

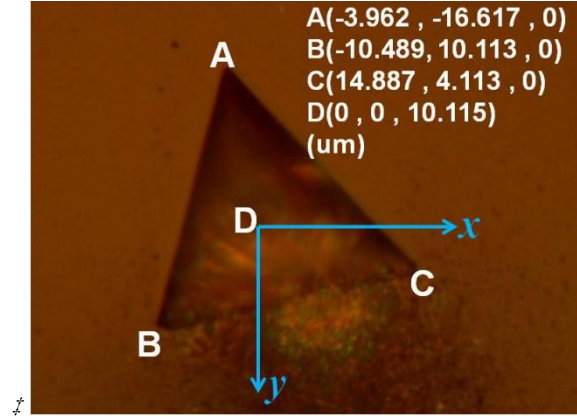
## Supporting Information

### **Room-Temperature High Performance Perovskite Tetrahedral Microlasers**

Xiaoxia Wang,<sup>a</sup> Huazhou Chen,<sup>b</sup> Hong Zhou,<sup>a</sup> Xiao Wang,<sup>a</sup> Shuangping Yuan,<sup>a</sup> Zhenqian Yang,<sup>b</sup> Xiaoli Zhu,<sup>a</sup> Renmin Ma,<sup>\*b</sup> Aanlian Pan<sup>\*a</sup>

a. Key Laboratory for Micro-Nano Physics and Technology of Hunan Province,  
State Key Laboratory of Chemo/Biosensing and Chemometrics,  
School of Physics and Electronics Science, and College of Materials Science and Engineering, Hunan  
University, Changsha 410082, P. R. China. E-mail: Aanlian.pan@hnu.edu.cn

b. State Key Laboratory for Mesoscopic Physics and School of Physics,  
Collaborative Innovation Center of Quantum Matter, Peking University,  
Beijing 100871, China. E-mail: renminma@pku.edu.cn



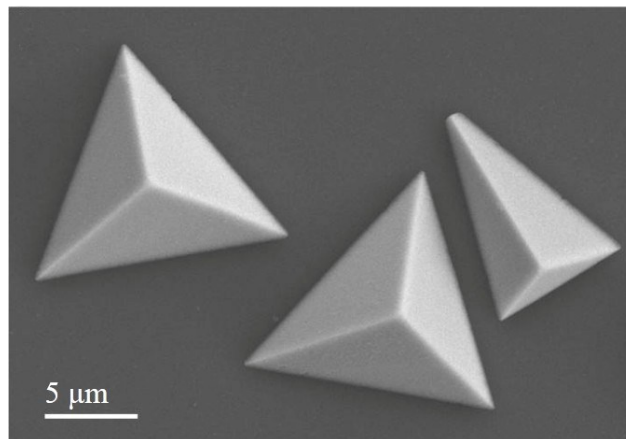
**Fig. S1.** Microscope image of a CsPbBr<sub>3</sub> tetrahedron with exactly position coordinates of the four apex angles. The calculated vector and length of each edge are as following:

$$\begin{aligned}\vec{DA} &= (-3.962, -16.617, -10.115), |\vec{DA}| = 19.85\mu m, \\ \vec{DB} &= (-10.489, 10.113, -10.115), |\vec{DB}| = 17.74\mu m, \\ \vec{DC} &= (14.887, 4.113, -10.115), |\vec{DC}| = 18.46\mu m,\end{aligned}$$

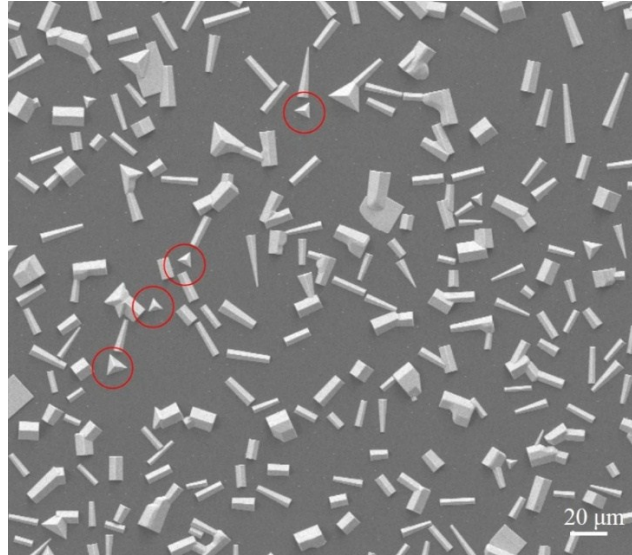
Then the angles are calculated by anti-trigonometric function:

$$\begin{aligned}\langle \vec{DA}, \vec{DB} \rangle &= \arccos \frac{\vec{DA} \cdot \vec{DB}}{|\vec{DA}| |\vec{DB}|} = 93.9^\circ, \\ \langle \vec{DA}, \vec{DC} \rangle &= 92.1^\circ, \langle \vec{DB}, \vec{DC} \rangle = 93.9^\circ,\end{aligned}$$

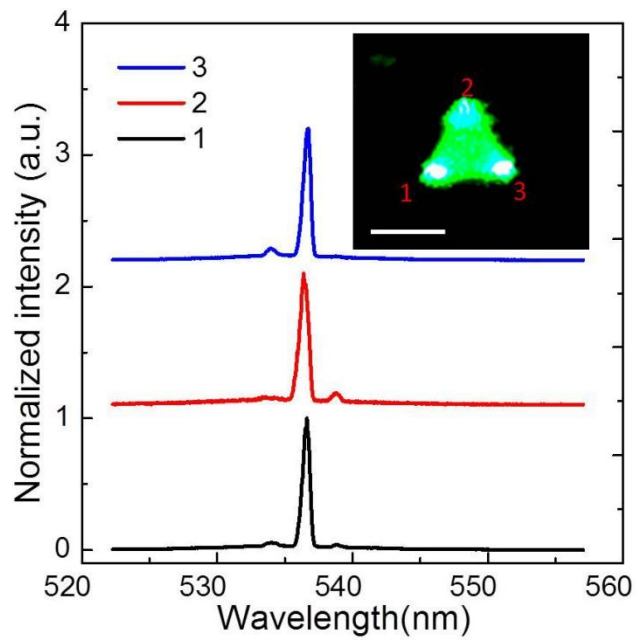
Based on the above mathematical calculations, the three apex angles are around  $\sim 90^\circ$  and the facet that contacting with the substrate is regular triangle, which give an exactly geometrical configuration of the tetrahedron-shaped CsPbBr<sub>3</sub> perovskite structures.



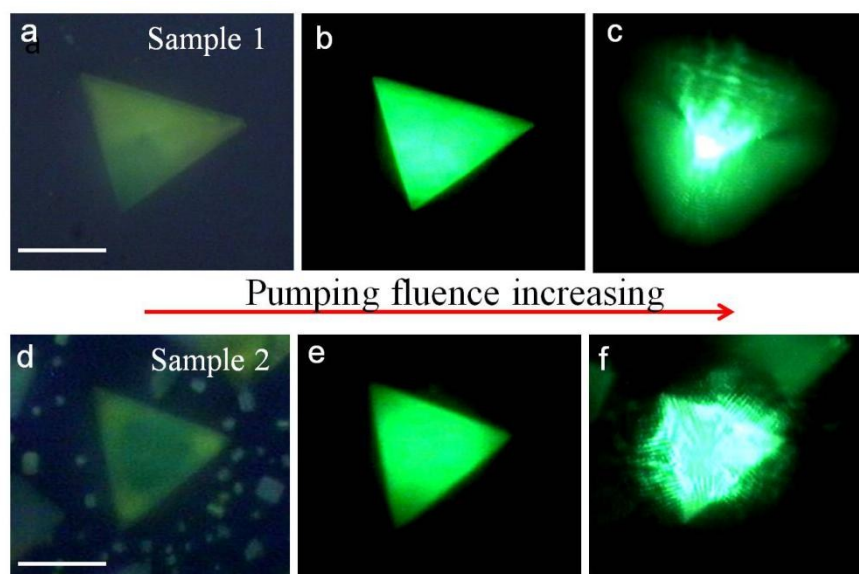
**Fig. S2.** SEM image of the as-grown samples with other morphologies



**Fig. S3.** SEM image of the as-grown sample in bare silicon substrate without  $\text{SiO}_2$  film; several tetrahedrons are found and marked with red circle.



**Fig. S4.** Lasing spectra profiles detected from the three base angles of a tetrahedron-shaped  $\text{CsPbBr}_3$ . Inset is the real-color optical image of the  $\text{CsPbBr}_3$  tetrahedron when pumped above threshold. Scale bar is 5  $\mu\text{m}$ .



**Fig. S5.** Optical images of other representative tetrahedron-shaped  $\text{CsPbBr}_3$  pumped at 800 nm with increasing the excitation intensity. Scale bar is 10  $\mu\text{m}$ . Further confirms the generic of the realization of two-photon pumped laser with the tetrahedron-shaped  $\text{CsPbBr}_3$  perovskite single crystals.