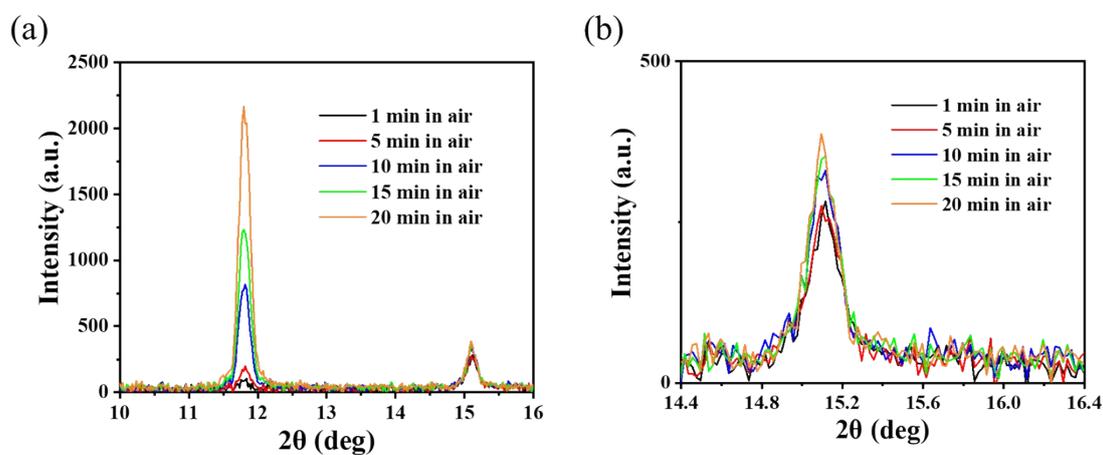
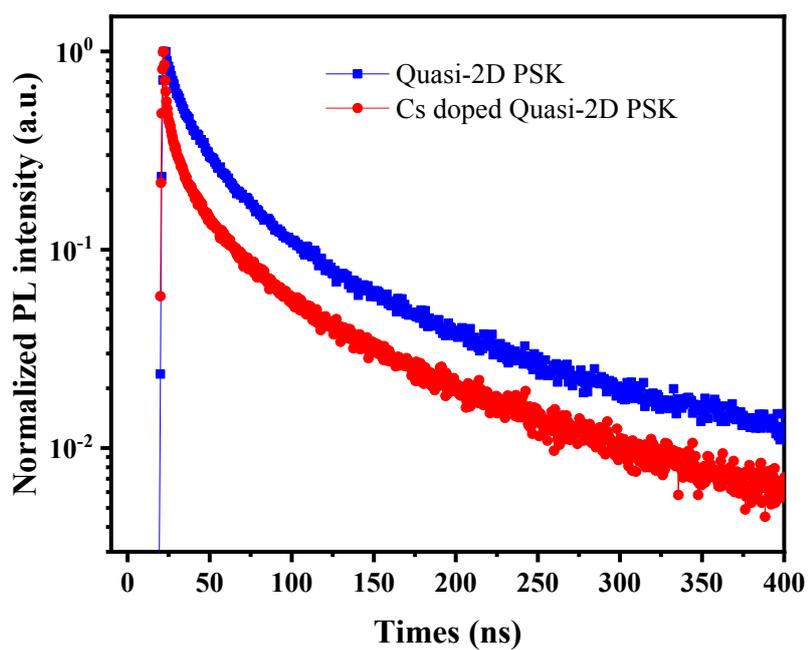


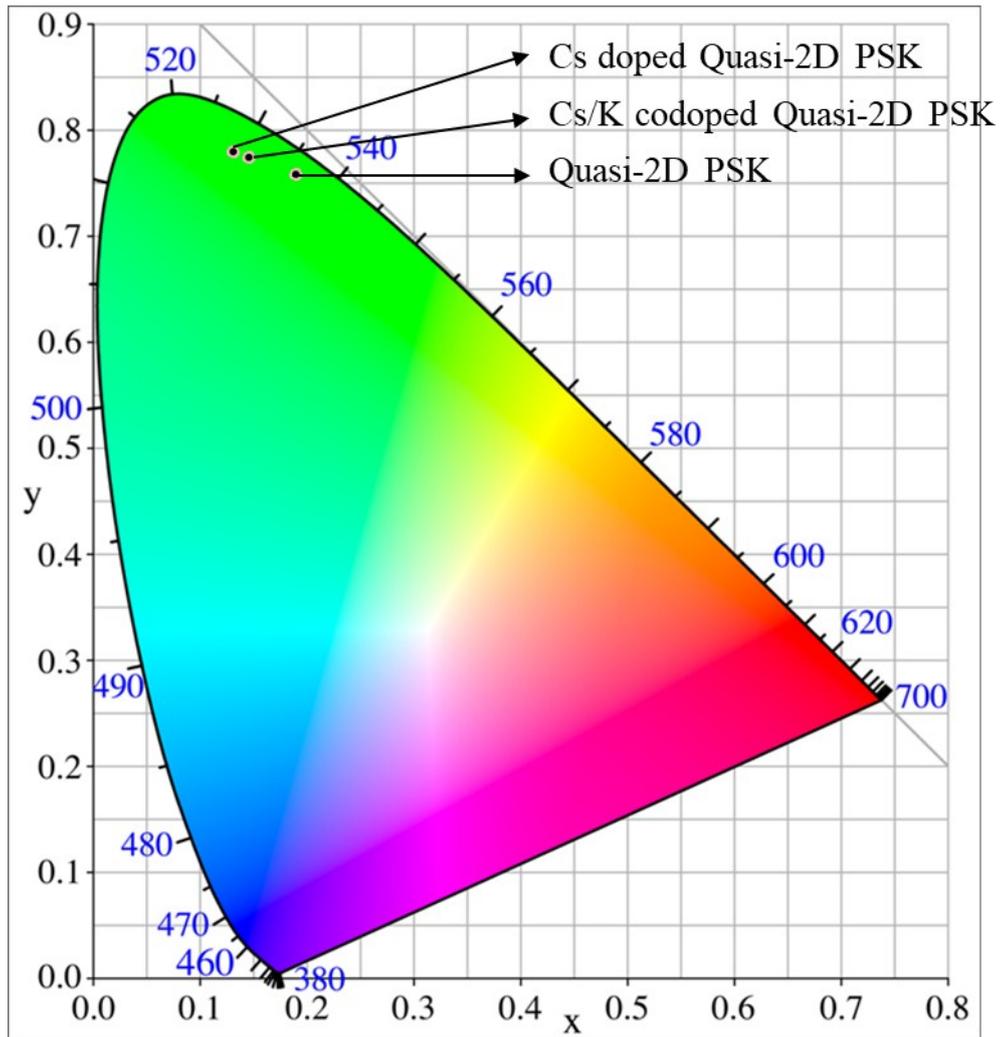
Support information



Supplementary Figure 1 | X-ray diffraction patterns of $\text{FA}_{0.5}\text{Cs}_{0.5}\text{PbBr}_3$ films with different time exposed in air.



Supplementary Figure 2 | Time resolved photoluminescence (TRPL) spectra of Cs doped quasi-2D PSK films and quasi-2D PSK films.



Supplementary Figure 3 | The corresponding Commission Internationale de l'Eclairage (CIE) coordinate of typical PeLED based on Quasi-2D PSK, Cs doped quasi-2D PSK and Cs/K codoped quasi-2D PSK.