Electronic supplementary information

Influence of the mobile ions on the electroluminescence of perovskite solar cells

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**Fig. S1** Electrical characterization under illumination for a solar cells with the structure ITO/PEDOT:PSS/polyTPD/MAPbI$_3$/PCBM/Ba-Ag, where the perovskite absorber thickness is 350 nm. The voltage scan speed is 0.35 V s$^{-1}$, in forward (negative to positive) and in reverse (positive to negative) bias.

<table>
<thead>
<tr>
<th></th>
<th>$J_{sc}$ (mA cm$^{-2}$)</th>
<th>$V_{oc}$ (mV)</th>
<th>$FF$ (%)</th>
<th>$PCE$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward</td>
<td>15.7</td>
<td>1087</td>
<td>79.7</td>
<td>13.6</td>
</tr>
<tr>
<td>Reverse</td>
<td>15.7</td>
<td>1088</td>
<td>80.2</td>
<td>13.7</td>
</tr>
</tbody>
</table>

**Table S1.** Photovoltaic parameters of the solar cell reported in Figure S1.
Fig. S2 (a) EQE and (b) electroluminescence for the non-ohmic device B when biased in dark for 300 s.

Fig. S3 DC component of the electroluminescence for the perovskite diode B (single carrier device) for increasing constant driving voltage ($V_{bias}$).
**Fig. S4** Time dependent current density curve showing the recovery of the current density after the fast J-V sweep, for device B.

**Fig. S5** (a) Simplified band diagram indicating the maximum attainable $V_{oc}$ as related to the quasi-Fermi level splitting $\Delta \mu$. (b) In a degraded solar cells, an extraction barrier is present at least at one of the interface (here the ETL), reducing the device built-in voltage and causing s-shaped J-V characteristics. (c) Forward biasing the device reduced the barrier for the electron injection (extraction), hence recovering the $V_{bi}$ and the device FF.