ELECTRONIC SUPPLEMENTARY INFORMATION

Bicolour, large area, inkjet-printed metal halide perovskite light emitting diodes

Vincent R. F. Schröder,[a] Nicolas Fratzscher,[b] Nicolas Zorn Morales,[b] Daniel Steffen Rühl,[b] Felix Hermerschmidt, *[b] Eva L. Unger[c,d,e] and Emil J. W. List-Kratochvil*[a,b]

a. Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Hahn-Meitner-Platz 1, 14109 Berlin, Germany

b. Institut für Physik, Institut für Chemie, Humboldt-Universität zu Berlin, IRIS Adlershof, Zum Großen Windkanal 2, 12489 Berlin, Germany

c. Department Solution Processing of Hybrid Materials & Devices, Helmholtz-Zentrum Berlin für Materialien und Energie, Kekuléstraße 5, 12489 Berlin, Germany

d. Institut für Chemie, IRIS Adlershof, Humboldt Universität zu Berlin, Zum Großen Windkanal 2, 12489 Berlin, Germany

e. Chemical Physics and NanoLund, Lund University, PO Box 124, 22100 Lund, Sweden

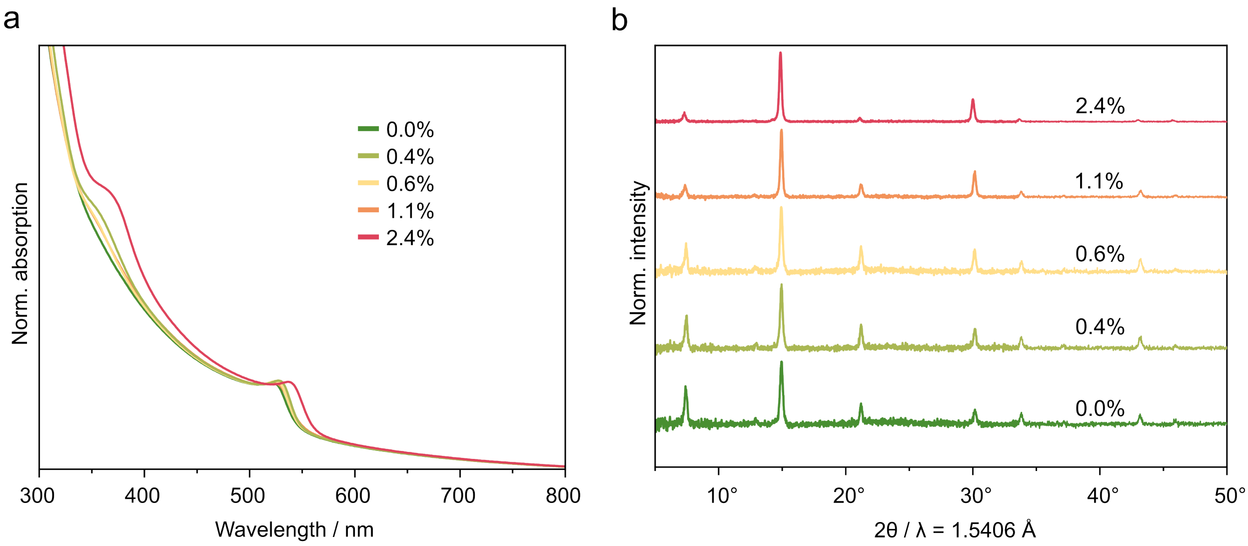

Figure S1: (a) Full view of the UV-vis spectra shown in Figure 2 b, showing the shift of the absorption edge of the patterned perovskite layers with increasing nominal iodide concentration. (b) Full view XRD pattern of the patterned perovskite layers.

Figure S2: Large area, dual coloured PeLEDs. Scale bar indicates 1 cm.

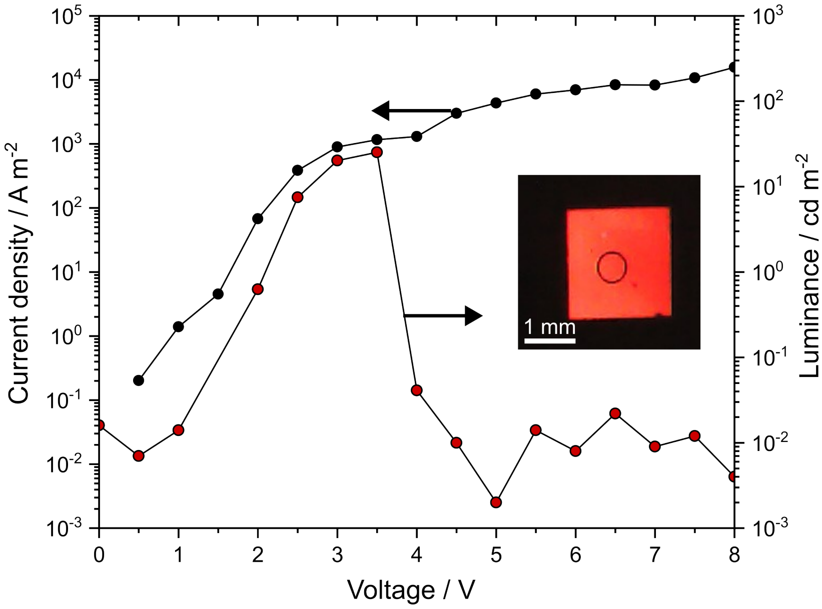

Figure S3: Current density-luminance-voltage characteristics of a pure red light emitting PeLED using $PEA_2MA_3Pb_4I_{13}$ as emitter layer. This layer was printed in a single step, no mixing of the perovskite inks took place. A maximum luminance of 25 cd m^{-2} was achieved.

Calculation of nominal iodide content

The nominal I^-/Br^- ratio ($R_{I/Br}$) was calculated from the volume (V_{drop}) of a single printed droplet, the number of printed droplets per area (N_{drops}) taken from the nominal printing resolution and the concentration of perovskite precursors in the ink (c). This yields the molarity of perovskite precursors in the printed ink. To yield the I^-/Br^- ratio, the stoichiometry (f) of both inks ($MAPbBr_3$ and $PEA_2MA_3Pb_4I_{13}$) needs to be considered.

$$R_{I/Br} = \frac{n_I}{n_{Br}} = \frac{V_{drop,I} \times N_{drop,I} \times c_I \times f_I}{V_{drop,Br} \times N_{drop,Br} \times c_{Br} \times f_{Br}}$$

The drop volume for the deposition of bromide inks and iodide ink are nominally 30 pL and 1 pL. Determination of the drop volume with the built-in analyser tool of the LP50 inkjet printer revealed a significant spread of drop volume with a mean volume of 24 pL (Figure S2). Determination of the real drop volume of the (nominal) 1 pL printhead was not possible with the LP50 analyser tool. The number of deposited droplets corresponds to the printing resolution of the Br^--based MHP film (350 dpi) and the drop spacing of the I^--based precursor ink on the Br^- MHP layer. A drop distance of 250 µm, 200 µm, 150 µm, 100 µm correspond here to a resolution of 102 dpi, 127 dpi, 169 dpi and 254 dpi. The resolution must be squared, to yield the number of drops per area N_{drop} (drops per square inch). The concentration of bromide ink is 0.125 M and 0.031 M for the iodide ink. The stoichiometric factors are 3 and 13 respectively.

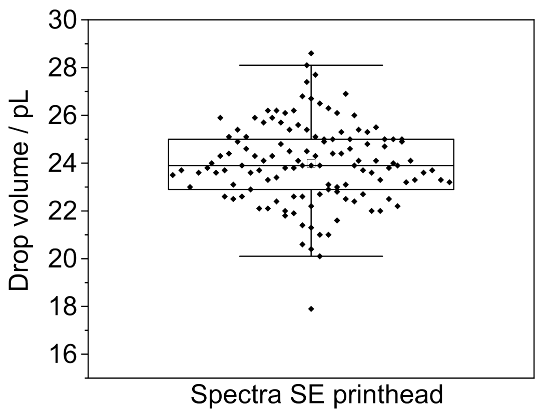

Figure S4: Determined drop volume of the 128 nozzles of a Spectra SE printhead with a nominal drop volume of 30 pL.