Supporting Information

The Luminescence Property of CsPb$_x$M$_{1-x}$Br$_3$ Perovskite Nanocrystals Transformed from Cs$_4$PbBr$_6$ Mediated by Various Divalent Bromide MBr$_2$ Salts

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PL decay lifetime

The PL decay curve were fitted with a triexponential function

$$A(t) = A_1 \exp\left(-\frac{t}{\tau_1}\right) + A_2 \exp\left(-\frac{t}{\tau_2}\right) + A_3 \exp\left(-\frac{t}{\tau_3}\right)$$

where $A_1$, $A_2$, and $A_3$ are time independent coefficient constants, and $t$ is time. $\tau_1$, $\tau_2$, and $\tau_3$ are decay lifetimes because of the intrinsic exciton relaxation, the interaction between excitons and phonons, and the interaction between excitons and defects, respectively.

$\tau_{\text{ave}}$, the average lifetime, can be calculated with a function

$$\tau_{\text{ave}} = \frac{A_1 \tau_1^2 + A_2 \tau_2^2 + A_3 \tau_3^2}{A_1 \tau_1 + A_2 \tau_2 + A_3 \tau_3}$$

Figure S2. PL decay curves of CsPb$_x$Zn$_{1-x}$Br$_3$ NCs synthesized at different temperature.
Table 1. Fluorescence lifetimes of CsPb$_x$Zn$_{1-x}$Br$_3$ NCs.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>70°C</th>
<th>80°C</th>
<th>90°C</th>
<th>100°C</th>
<th>130°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Time(ns)</td>
<td>5.04</td>
<td>4.79</td>
<td>4.33</td>
<td>4.31</td>
<td>4.70</td>
</tr>
</tbody>
</table>

Figure S2. XPS spectra for CsPb$_x$Eu$_{1-x}$Br$_3$ NCs. (a–d) The high-resolution XPS analysis corresponding to Cs 3d, Pb 4f, Eu 3d and Br 3d, respectively.

Figure S3. XPS spectra for CsPb$_x$Zn$_{1-x}$Br$_3$ NCs. (a–d) The high-resolution XPS analysis corresponding to Cs 3d, Pb 4f, Zn 2p and Br 3d, respectively.
Figure S4. XPS spectra for CsPb$_x$Mn$_{1-x}$Br$_3$ NCs. (a–d) The high-resolution XPS analysis corresponding to Cs 3d, Pb 4f, Mn 2p and Br 3d, respectively.

Figure S5. EDS element mapping images of CsPb$_x$Zn$_{1-x}$Br$_3$ NCs. (a–e) Images of Cs, Pb, Zn and Br.

(a) (b) (c) (d) (e)
Figure S6. EDS element mapping images of CsPb$_{x}$Mn$_{1-x}$Br$_3$ NCs. (a-e) images of Cs, Pb, Mn and Br.

Figure S7. EDS element mapping images of CsPb$_{x}$Eu$_{1-x}$Br$_3$ NCs. (a-e) images of Cs, Pb, Eu and Br.
Table S2. Substitution rates for lead ions in CsPb$_{1-x}$M$_x$Br$_3$ NCs

<table>
<thead>
<tr>
<th></th>
<th>Cs+ (%)</th>
<th>Pb$^{2+}$ (%)</th>
<th>M$^{2+}$ (%)</th>
<th>Br (%)</th>
<th>M$^{2+}$/ (Pb$^{2+}$+M$^{2+}$) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CsPb$_{1-x}$Mn$_x$Br$_3$</td>
<td>1.99</td>
<td>0.51</td>
<td>1.57</td>
<td>8.9</td>
<td>75.48</td>
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<tr>
<td>CsPb$_{1-x}$Eu$_x$Br$_3$</td>
<td>12.09</td>
<td>6.61</td>
<td>7.04</td>
<td>7.16</td>
<td>51.58</td>
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<tr>
<td>CsPb$_{1-x}$Zn$_x$Br$_3$</td>
<td>3.17</td>
<td>0.45</td>
<td>1.94</td>
<td>12.57</td>
<td>81.17</td>
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