

Optical and electronic properties of mixed halide (X = I, Cl, Br) methylammonium lead perovskite solar cells.

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SUPPORTING INFORMATION

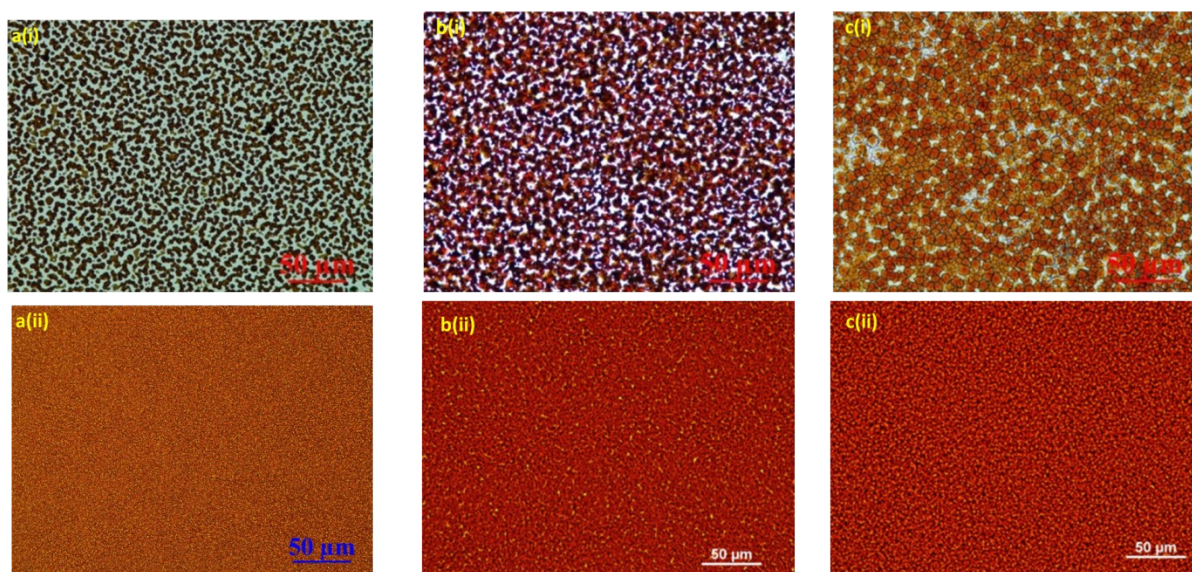
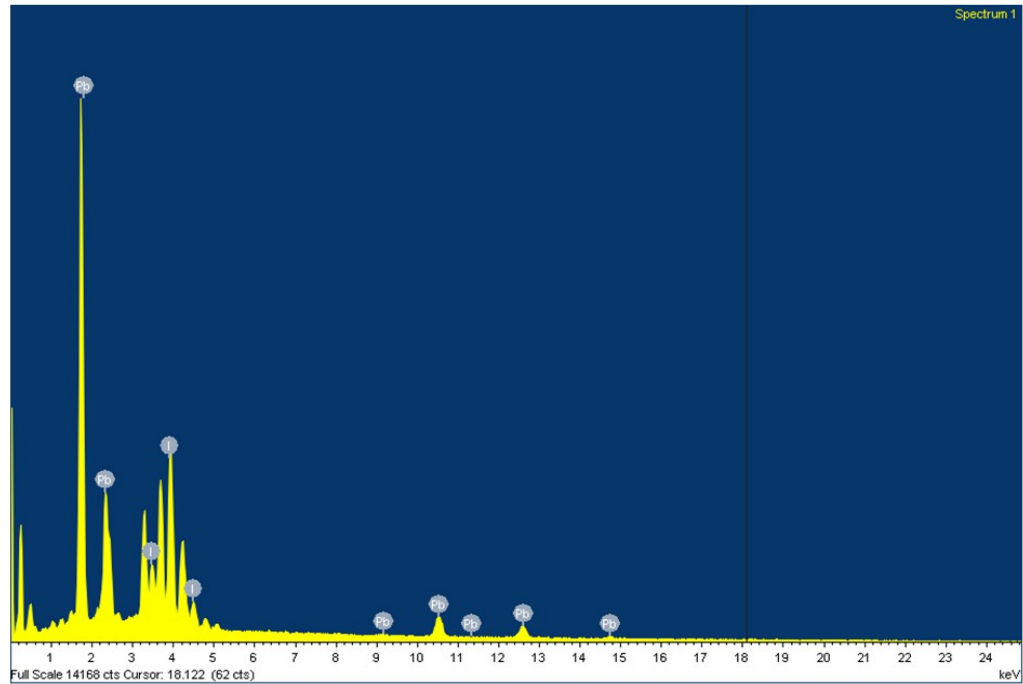


Figure S1: Diascopic illumination optical microscopy images on (i) Glass/ITO and on (ii) Glass/ITO/ PEDOT.PSS of (a) MAPbI₃, (b) MAPbI_{3-x}Cl_x and (c) MAPbI_{3-x}Br_x.

a)



b)

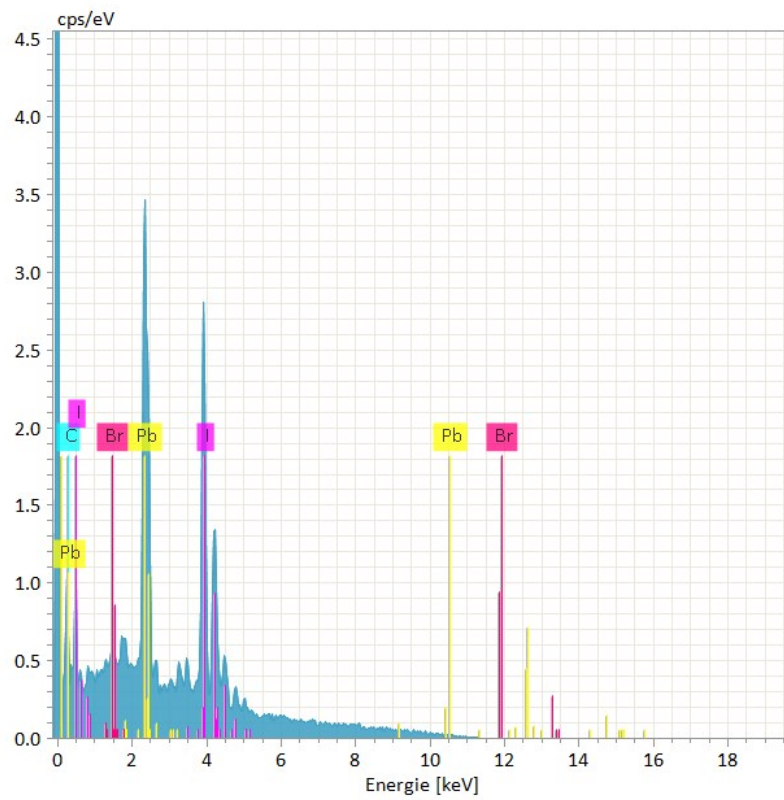


Figure S2: a) EDX spectra of thin film of perovskite ($\text{MAPbI}_{3-x}\text{Cl}_x$) on a glass substrate coated with high conductivity PEDOT:PSS (PH1000) containing 5% v/v (DMSO). b) EDX

data of a thin film of $\text{CH}_3\text{NH}_3\text{PbI}_{3-x}\text{Br}_x$ on a glass substrate coated with ITO/PEDOT: PSS (Clevos PH).

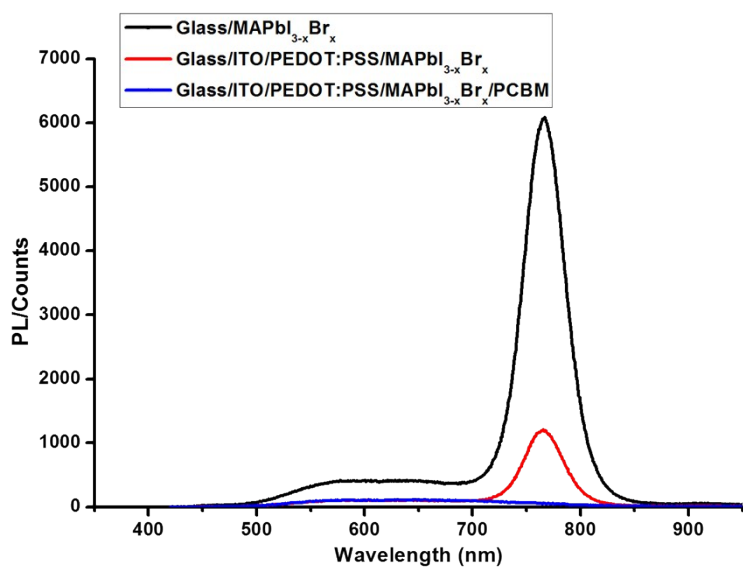


Figure S3: Photoluminescence quenching in perovskite samples.

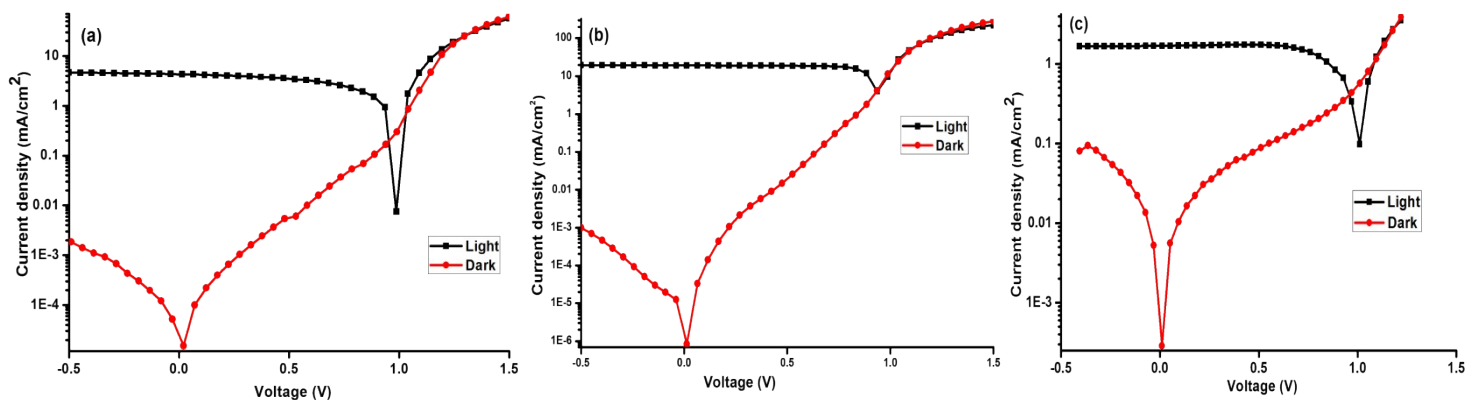


Figure S4: Semi-logarithmic current-voltage characteristics (a) MAPbI_3 , (b) $\text{MAPbI}_{3-x}\text{Cl}_x$ and (c) $\text{MAPbI}_{3-x}\text{Br}_x$

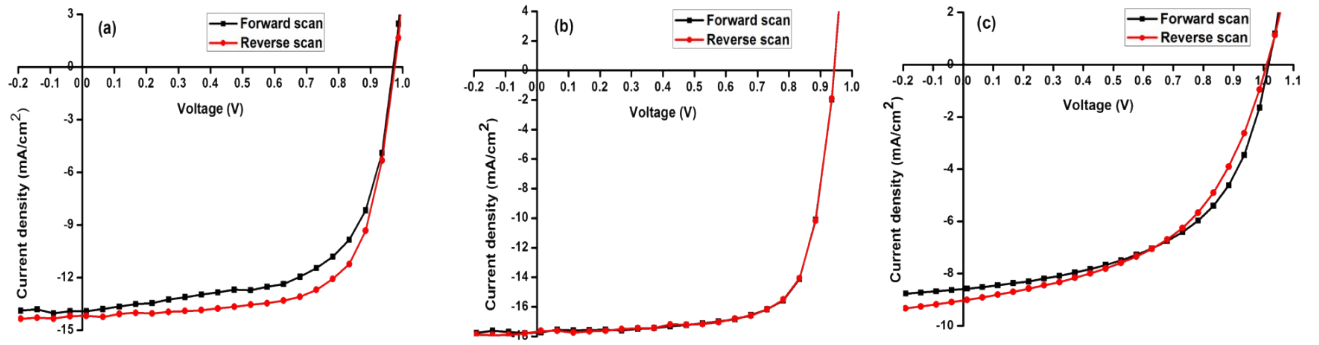


Figure S5: Current-voltage curve of the perovskite solar cell, forward and reverse scan 20 mV/s showing minimum hysteric behaviour.

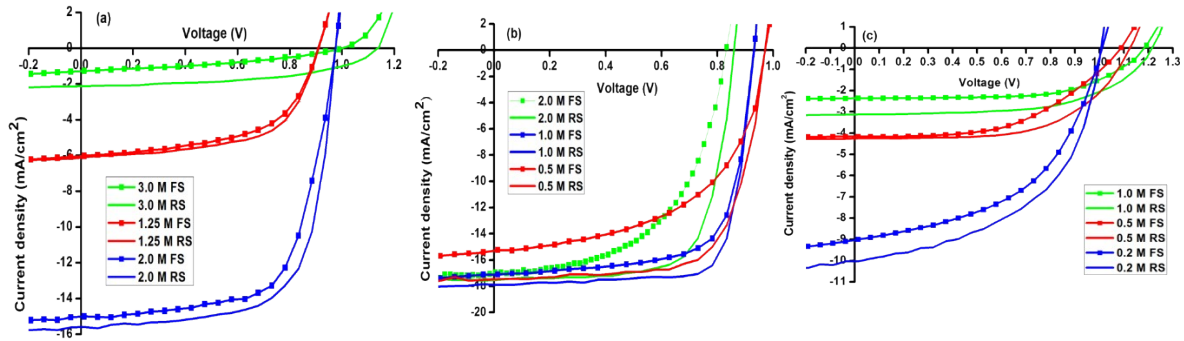


Figure S6: Concentration-dependent forward and reverse J-V scans of ITO/PEDOT:PSS/MAPbX₃/PCBM/Al solar cells (a) PbMAI₃, (b) PbMAI_{3-x}Cl_x and (c) PbMAI_{3-x}Br_x

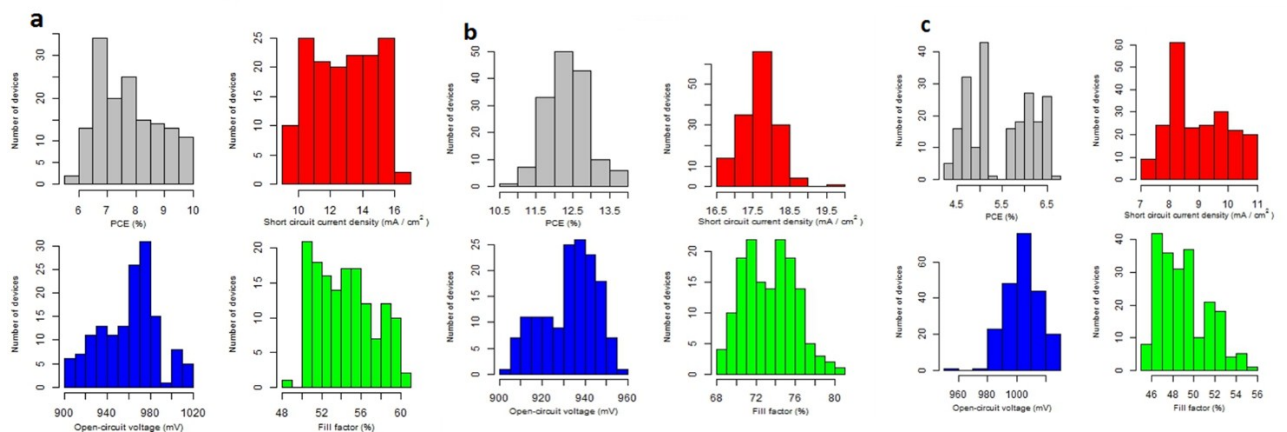


Figure S7: Histograms of device parameters (V_{oc} , J_{sc} , FF and PCE) for 100 separate (a) PbMAI₃, (b) PbMAI_{3-x}Cl_x and (c) PbMAI_{3-x}Br_x devices.

Table S1: Photovoltaic device parameters (V_{oc} , J_{sc} , FF and PCE) for PbMAI_3 , $\text{PbMAI}_{3-x}\text{Cl}_x$ and $\text{PbMAI}_{3-x}\text{Br}_x$ devices.

Perovskite	V_{oc} (mV)	J_{sc} (mA/cm²)	FF	PCE (%)
PbMAI_3	961 ± 26	12.8 ± 2.0	54.4 ± 2.9	7.7 ± 1.1
$\text{PbMAI}_{3-x}\text{Cl}_x$	933 ± 13	17.6 ± 0.5	73.4 ± 2.6	12.3 ± 0.6
$\text{PbMAI}_{3-x}\text{Br}_x$	1005 ± 12	9.0 ± 1.0	49.0 ± 2.3	5.5 ± 0.7