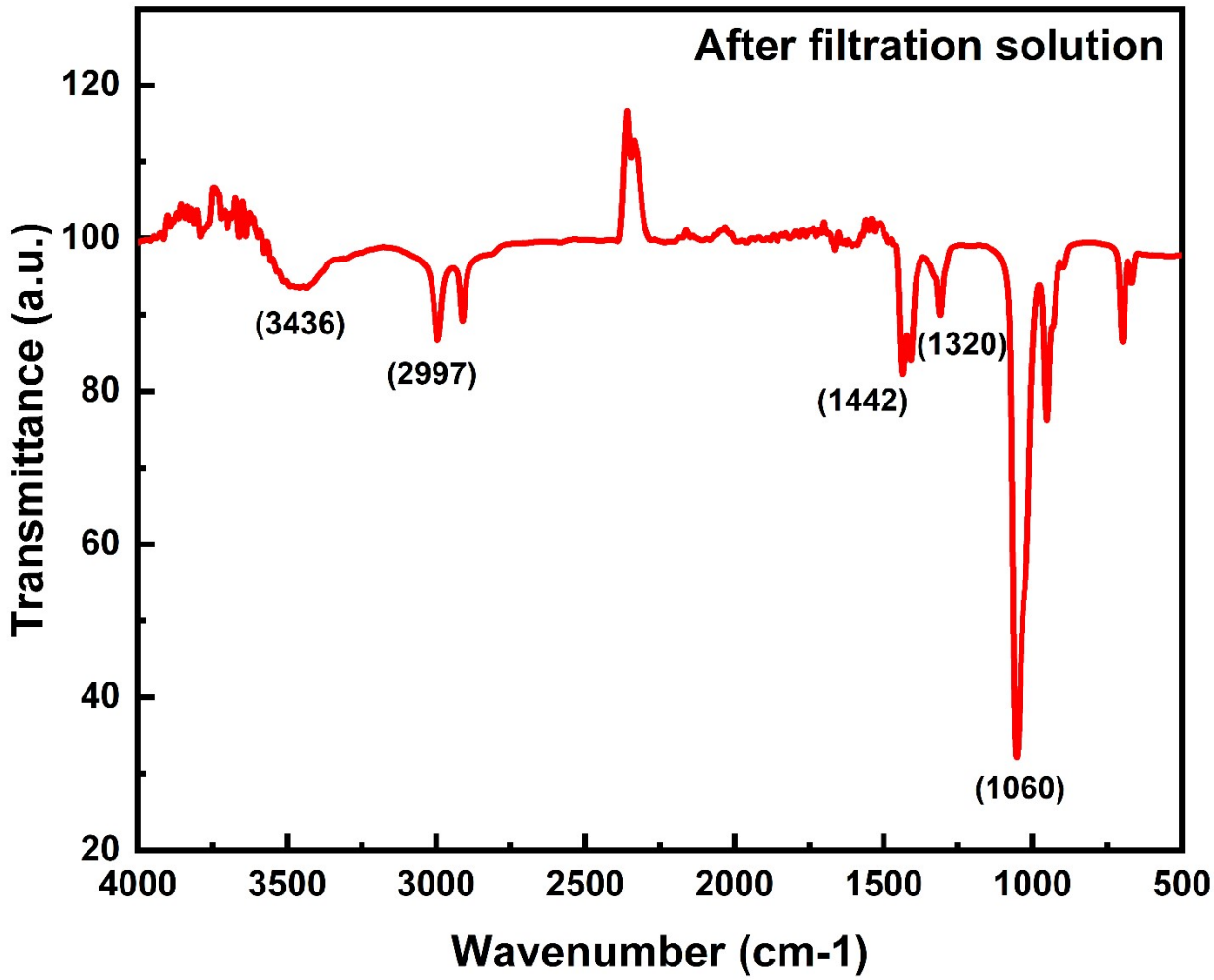

Fig S5. FTIR spectra of PSK: GO 0.18mg/ml solution after filtration.

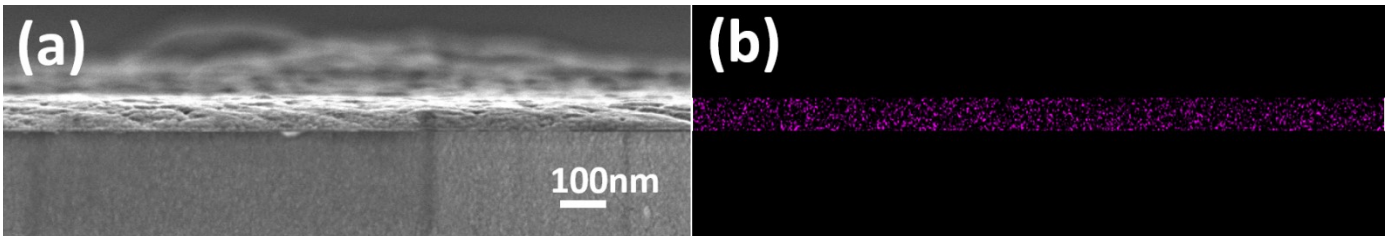

Fig S6. (a)SEM image a side-view and (b) Sulfur EDX elemental mapping of PSK: GO 0.18mg/ml layer intermingled with NH, CH, CH, SH-modified GO nanoparticles.

Table S1. Comparison of FWHM and threshold values of different types of films before and after annealing at 130 ^{o}C for 24 hours.

Film Type	FWHM before Ann.	FWHM after Ann.	Threshold before Ann.	Threshold after Ann.
$CsPbBr_3$	10.0 nm	11.0 nm	33.9	41.7
$CsPbBr_3$+0.03mg/mlGO	9.7 nm	9.29 nm	20.1	31.8
$CsPbBr_3$+0.06mg/mlGO	9.0 nm	8.02 nm	19.0	38.1
$CsPbBr_3$+0.09mg/mlGO	8.5 nm	8.60 nm	19.1	31.9
$CsPbBr_3$+0.12mg/mlGO	7.5 nm	9.21 nm	15	32.1
$CsPbBr_3$+0.15mg/mlGO	7.4nm	6.69 nm	14.2	30.4
$CsPbBr_3$+0.18mg/mlGO	6.5 nm	6.02 nm	17.2	25.2