

## SUPPORTING INFORMATION

# Broadband Emitting 2D-Hybrid Organic Inorganic Perovskite Based on Cyclohexane-*bis*(methylamonium) Cation

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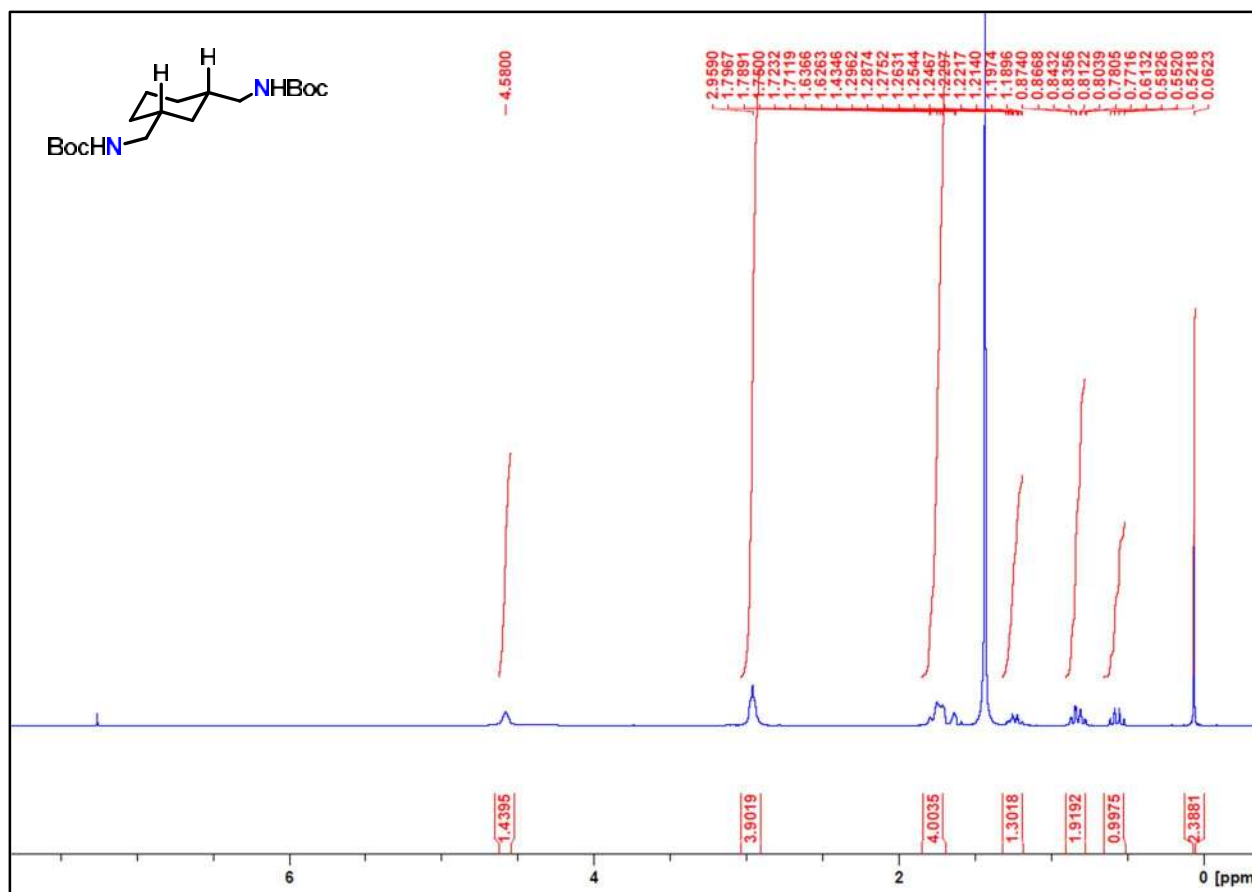
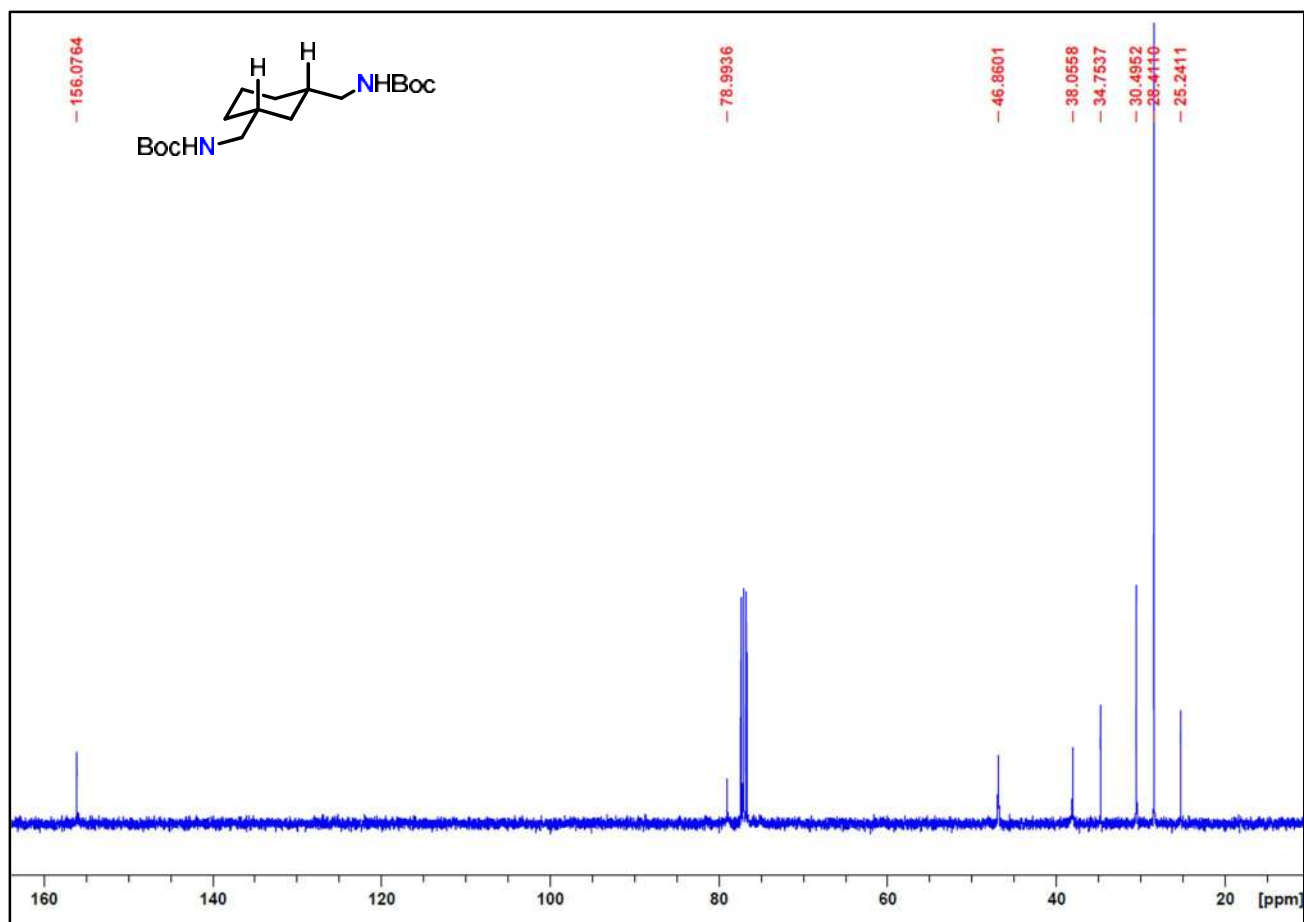
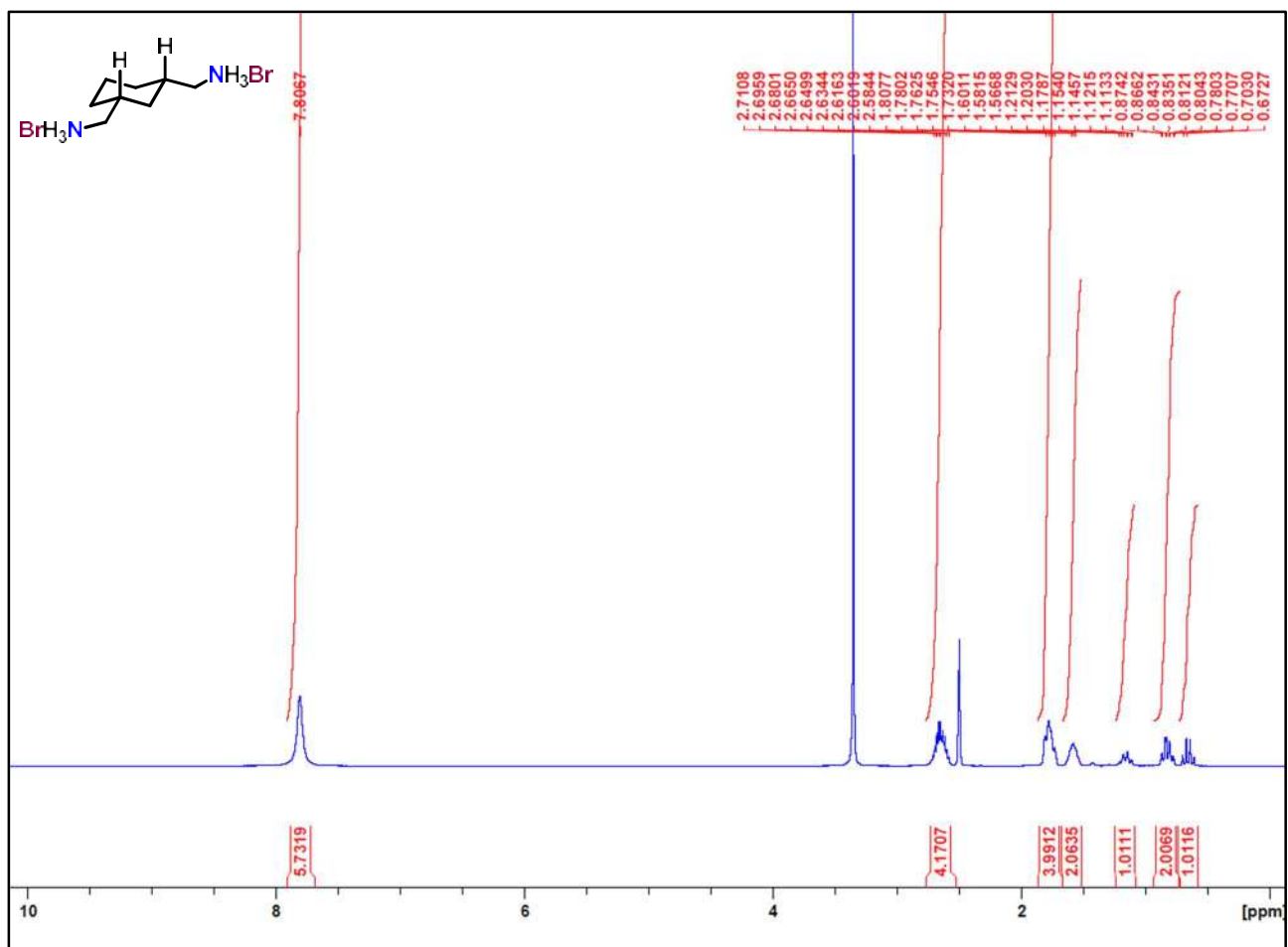


Figure S1. <sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of cis-(CyB-NH-Boc).



**Figure S2:** <sup>13</sup>C NMR spectrum (100 MHz, CDCl<sub>3</sub>) of cis-(CyB-NH-Boc).



**Figure S3.** <sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of cis-(CyBMABr).

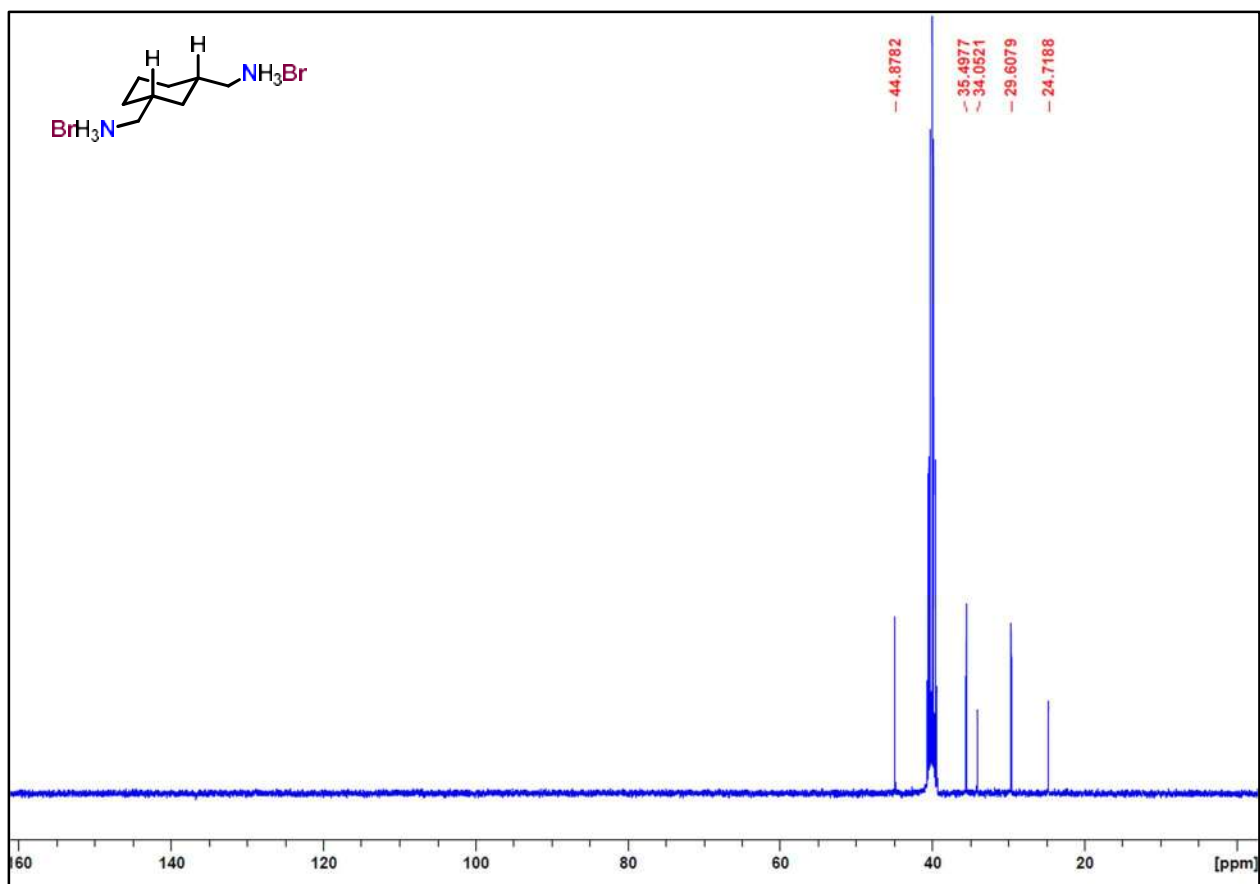


Figure S4.  $^{13}\text{C}$  NMR spectrum (100 MHz,  $\text{CDCl}_3$ ) of *cis*-(CyBMABr).

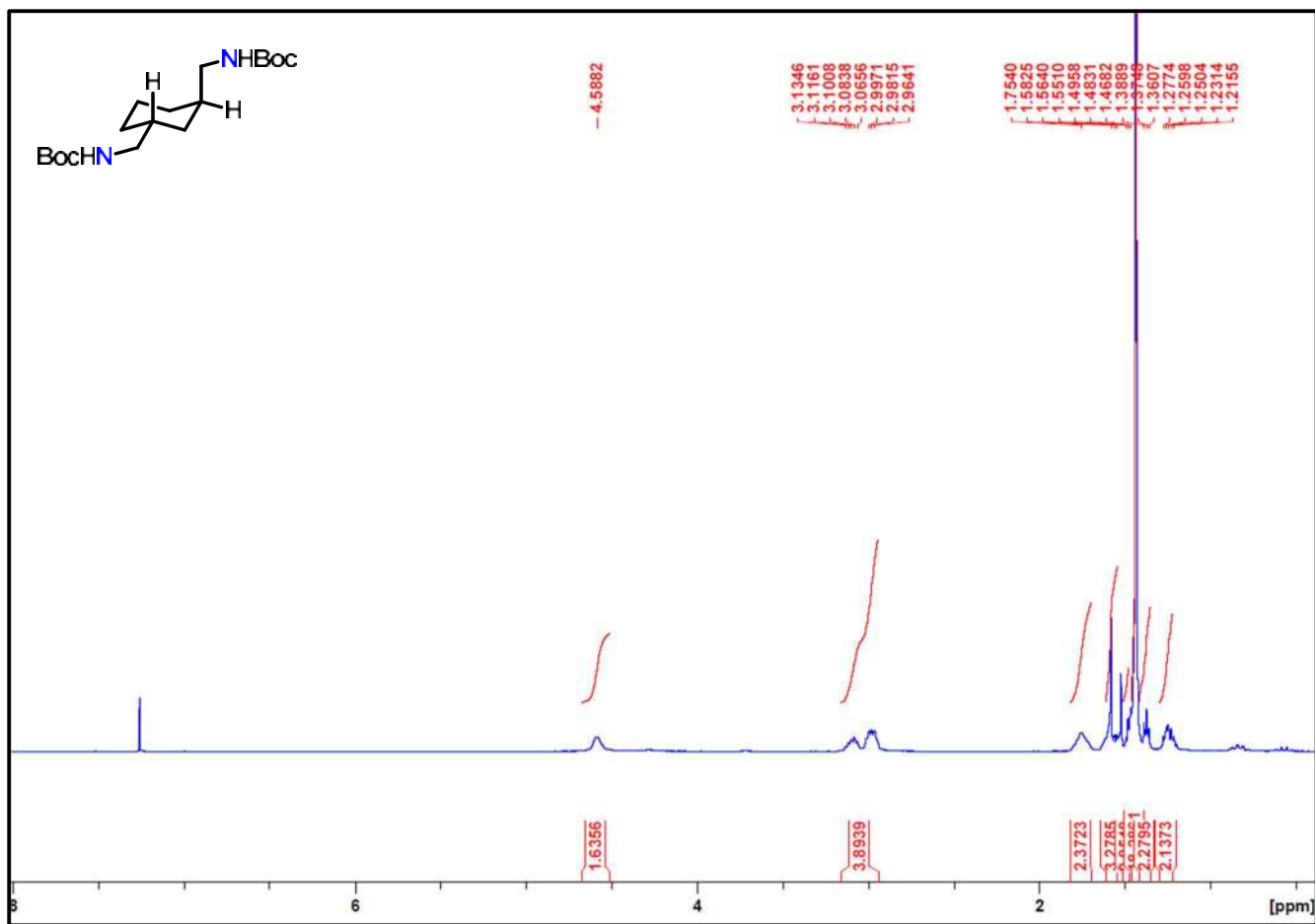
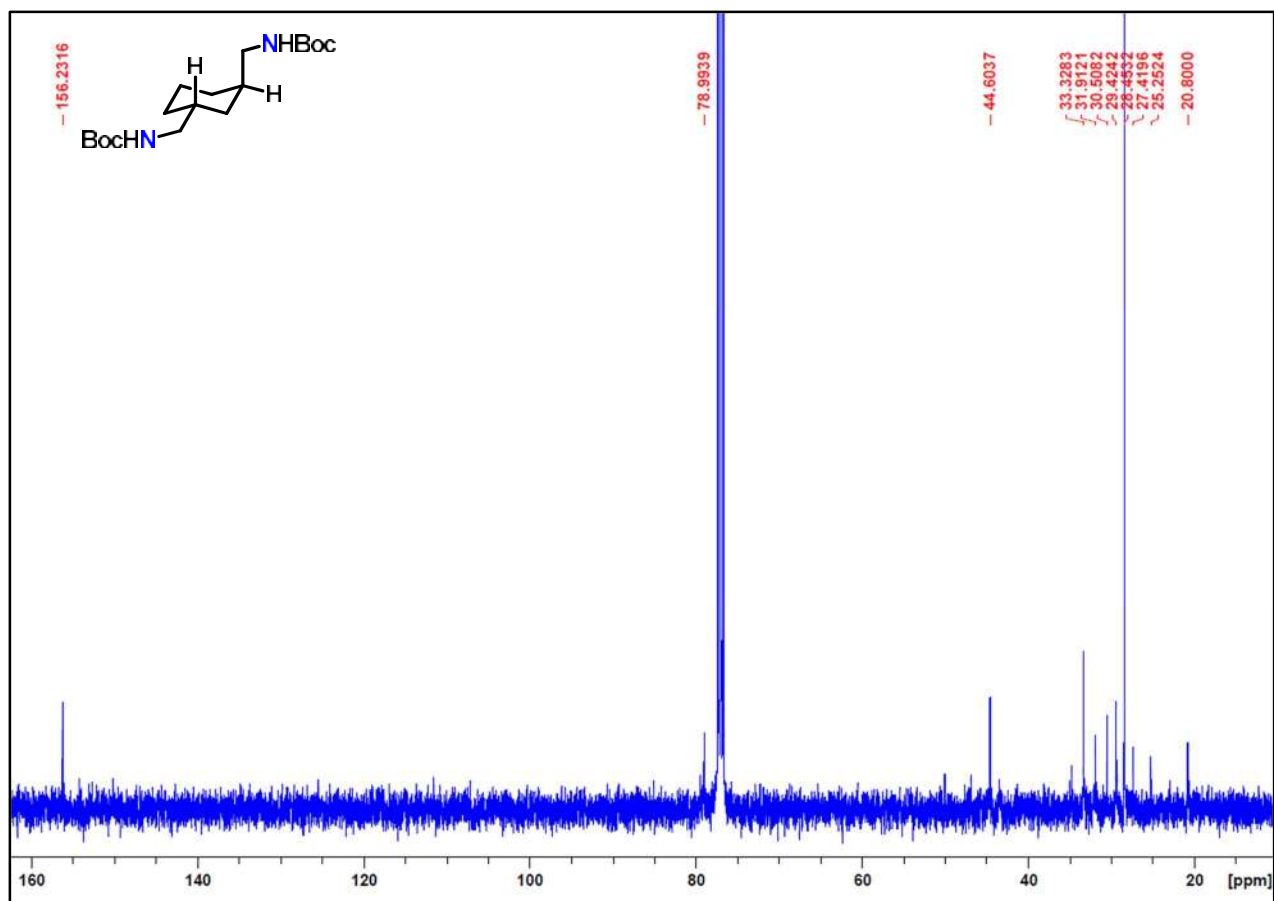


Figure S5. <sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of trans-(CyB-NH-Boc).



**Figure S6.** <sup>13</sup>C NMR spectrum (100 MHz, CDCl<sub>3</sub>) of trans-(CyB-NH-Boc).

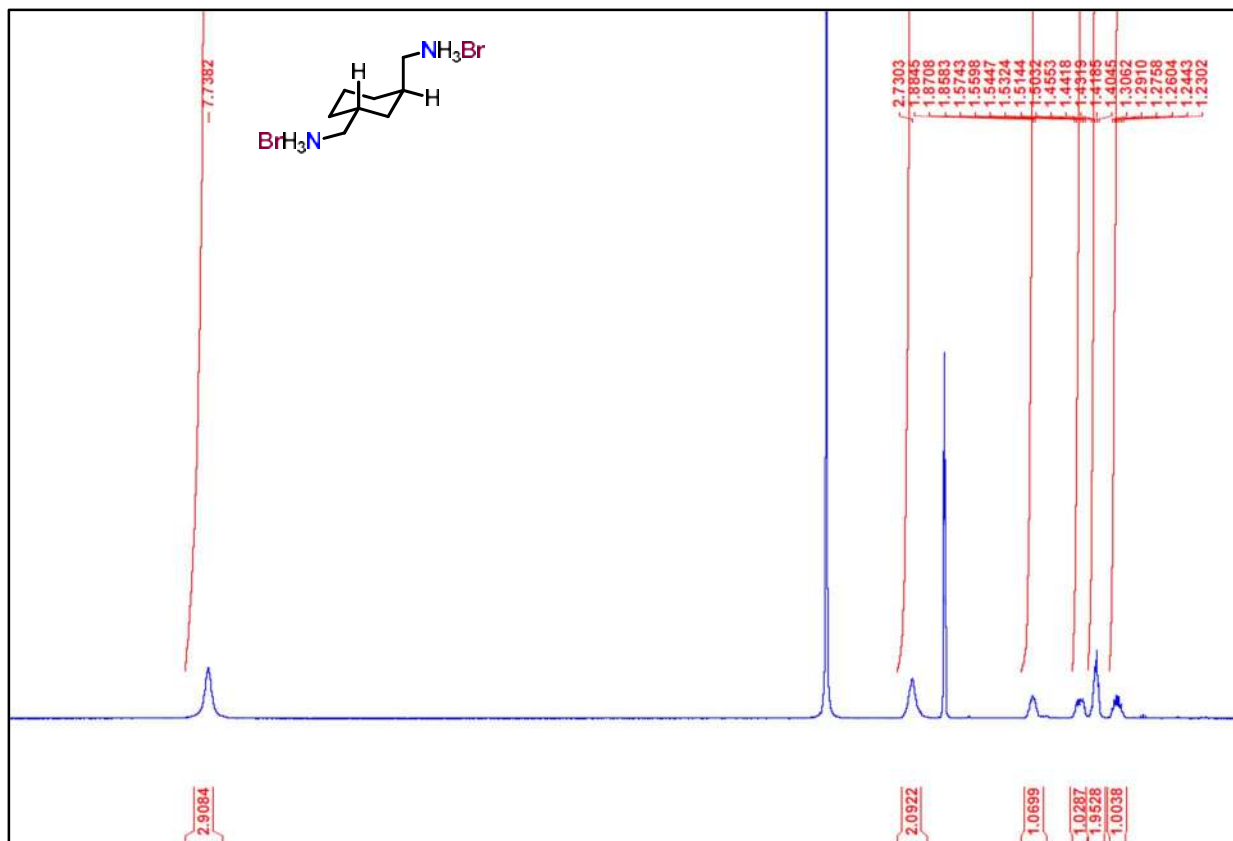


Figure S7. <sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of trans-(CyBMABr).



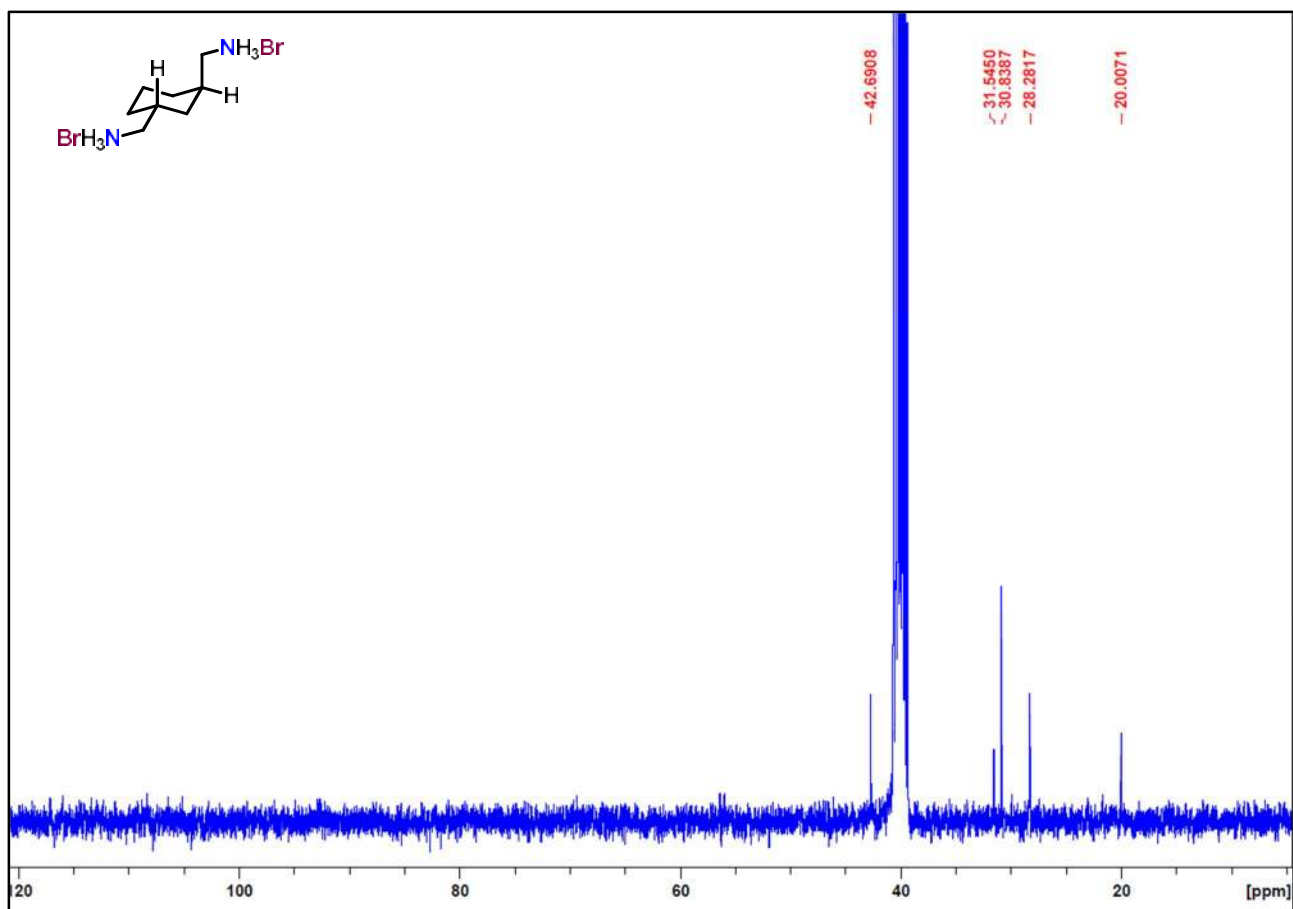
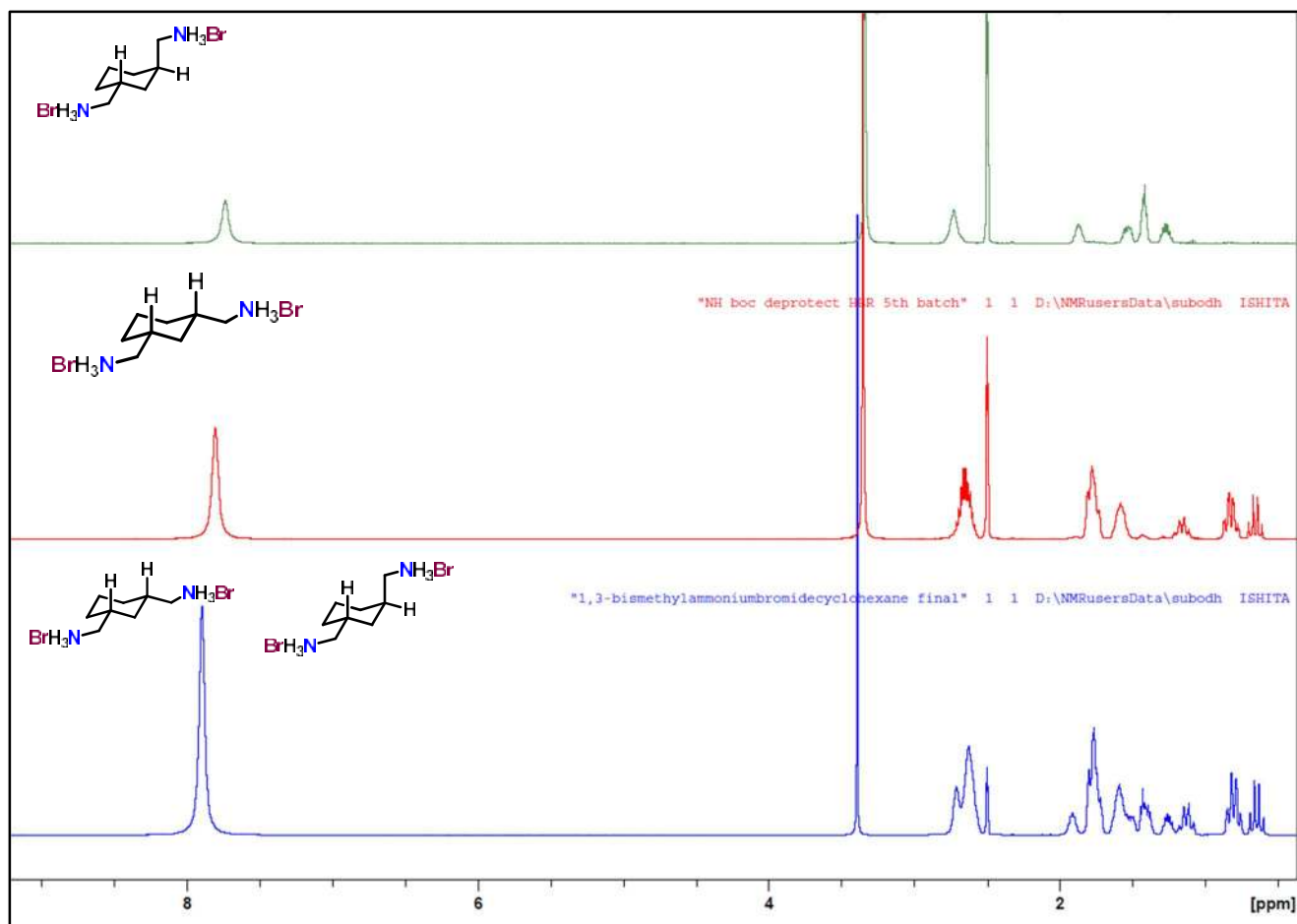
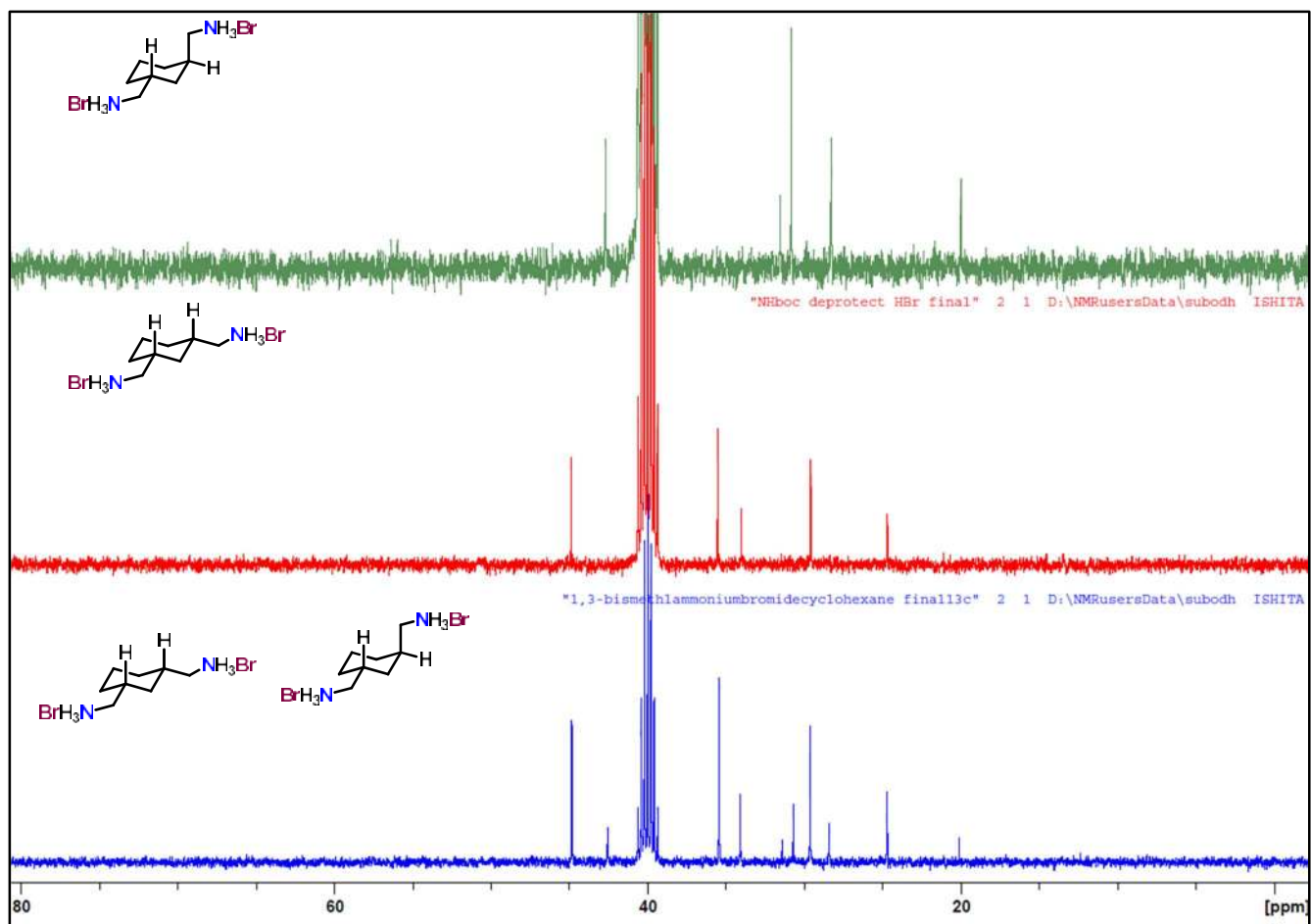


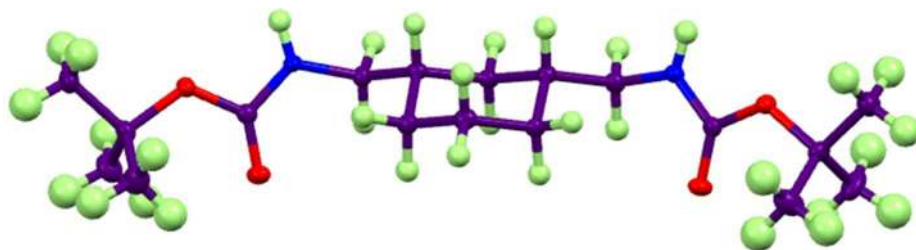
Figure S8:  $^{13}\text{C}$  NMR spectrum (100 MHz,  $\text{CDCl}_3$ ) of *trans*-(CyBMABr).



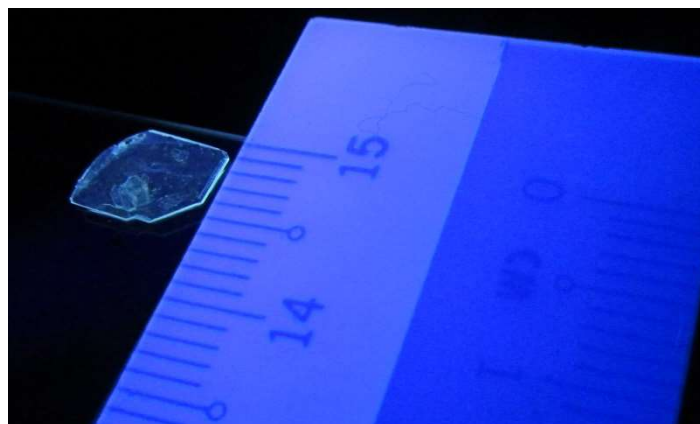
**Figure S9.** <sup>1</sup>H NMR overlay spectrum (400 MHz, CDCl<sub>3</sub>) of cis, trans-(CyBMABr), cis-(CyBMABr), trans-(CyBMABr).



**Figure S10.**  $^{13}\text{C}$  NMR overlay spectrum (100 MHz,  $\text{CDCl}_3$ ) of *cis*, *trans*-(CyBMABr), *cis*-(CyBMABr), *trans*-(CyBMABr).



**Figure S11.** X-ray crystal structure of cis-(CyB-NH-Boc).



**Figure S12.** Photograph of (CyBMA)PbBr<sub>4</sub>, 2D-crystal (5mm × 5mm × 0.08mm).

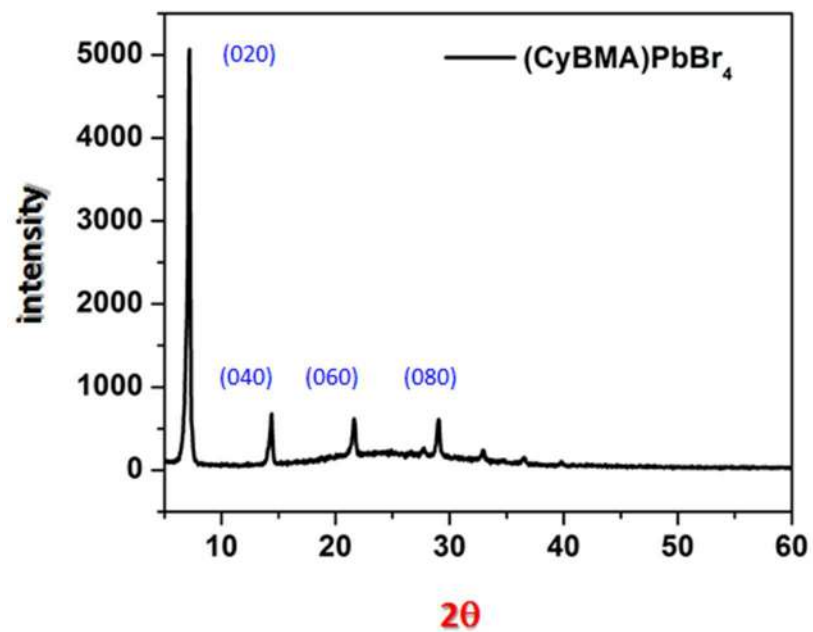


Figure S13. X-ray diffraction pattern of the (CyBMA)PbBr<sub>4</sub> spin coated film.

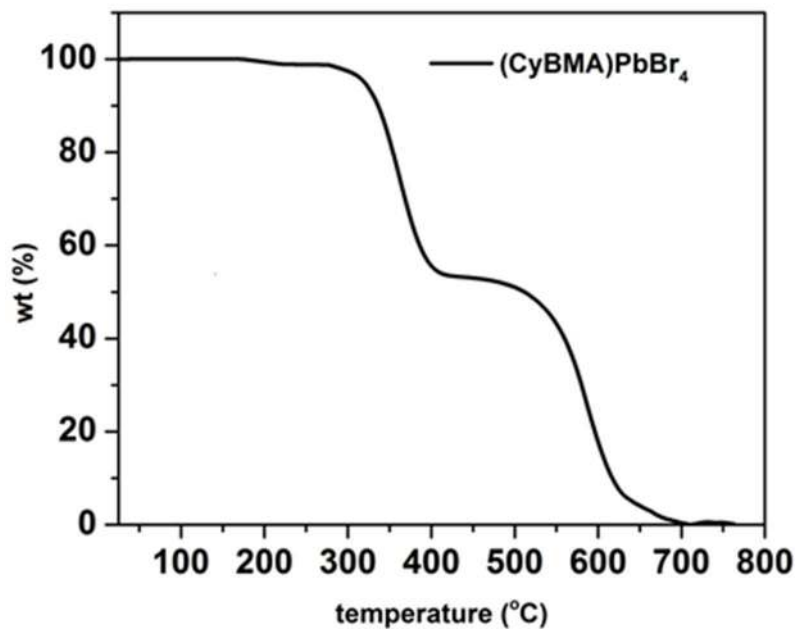
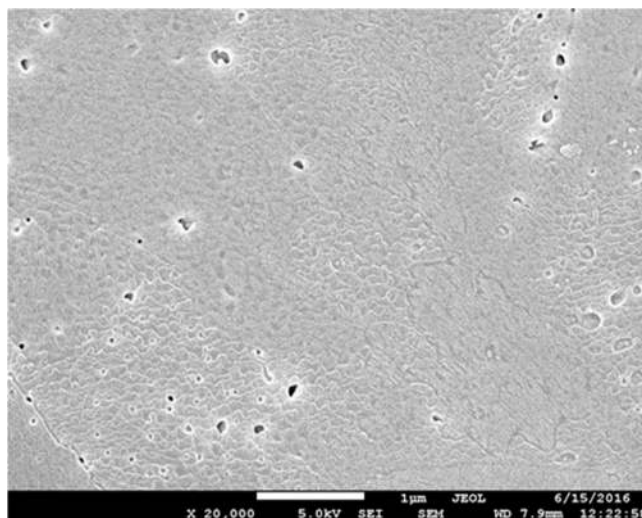


Figure S14. (CyBMA)PbBr<sub>4</sub> crystal thermal gravimetric analysis (TGA) plot.



**Figure S15.** SEM image the (CyBMA)PbBr<sub>4</sub> spin coated film of on a quartz substrate.



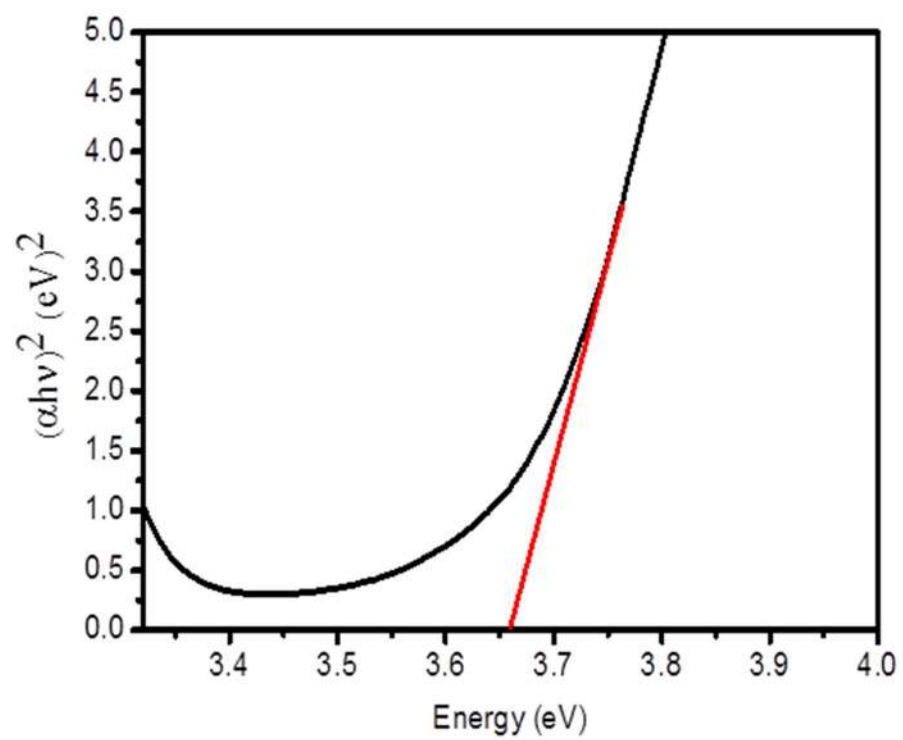
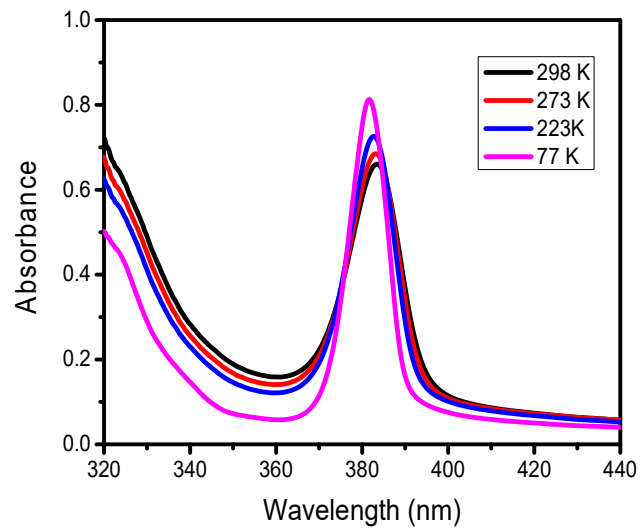
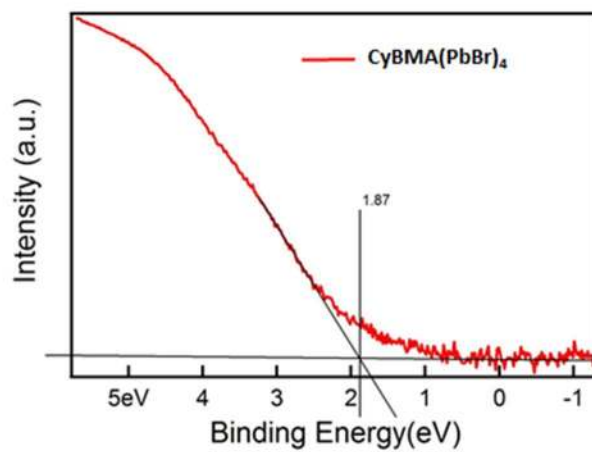
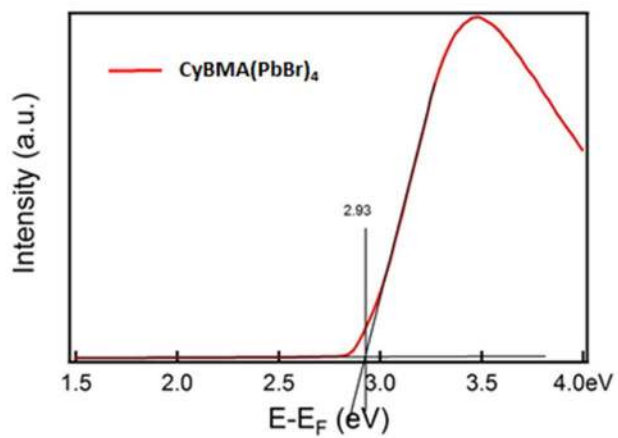


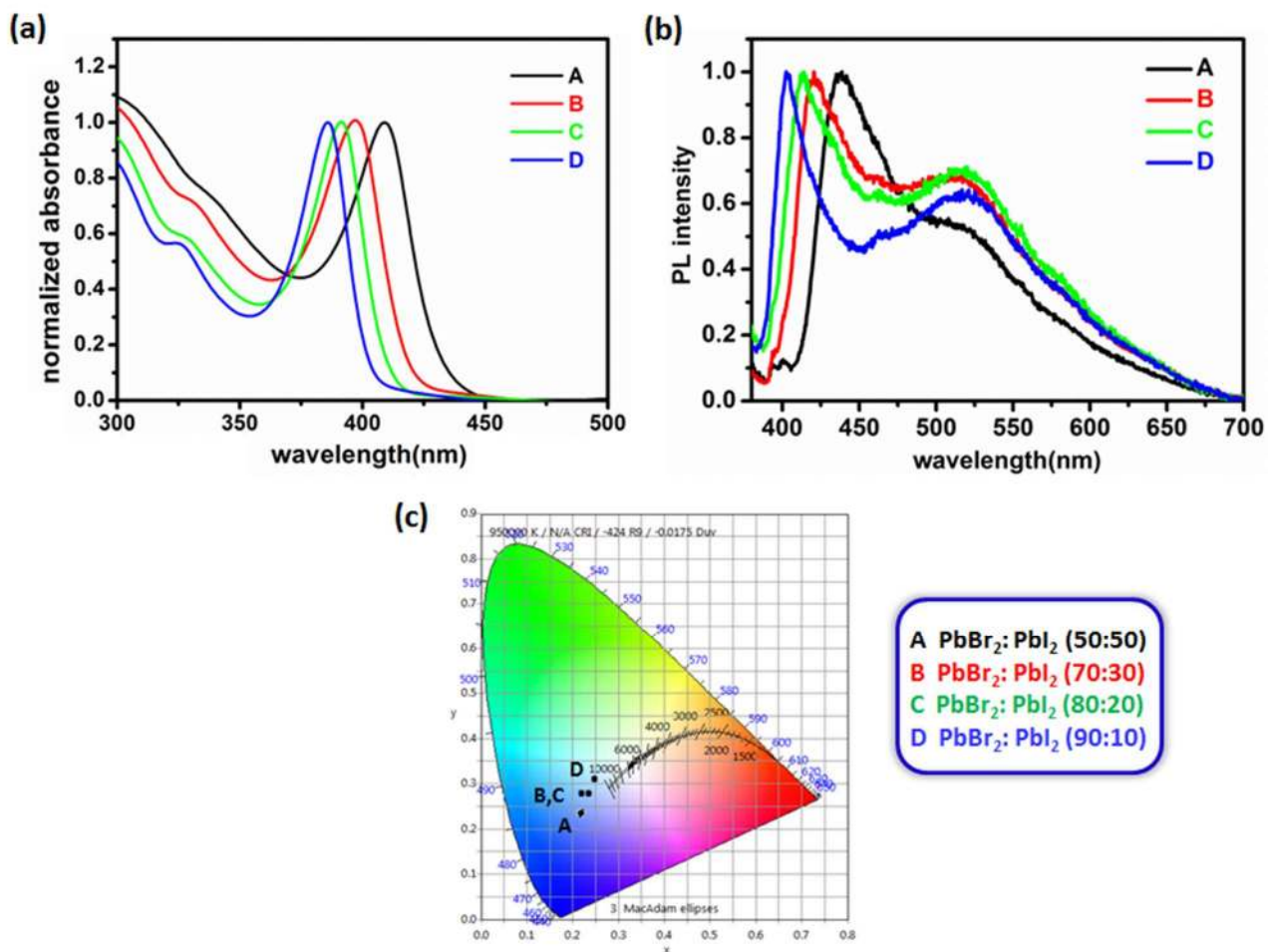
Figure S16. (CyBMA)PbBr<sub>4</sub> film Tauc plot



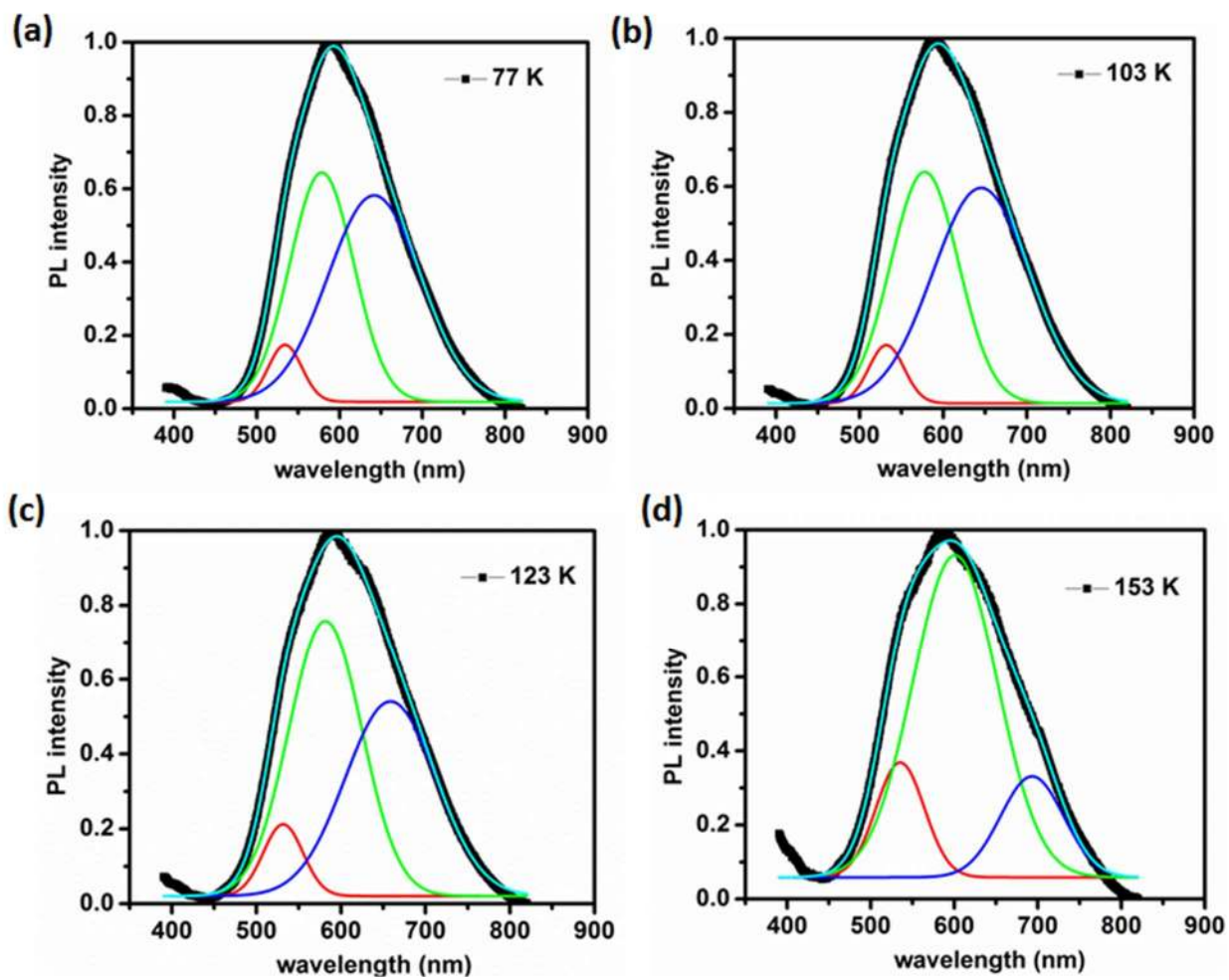
**Figure S17.** CyBMA)PbBr<sub>4</sub> temperature dependent UV-Vis spectra



**Figure S18.** (CyBMA)PbBr<sub>4</sub> Ultraviolet photoelectron spectroscopy (UPS) spectra.



**Figure S19.** (a) Uv-Vis spectra, (b) PL spectra, (c) 1931 chromaticity coordinates for the mixed- halide compositions of (CyBMA)PbBr<sub>4</sub>.



**Figure S20.** Gaussian fittings for the B-band of (CyBMA)PbBr<sub>4</sub> at different temperatures, (a) at 77 K, (b) 103 K, (c) 123 K and (d) 153K.

**Table S1.** *cis*-(CyB-NH-Boc). Structural data

<b>Structural Parameters</b>	<b><i>cis</i>-(CyB-NH-Boc).</b>
Molecular formula	C <sub>8</sub> H <sub>20</sub> Br <sub>4</sub> N <sub>2</sub> Pb
formula weight	342.47
Crystal system	monoclinic
Space group	<i>P</i> 1 21/ <i>c</i> 1
<i>a</i> (Å)	15.990(4)
<i>b</i> (Å)	10.027(2)
<i>c</i> (Å)	12.774(3)
$\alpha$ (deg)	90.00
$\beta$ (deg)	103.894(4)
$\gamma$ (deg)	90.00
Volume (Å <sup>3</sup> )	1988.2(8)
<i>Z</i>	4
Calculated density (mg/m <sup>3</sup> )	1.144
absorption coefficient (mm <sup>-1</sup> )	0.080
<i>F</i> (000)	752
goodness-of-fit on <i>F</i> <sup>2</sup>	1.001
Final <i>R</i> indices [ <i>I</i> > 2 $\sigma$ ( <i>I</i> )]	<i>R</i> <sub>1</sub> = 0.0753 <i>wR</i> <sub>2</sub> = 0.1637
<i>R</i> indices (all data)	<i>R</i> <sub>1</sub> = 0.1304 <i>wR</i> <sub>2</sub> = 0.1912

**Table S2.** (CyBMA)PbBr<sub>4</sub> crystal data at various temperatures.

<b>Structural Parameters of (CyBMA)PbBr<sub>4</sub></b>	<b>298 K</b>	<b>173 K</b>	<b>103 K</b>
Crystal system	orthorhombic	orthorhombic	orthorhombic
<i>a</i> (Å)	8.5661	8.5255	8.5019
<i>b</i> (Å)	24.4566	24.3482	24.3306
<i>c</i> (Å)	7.9791	7.9378	7.9451
$\alpha$ (deg)	90.00	90.00	90.00
$\beta$ (deg)	90.00	90.00	90.00
$\gamma$ (deg)	90.00	90.00	90.00