Cesium Enhances Long-Term Stability of Lead Bromide Perovskite-Based Solar Cells

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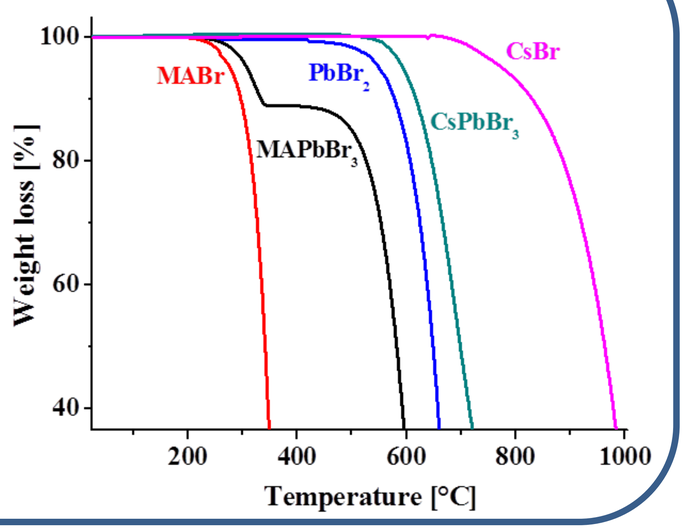
Background

Recently, we showed that replacing the organic cation in halide perovskites by cesium, Cs^+, to form $CsPbBr_3$, with a completely inorganic perovskite (CIP) structure at standard temperature and pressure can lead to photovoltaic (PV) devices made with this material with efficiencies as high as those of analogous hybrid organic-inorganic ones.[1] That result calls for a direct comparison between PV cells with $CsPbBr_3$ and those with methyl ammonium lead bromide, $MAPbBr_3$, both in terms of PV performance and stability, *using perovskites that are prepared in the same manner*. We now report this comparison in terms of thermal properties, and the corresponding PV device performance and stability. [2]

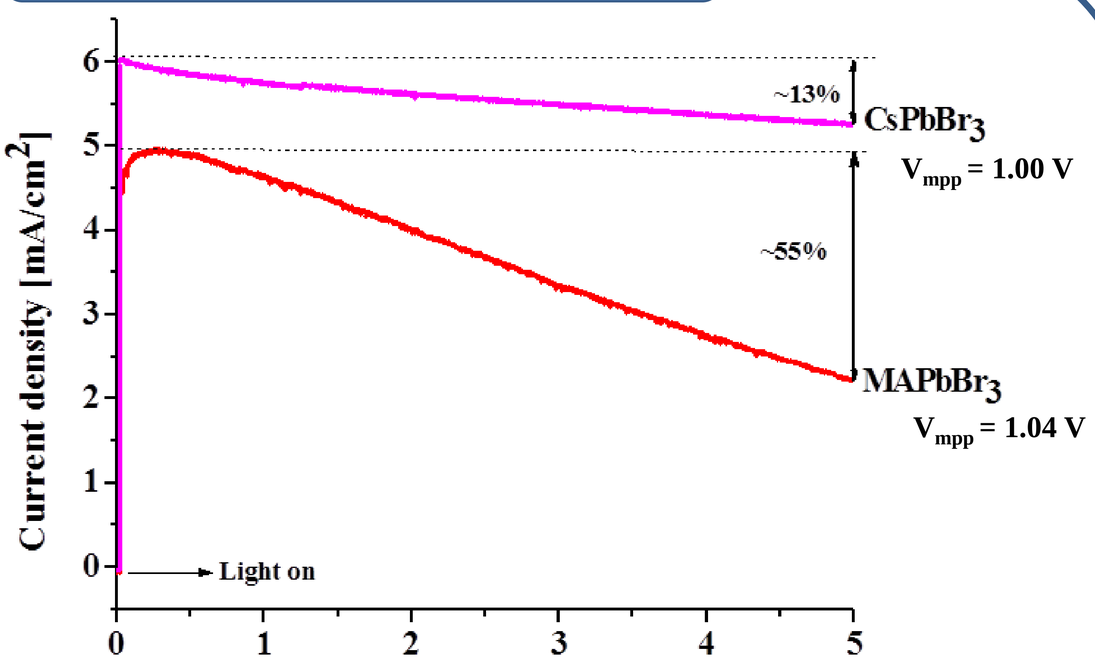
[1] M. Kulbak, D. Cahen and G. Hodes, *J. Phys. Chem. Lett.* (2015), **6**, 2452–2456
[2] M. Kulbak, S. Gupta, N. Kedem, I. Levine, T. Bendikov, G. Hodes, D. Cahen , *J. Phys. Chem. Lett.* (2015), **7**, 167-172

1 - Thermal properties

Thermogravimetric analyses of the perovskites and their different building blocks show higher thermal stability of $CsPbBr_3$ than of $MAPbBr_3$



2 - Operational stability



J_{SC} vs. T:

- The devices have **no encapsulation**.
- The $MAPbBr_3$ cell shows a strong decay in photocurrent density @ MP as function of time, while $CsPbBr_3$ decays much less and slower in the same time frame.

3 – JV curves

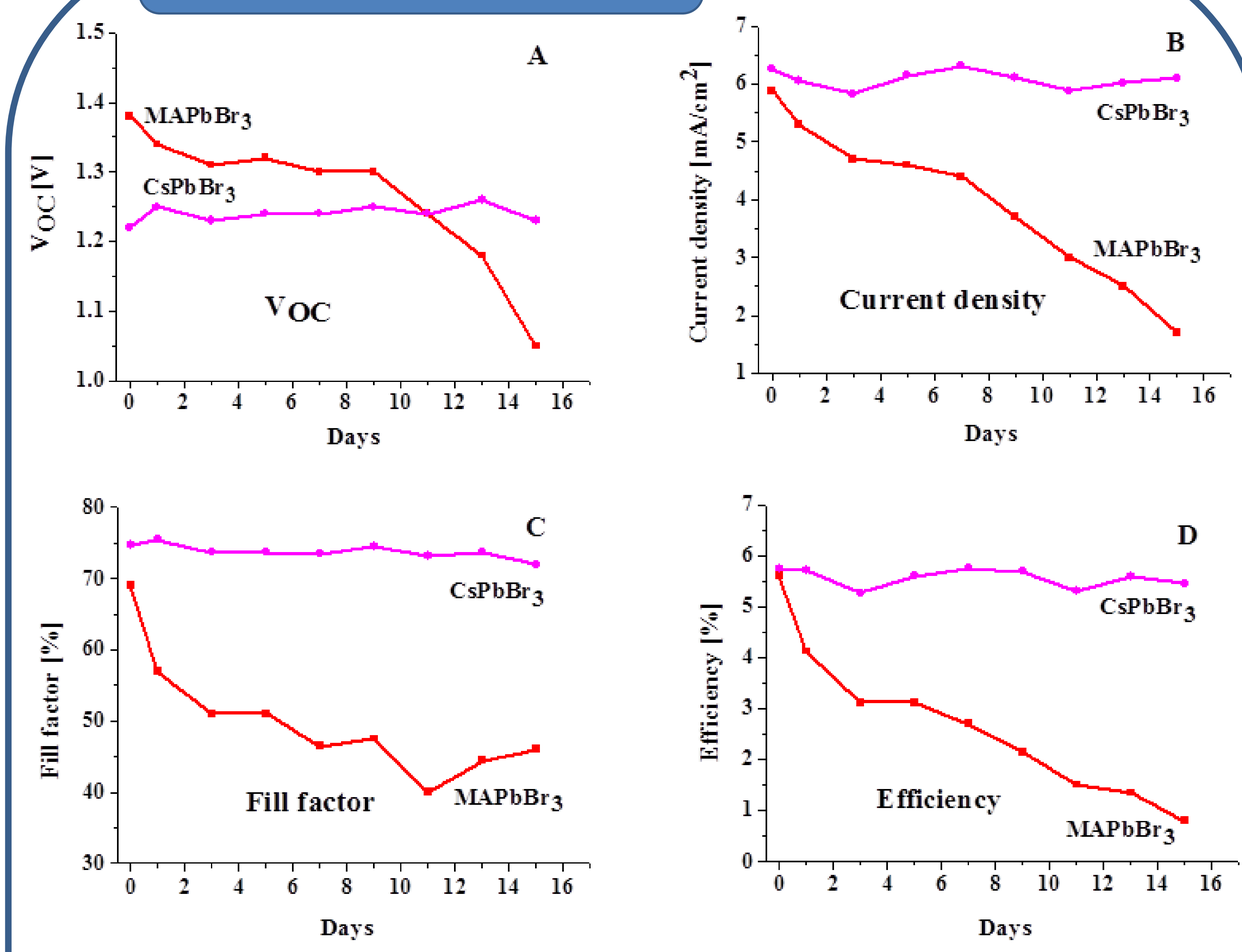
Best performing devices:

Scan direction	V_{OC} (Volt)	J_{SC} (mA/cm^2)	FF (%)	PCE (%)
FWD	1.25	6.7	73	6.2
REV	1.25	6.7	72	6.1

Scan direction	V_{OC} (Volt)	J_{SC} (mA/cm^2)	FF (%)	PCE (%)
FWD	1.38	6.4	73	6.5
REV	1.4	6.4	74	6.6

- Cs- and MA-based devices demonstrated comparable performance under AM 1.5 illumination. The $CsPbBr_3$ cell gave a somewhat lower V_{OC} but this was compensated by a higher J_{SC}.

4 - Aging analysis



- Measurements were done in *ambient* under relative humidity (RH) of 60-70 %; cells were stored in dry air atmosphere, in the dark at RH of ~15-20 %.
- While $MAPbBr_3$-based devices show steady decay in all parameters, $CsPbBr_3$-based cells show no significant decay.

Conclusions

Cs-based $APbBr_3$ cells are as efficient as, and more stable than methylammonium-based ones, after aging, under constant illumination at/near MP, and (not shown) under electron beam irradiation.

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