

Supporting Information

“Structural Characterization and Room Temperature Low Frequency Raman Scattering from MAPbI₃ Halide Perovskite Films Rigidized by Cesium Incorporation”

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The Cs ion concentrations in the MAPbI₃ thin films are calculated by EDAX. The absolute numbers were calculated by using three model system by assuming we have CsPbI₃, MAPbI₃ and MA_{1-x}Cs_xPbI₃.

Table S 1: Absolute number (% Cs) MA_{1-x}Cs_xPbI₃ calculated for different dipping time.

Cs doping	Dipping time (min)	Absolute number (% Cs) MA _{1-x} Cs _x PbI ₃
MAPbI ₃	0	0
Doping 1	1	0.05
Doping 2	3	0.24
Doping 3	9	0.33
Doping 4	16	0.59
Doping 5	28	0.60
Doping 6	40	0.80

Calculations

By considering three phase model systems, we assume the presence of three different phases in our system; namely MAPbI₃, MA_{1-x}Cs_xPbI₃ and CsPbI₃, which subsequently change with Cs doping. The MA and Cs ions are only the variable elements in the measurements. EDAX errors not included considering errors are same for all measurements. By solving three equations for each EDAX measurement, we estimate the amount of Cs doping in the MAPbI₃ material.

Considering Cs = x and MA = y and NSi = Constant (other element) we use the following relation to calculate the atomic percentage.

- 1) Atomic percentage of Cs = $\frac{y}{(4 + 2x + y + \text{Nsi})} + \frac{1}{5 + \text{Nsi}}$
- 2) Atomic percentage of Pb = $\frac{3}{2x + y + 15 + \text{Nsi}}$
- 3) X+Y= 1

EDAX reports of different samples are given below.

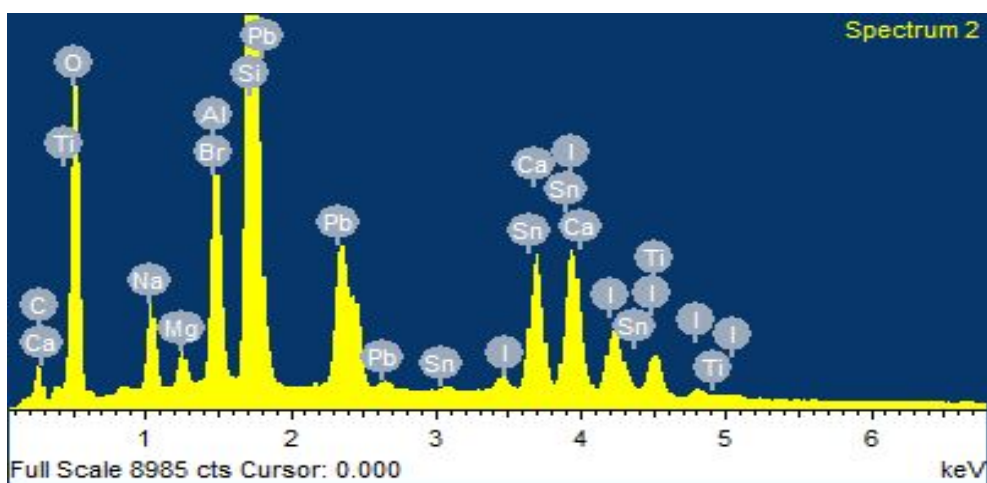


Figure S 1 EDAX Spectrum of MAPbI₃ Sample

Table S 2EDAX data of MAPbI₃ sample

Element	Weight%	Atomic%
C K	7.66	16.79
O K	28.40	46.77
Na K	2.94	3.37
Mg K	0.89	0.96
Al K	4.07	3.98
Si K	20.15	18.90
Ca K	4.86	3.20
Ti K	1.09	0.60
Br L	1.08	0.36
Sn L	1.15	0.25
I L	16.19	3.36
Pb M	11.52	1.46
Totals	100.00	

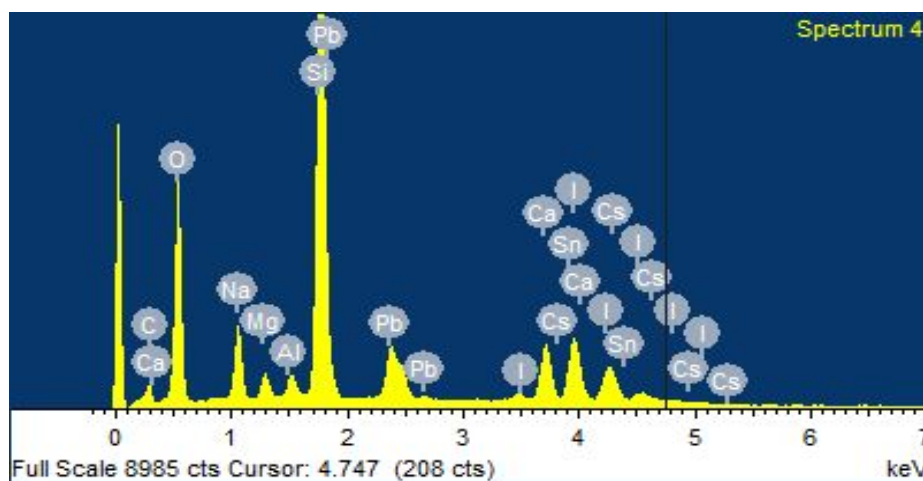


Figure S 2 EDAX Spectrum of Cs doped MAPbI₃ Sample (doping 1)

Table S 3 EDAX data of Cs doped MaPbI₃ (doping 1)

Element	Weight%	Atomic%
C K	10.68	17.53
O K	40.16	55.11
Na K	5.61	5.36
Mg K	1.37	1.24
Al K	0.87	0.71
Si K	20.18	15.77
Ca K	2.90	1.59
Sn L	0.73	0.13
I L	10.10	1.75
Cs L	0.47	0.08
Pb M	6.93	0.73
Totals	100.00	

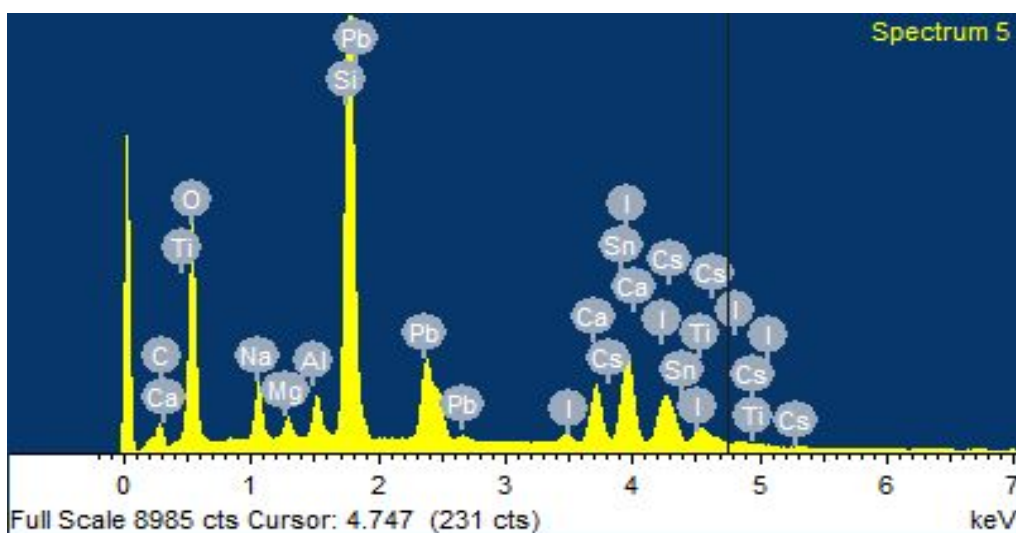


Figure S 3EDAX Spectrum of Cs doped MAPbI₃ Sample (doping 2)

Table S 4 EDAX Data of Cs doped MAPbI₃ (doping 2)

Element	Weight%	Atomic%
C K	9.48	17.33
O K	40.16	54.99
Na K	5.61	5.26
Mg K	1.37	1.34
Al K	0.87	0.71
Si K	20.48	15.47
Ca K	2.60	1.89
Sn L	0.93	0.10
I L	9.90	1.78
Cs L	1.87	0.28
Pb M	6.73	0.85
Totals	100.00	

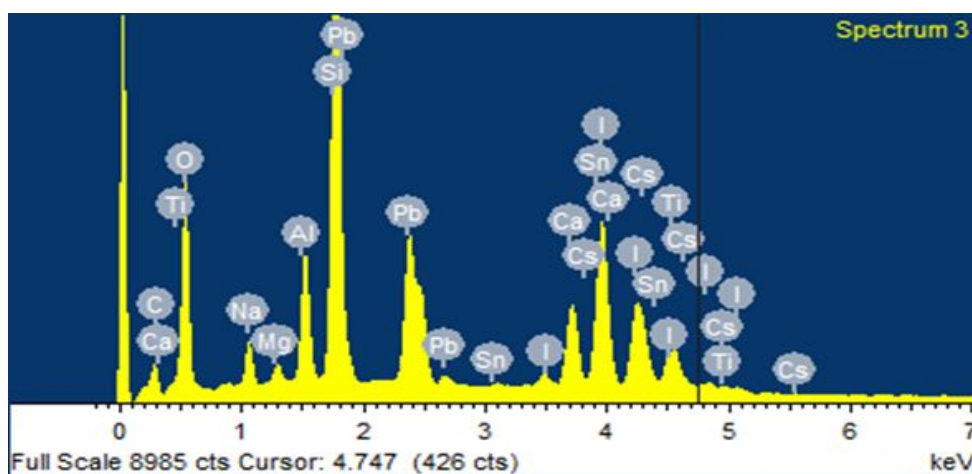


Figure S 4 EDAX Spectrum of Cs doped MAPbI₃ Sample (doping 3)

Table S 5 EDAX data of Cs doped MAPbI₃

Element	Weight%	Atomic%
C K	9.09	20.55
O K	28.20	47.60
Na K	2.60	3.05
Mg K	0.73	0.81
Al K	3.97	3.98
Si K	15.50	15.05
Ca K	3.07	2.07
Ti K	0.96	0.54
Sn L	0.86	0.20
I L	18.71	3.98
Cs L	2.50	0.38
Pb M	13.81	1.80
Totals	100.00	

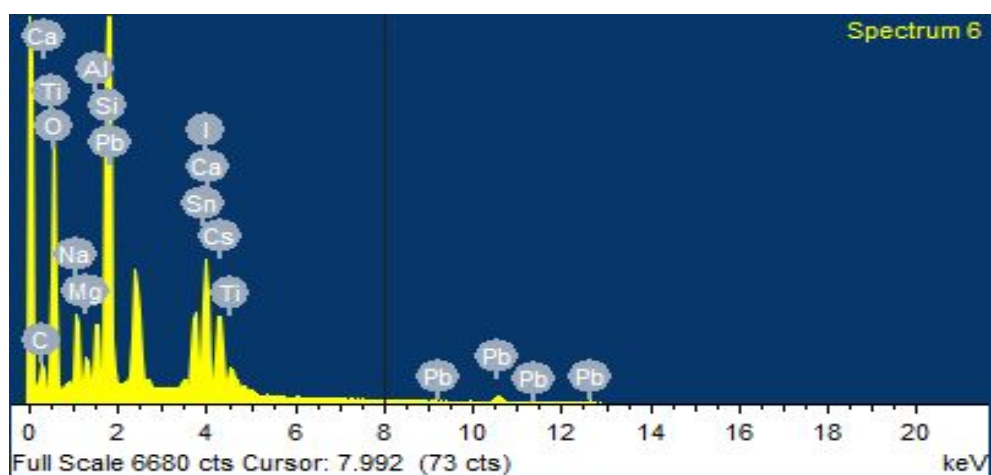


Figure S 5 EDAX Spectrum of Cs doped MAPbI₃ Sample (doping 4)

Table S 6 EDAX data of Cs doped MAPbI₃ (doping 4)

Element	Weight%	Atomic%
C K	8.72	17.76
O K	34.65	52.98
Na K	4.02	4.27
Mg K	1.12	1.13
Al K	1.68	1.52
Si K	18.10	15.76
Ca K	2.75	1.74
Ti K	0.35	0.18
Sn L	0.82	0.17
I L	14.15	2.73
Cs L	3.16	0.64
Pb M	10.47	1.24
Totals	100.00	

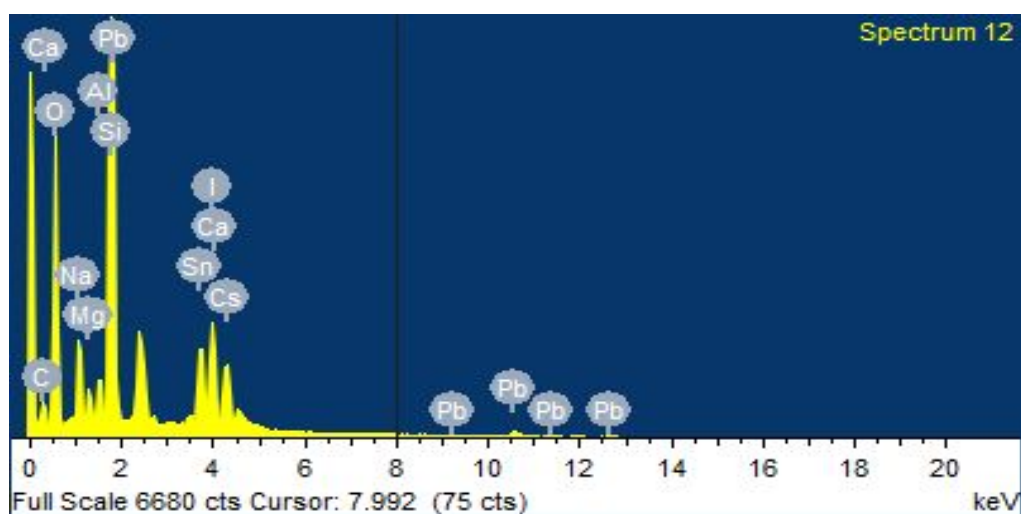


Table S 7 EDAX data of Cs doped MAPbI3 (doping 5)

Figure S 6 EDAX Spectrum of Cs doped MAPbI3 Sample (doping 5)

Element	Weight%	Atomic%
C K	8.56	16.62
O K	37.56	54.77
Na K	4.65	4.85
Mg K	1.17	1.12
Al K	1.20	1.04
Si K	19.09	16.17
Ca K	2.91	1.69
Sn L	0.82	0.16
I L	12.28	2.22
Cs L	3.20	0.66
Pb M	8.56	0.96
Totals	100.00	

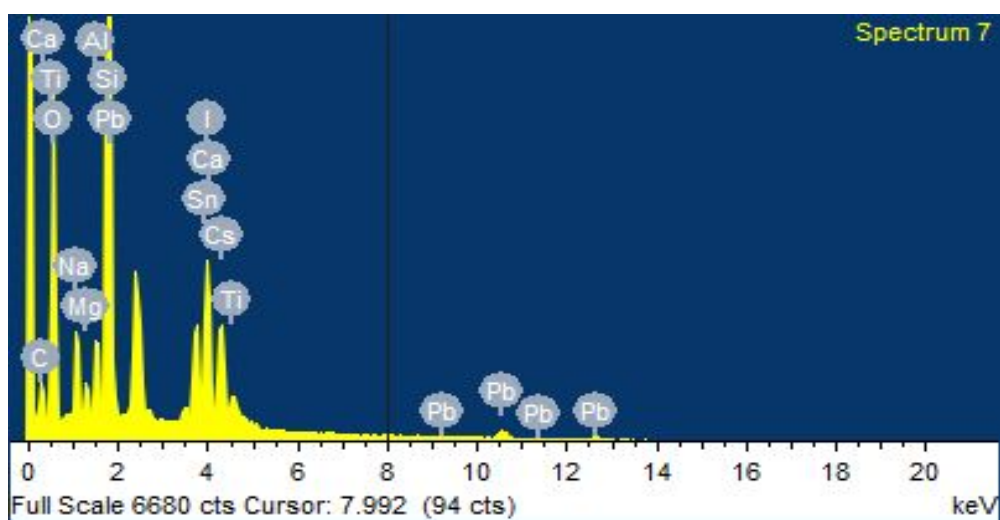


Figure S 7 EDAX Spectrum of Cs doped MAPbI3 Sample (doping 6)

Table S 8 EDAX data of MaPbI3 (Doping 6)

Element	Weight%	Atomic%
C K	10.00	20.20
O K	34.10	51.71
Na K	3.77	3.98
Mg K	0.98	0.98
Al K	1.64	1.23
Si K	17.49	15.11
Ca K	2.62	1.59
Ti K	0.44	0.22
Sn L	0.84	0.17
I L	14.04	2.68
Cs L	3.70	0.91
Pb M	10.38	1.22
Totals	100.00	

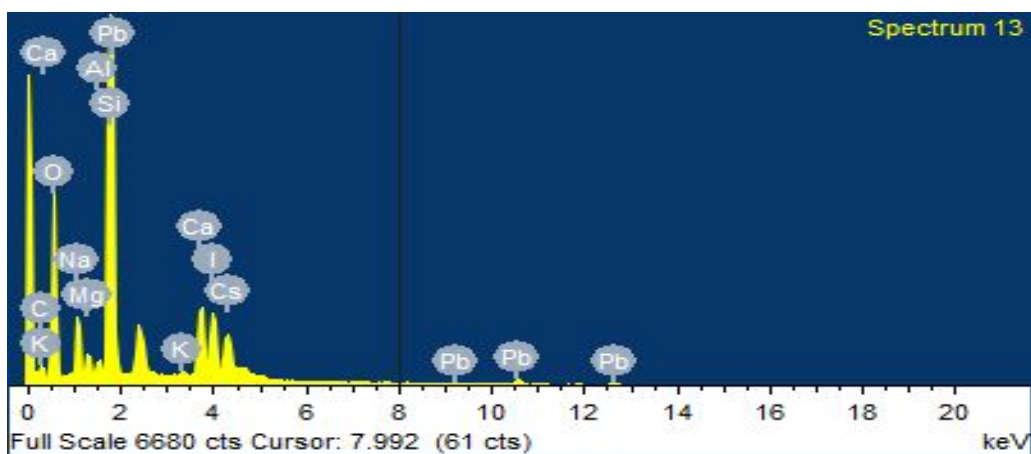


Figure S 8 EDAX Spectrum of Cs doped CsPbI₃ Sample

Table S 9 EDAX data of CsPbI₃

Element	Weight%	Atomic%
C K	8.44	16.10
O K	36.55	52.33
Na K	4.62	4.60
Mg K	1.20	1.13
Al K	0.48	0.41
Si K	24.40	19.27
K K	0.25	0.15
Ca K	3.97	2.27
I L	9.00	1.74
Cs L	4.2	1.24
Pb M	6.89	0.76
Totals	100.00	