Electronic Supporting Information

Strong Confinement via 2D-to-3D Zeolite Transformation Enables Blue-Emitting $CsPbBr_3$ Quantum Dots for Backlight Displays

Hongkai Li,[a] Yuchi Zhang,[a] Le Han,[a] Changshuai Gong,[a] Yan Xu[a,b]*

[a]*Department of Chemistry, College of Sciences, Northeastern University, Shenyang, Liaoning 110819, P. R. China*

[b]*Foshan Graduate School of Innovation, Northeastern University, Foshan, Guangdong, 528311, P. R. China.*

$$2PbBr_2 + CsBr \rightarrow CsPb_2Br_5 \# \ (1)$$

$$CsPb_2Br_5 + CsBr \rightarrow 2CsPbBr_3 \# \ (2)$$

$$CsPb_2Br_5 \rightarrow CsPbBr_3 + PbBr_2 \# \ (3)$$

$$PbBr_2 + CsBr \rightarrow CsPbBr_3 \# \ (4)$$

Fig. S1 Reactions during the grinding and thermal diffusion process.[1]

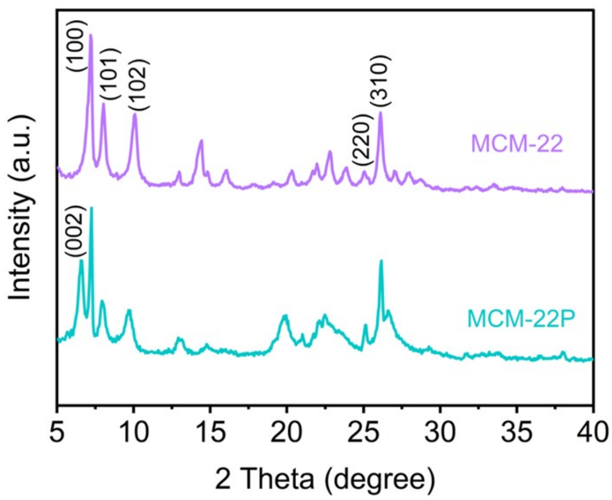

Fig. S2 XRD patterns of MCM-22P and MCM-22.

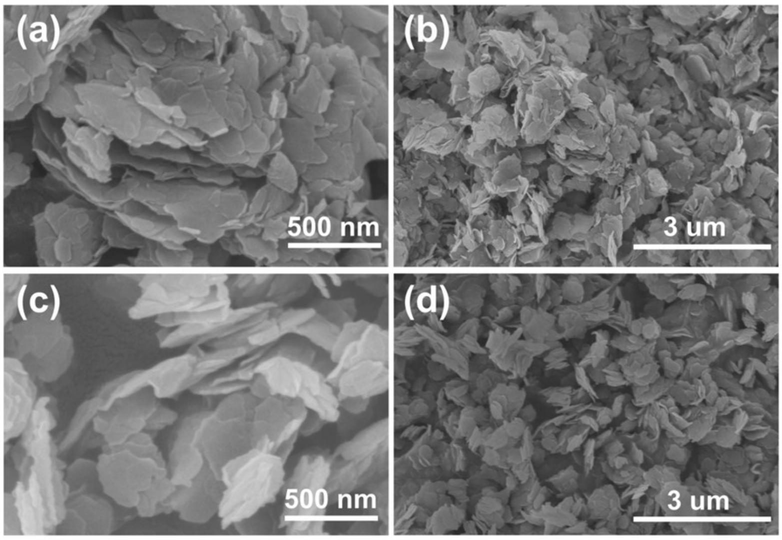

Fig. S3 SEM images of (a-b) MCM-22P and (c-d) MCM-22.

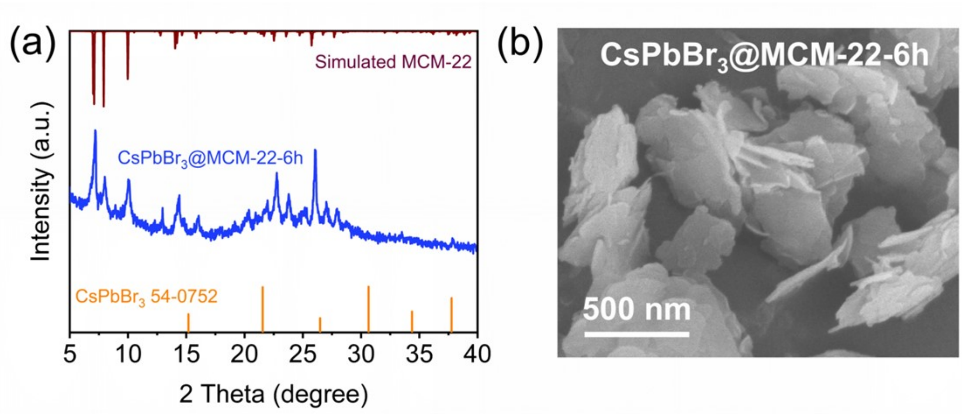

Fig. S4 (a) XRD pattern and (b) SEM image of $CsPbBr_3$@MCM-22-6h.

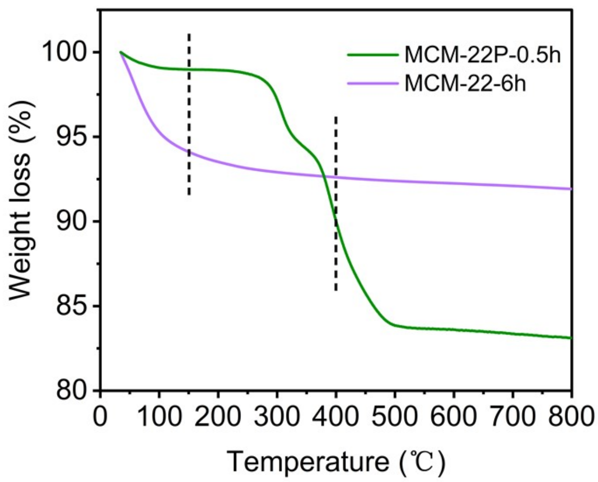

Fig. S5 TG curves of MCM-22P-0.5h and MCM-22-6h obtained by calcining MCM-22P at 550 °C for 0.5 h and 6 h, respectively.

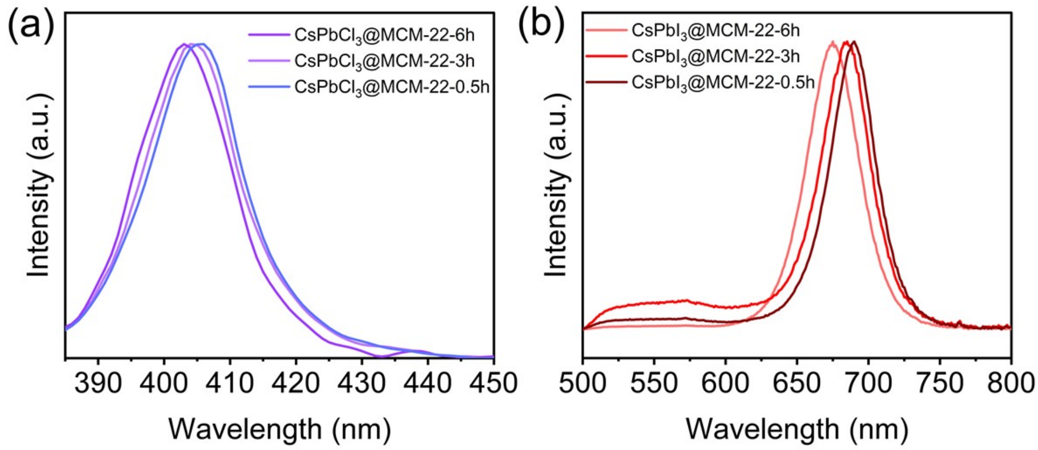

Fig. S6 PL spectra of (a) $CsPbCl_3$@MCM-22 and (b) $CsPbI_3$@MCM-22 composites obtained from different calcination times (λ_{ex} = 365 nm).

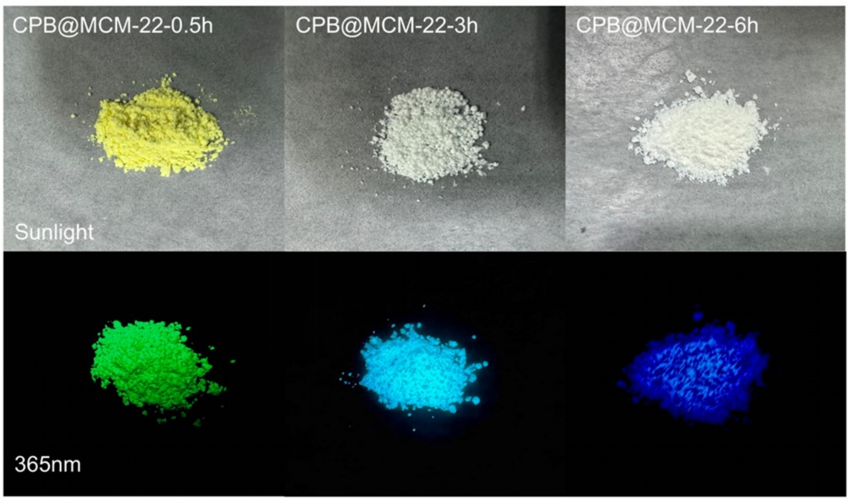

Fig. S7 Photographs of $CsPbBr_3$@MCM-22 composites taken at different calcination durations under sunlight and 365 nm UV lamp irradiation.

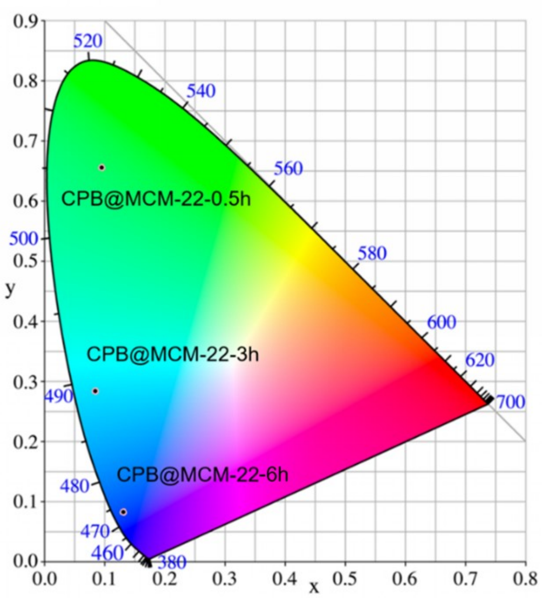

Fig. S8 CIE diagram of $CsPbBr_3$@MCM-22 composites obtained with varying calcination durations.

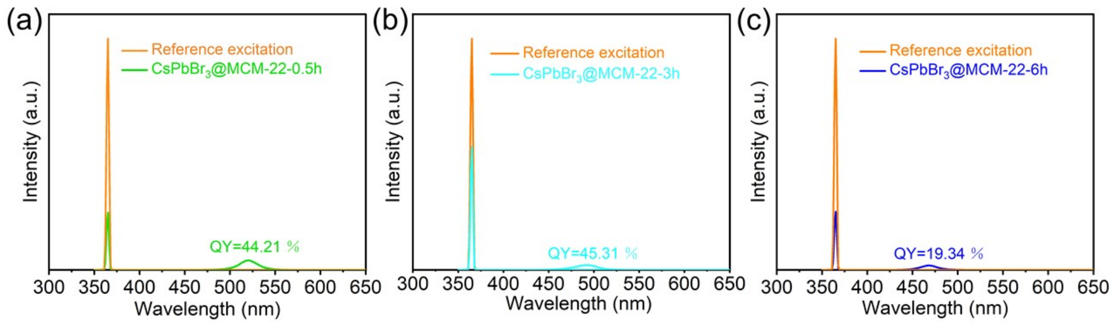

Fig. S9 PLQY of (a) $CsPbBr_3$@MCM-22-0.5h, (b) $CsPbBr_3$@MCM-22-3h, and (c) $CsPbBr_3$@MCM-22-6h, respectively.

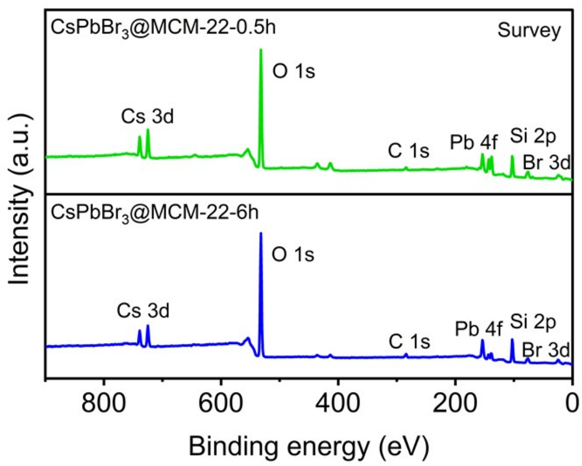

Fig. S10 XPS survey spectra of $CsPbBr_3$@MCM-22-0.5h and $CsPbBr_3$@MCM-22-6h.

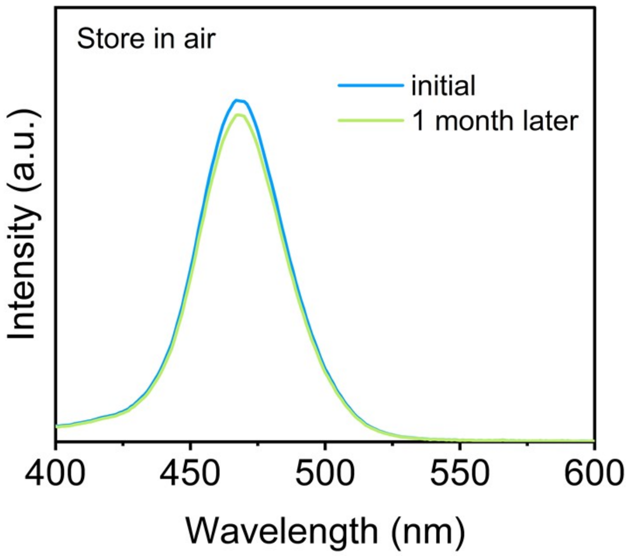

Fig. S11 Fluorescence spectra of $CsPbBr_3$@MCM-22-6h in air before and after one month.

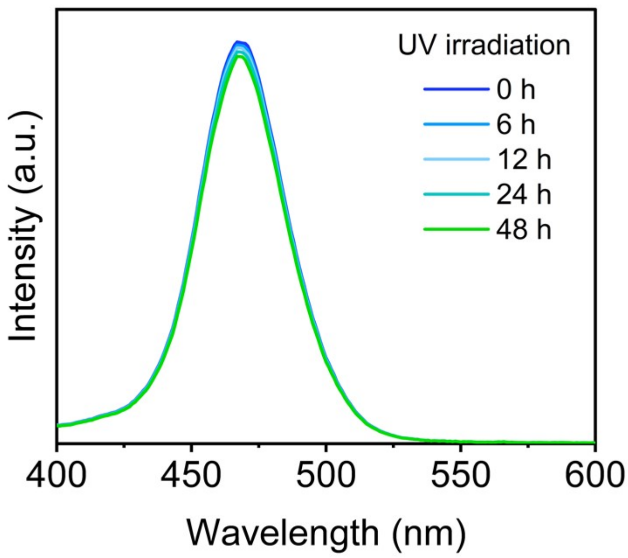

Fig. S12 Luminescent stability of $CsPbBr_3$@MCM-22-6h under 365 nm excitation wavelength for 48 h.

Table S1 Comparison of BET surface areas and pore volumes of MCM-22 and $CsPbBr_3$@MCM-22-6h.

Samples	SBET (m^2/g)	Sext (m^2/g)	Vtotal (cm^3/g)	Vmicro (cm^3/g)	Vmeso (cm^3/g)
MCM-22	415	88	0.510	0.168	0.342
$CsPbBr_3$@MCM-22-6h	73	40	0.291	0.017	0.274

Table S2 Weight losses of of MCM-22P-0.5h and MCM-22-6h.

Samples	Weight loss (%)		
	50-150°C	150-400°C	400-800°C
MCM-22P-0.5h	1.02	8.98	6.88
MCM-22-6h	5.89	1.51	0.68

Table S3 Comparisons of luminescence, particle size and stability of blue-emitting $CsPbBr_3$ PQDs encapsulated in various inorganic porous materials.

Materials	Peak (nm)	Diameter (nm)	Stability	Ref.
$CsPbBr_3$@W-S-1	468	2.0	High stability in water	1
$CsPbBr_3$@SBA-15	487	3.1	High stability in air	2
$CsPbBr_3$@m-SiO_2	453	—	High stability in air	3
$CsPbBr_3$@N-S-1	474	2.38	High stability in water	4
$CsPbBr_3$@MSN	470	3.0	High stability in air	5
$CsPbBr_3$@MCM-22	467	2.1	High stability in water	This work

References

1. H. Y. Zhang, B. L. Wang, Z. J. Niu, G. R. Chen, B. Y. Guan, J. Y. Li, and J. H. Yu, Ultrasmall water-stable $CsPbBr_3$ quantum dots with high intensity blue emission enabled by zeolite confinement engineering, *Mater. Horiz.,* 2023*,* **10**, 5079–5086.
2. V. Malgras, J. Henzie, T. Takei,.and Prof. Y. Yamauchi, Stable Blue Luminescent $CsPbBr_3$ Perovskite Nanocrystals Confined in Mesoporous Thin Films, *Angew. Chem. Int. Ed.* 2018, **57** 8881–8885.
3. S. N. Li, Y. R. Yang, J. H. Song, X. L. Meng, C. B. Bai, B. Wei, F. Ma, and L. Zhang, Static-spun mesoporous silica-coated $CsPbBr_3$ blue fibres: synthesis and fluorescence properties, *Nanoscale Res. Lett.,* 2024*,* **19**, 180.
4. Y. C. Zhang, H. K. Li, L. Han, and Y. Xu, Engineering Green-to Blue-Emitting $CsPbBr_3$ Quantum Dots in Nanozeolite with High Stability for Backlight Display Application, *Nano Lett.,* 2024*,* **24**, 16400–16407.
5. K. X. Cui, Y. Chen, K. Y. Xie, H. N. Peng, L. P. Ding, and Y. Fang, Nanoconfined Synthesis of $CsPbBr_3$ Quantum Dots: Enhanced Stability, Tunable Luminescence, and Sensitive Sensing Application, *ACS Appl. Mater. Interfaces.,* 2025*,* **17**, 20075–20086.