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 CsPbBr3, 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 CsPbBr3 and those with methyl ammonium lead bromide, MAPbBr3, 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 - Thermal properties

Thermogravimetric analyses of the perovskites and their different building blocks show higher thermal stability of CsPbBr3 than of MAPbBr3.

2 - Operational stability

- The devices have no encapsulation.
- The MAPbBr3 cell shows a strong decay in photocurrent density @ MP as function of time, while CsPbBr3 decays much less and slower in the same time frame.

3 – JV curves

Best performing devices:

<table>
<thead>
<tr>
<th>Scan direction</th>
<th>Voc (V)</th>
<th>Jsc (mA/cm²)</th>
<th>FF (%)</th>
<th>PCE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FWD</td>
<td>1.25</td>
<td>6.7</td>
<td>73</td>
<td>6.2</td>
</tr>
<tr>
<td>REV</td>
<td>1.25</td>
<td>6.7</td>
<td>72</td>
<td>6.1</td>
</tr>
</tbody>
</table>

- Cs- and MA-based devices demonstrated comparable performance under AM 1.5 illumination. The CsPbBr3 cell gave a somewhat lower Voc but this was compensated by a higher Jsc.

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 MAPbBr3-based devices show steady decay in all parameters, CsPbBr3-based cells show no significant decay.

Conclusions

Cs-based APbBr3 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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