

## Ion Doped Lead-Free Double Perovskite Cs<sub>2</sub>NaBiCl<sub>6</sub> with Multiple Excitation and Tunable Emission towards Light Emitting and Anti-counterfeiting Applications

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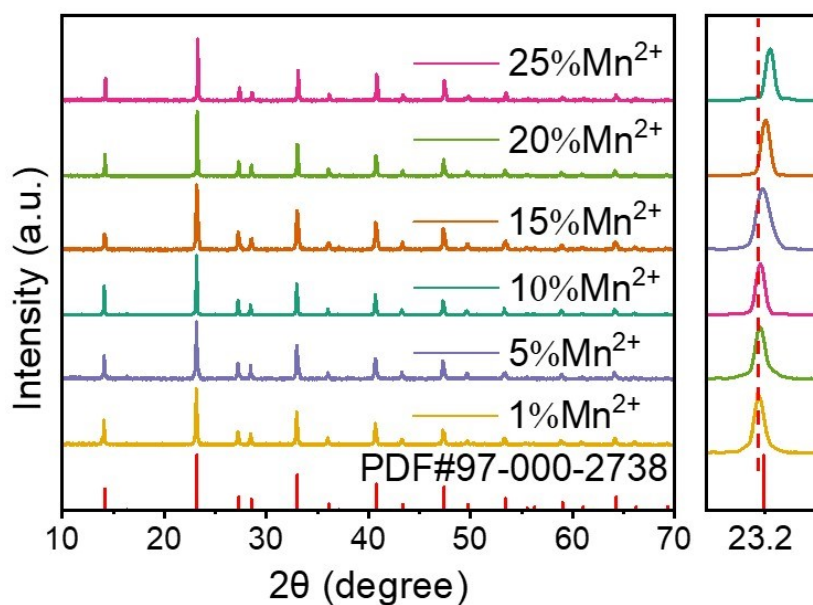


Fig. S1 X-ray diffraction patterns of the as-prepared CNBC: 30% Br, x% Mn<sup>2+</sup> (x=1-25).

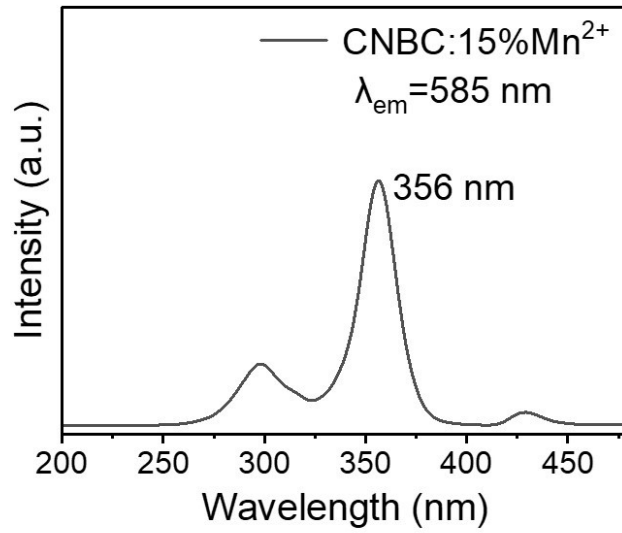


Fig. S2 The PLE spectrum of the as-prepared CNBC: 15% Mn<sup>2+</sup>.

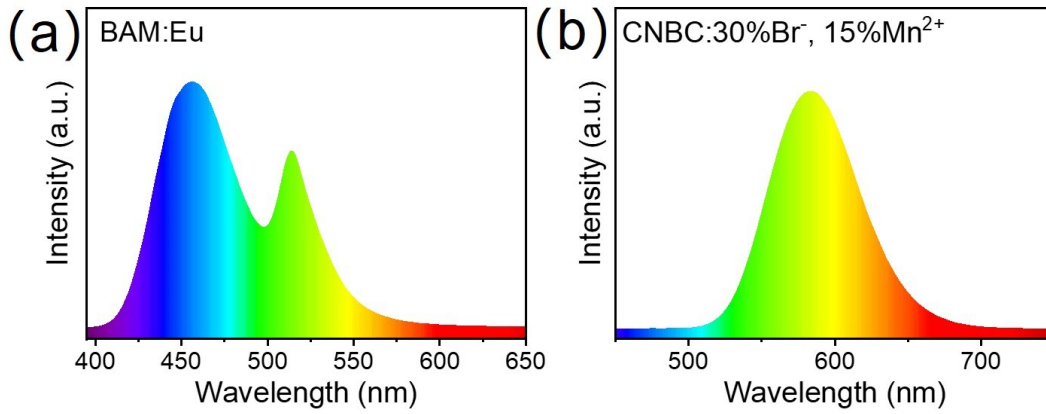


Fig. S3 (a) EL spectra of BaMgAl<sub>10</sub>O<sub>17</sub>: Eu<sup>3+</sup> and (b) CNBC:30% Br<sup>-</sup>, 15% Mn<sup>2+</sup>.

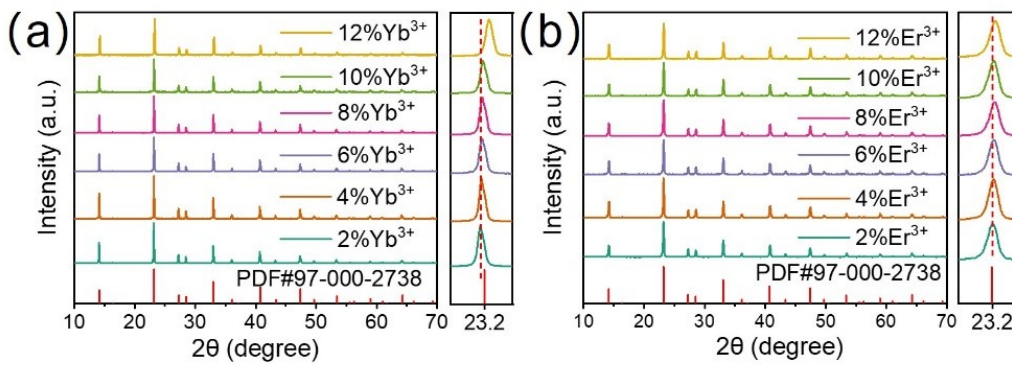


Fig. S4 X-ray diffraction patterns of the as-prepared (a) CNBC: 30% Br<sup>-</sup>, 15% Mn<sup>2+</sup>, 12% Er<sup>3+</sup>, x% Yb<sup>3+</sup> (x=2-12) and (b) CNBC: 30% Br<sup>-</sup>, 15% Mn<sup>2+</sup>, x% Er<sup>3+</sup>, 12% Yb<sup>3+</sup> (x=2-12).

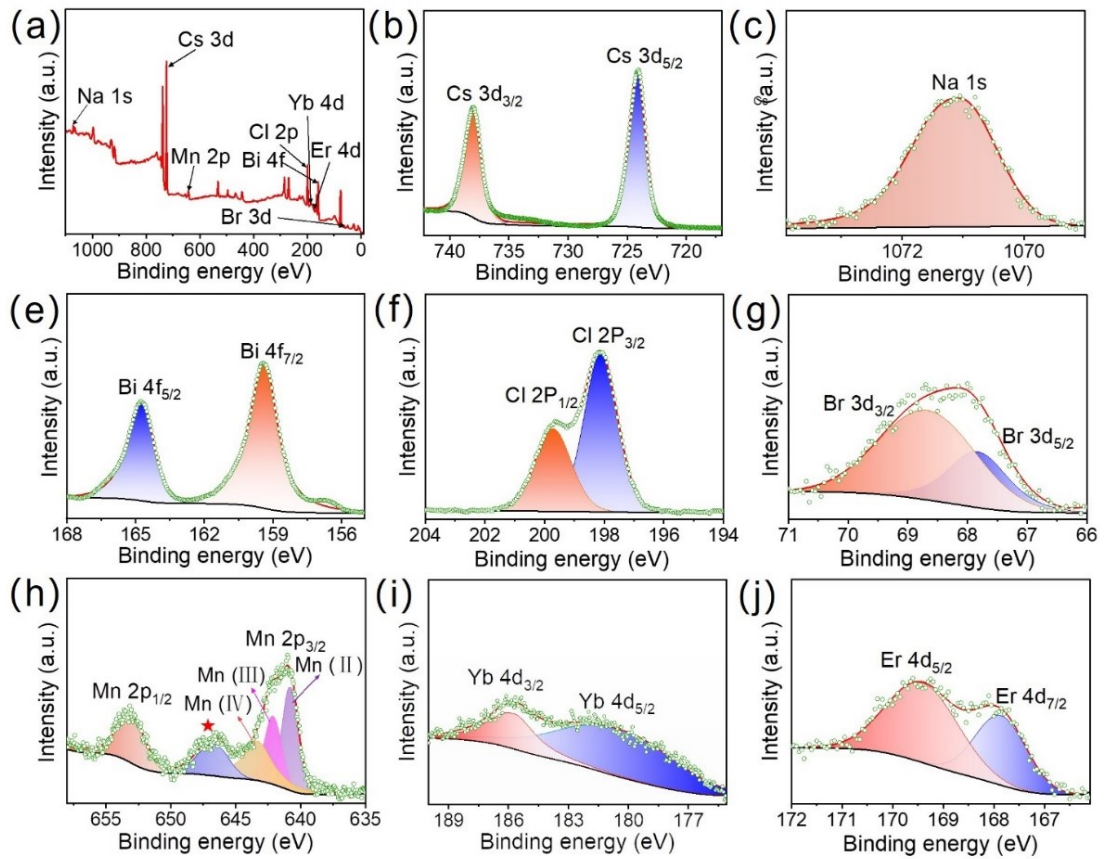


Fig. S5 XPS of CNBC: 30% Br<sup>-</sup>, 15% Mn<sup>2+</sup>, 12% Er<sup>3+</sup>, 12% Yb<sup>3+</sup> powders; (b)~(i) High-resolution XPS spectra of Cs 3d,

Na 1s, Bi 4f, Cl 2p, Br 3d, Mn 2p, Er 4d and Yb 4d.

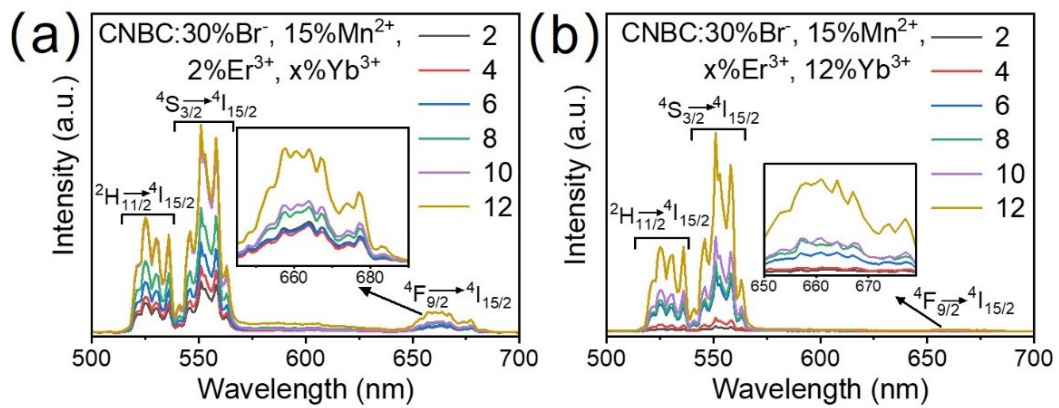


Fig. S6 PL spectra of (a) CNBC:30% Br<sup>-</sup>, 15% Mn<sup>2+</sup>, 12% Er<sup>3+</sup>, x% Yb<sup>3+</sup> (x=2-12),  $\lambda_{\text{ex}} = 980$  nm, and (b) CNBC:30% Br<sup>-</sup>,

15% Mn<sup>2+</sup>, x% Er<sup>3+</sup>, 12% Yb<sup>3+</sup> (x=2-12),  $\lambda_{\text{ex}} = 980$  nm.

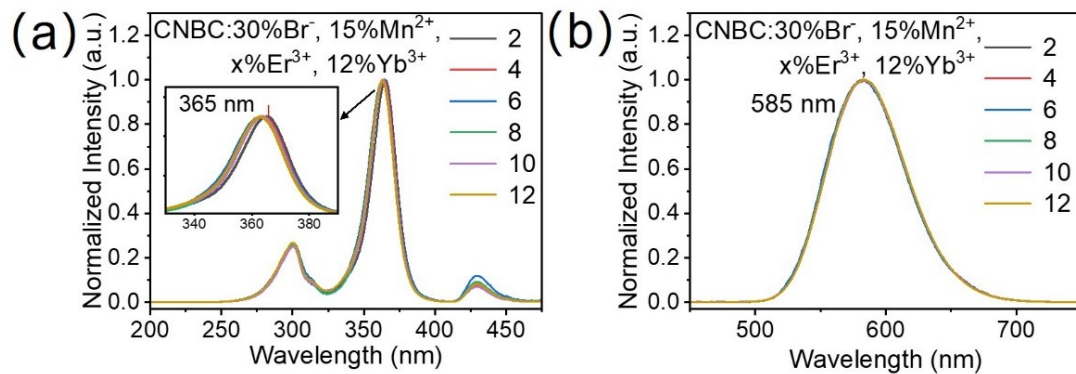


Fig. S7 (a) PLE spectrum of CNBC:30% Br, 15% Mn<sup>2+</sup>, x% Er<sup>3+</sup>, 12% Yb<sup>3+</sup> (x=2-12), monitored emission peak at 585 nm. (b) PL spectrum of CNBC:30% Br, 15% Mn<sup>2+</sup>, x% Er<sup>3+</sup>, 12% Yb<sup>3+</sup> (x=2-12),  $\lambda_{ex}$  = 365 nm.

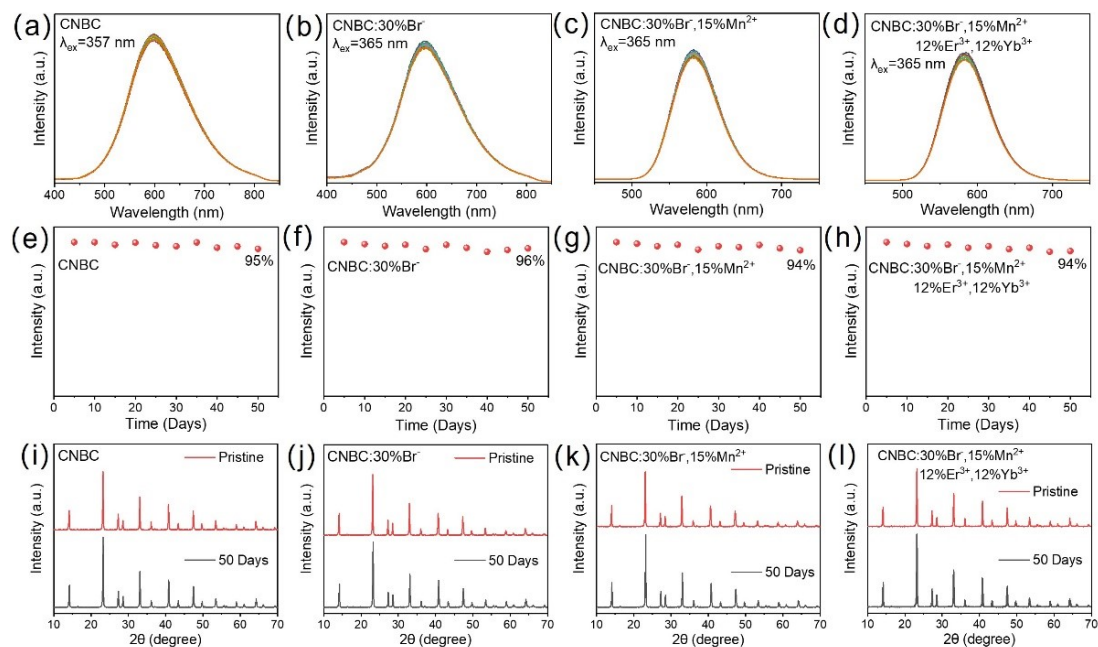


Fig. S8 Spectral stability and XRD patterns of the four different DP samples under ambient environment during 0-50 days.

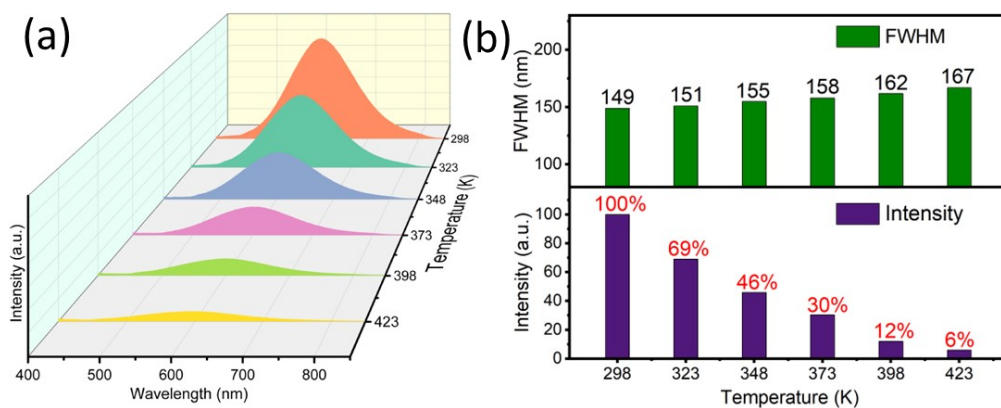


Fig. S9 (a) Temperature-dependent PL spectra of CNBC upon 357 nm excitation; (b) The corresponding FWHM and integral PL intensity.

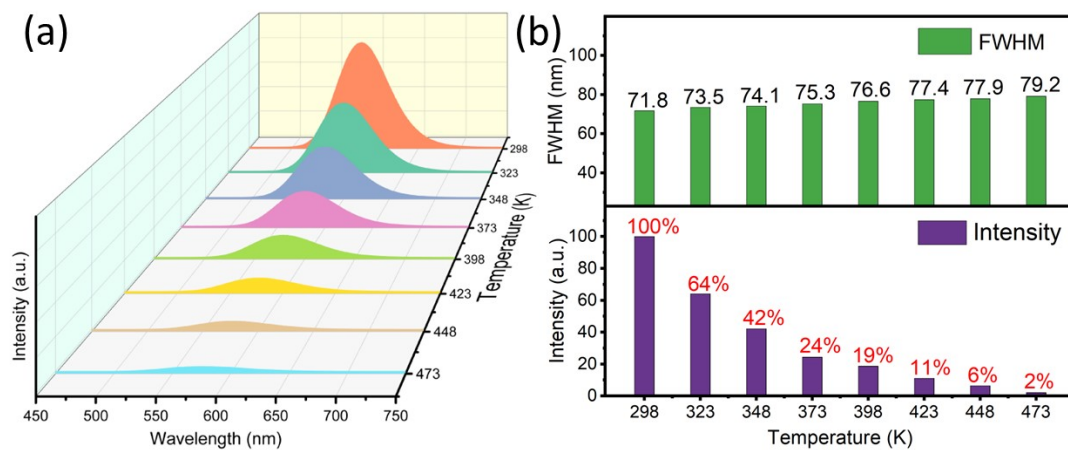


Fig. S10 (a) Temperature-dependent PL spectra of CNBC:30% Br<sup>-</sup>, 15% Mn<sup>2+</sup> upon 365 nm excitation; (b) The corresponding FWHM and integral PL intensity.