Supporting Information

Tunable Near-Infrared Luminescence in Tin Halide Perovskite Devices

May L. Lai[1], Timothy Y. S. Tay[1], Aditya Sadhanala[1], Siân E. Dutton[1], Guangru Li[1], Richard H. Friend[1]* and Zhi-Kuang Tan[1,2,3]*

[1] Cavendish Laboratory, University of Cambridge, JJ Thomson Avenue, Cambridge, CB3 0HE, UK
[2] Department of Chemistry, National University of Singapore, 3 Science Drive 3, S117543, Singapore
[3] Solar Energy Research Institute of Singapore, National University of Singapore, 7 Engineering Drive 1, S117574, Singapore

SUPPORTING FIGURES

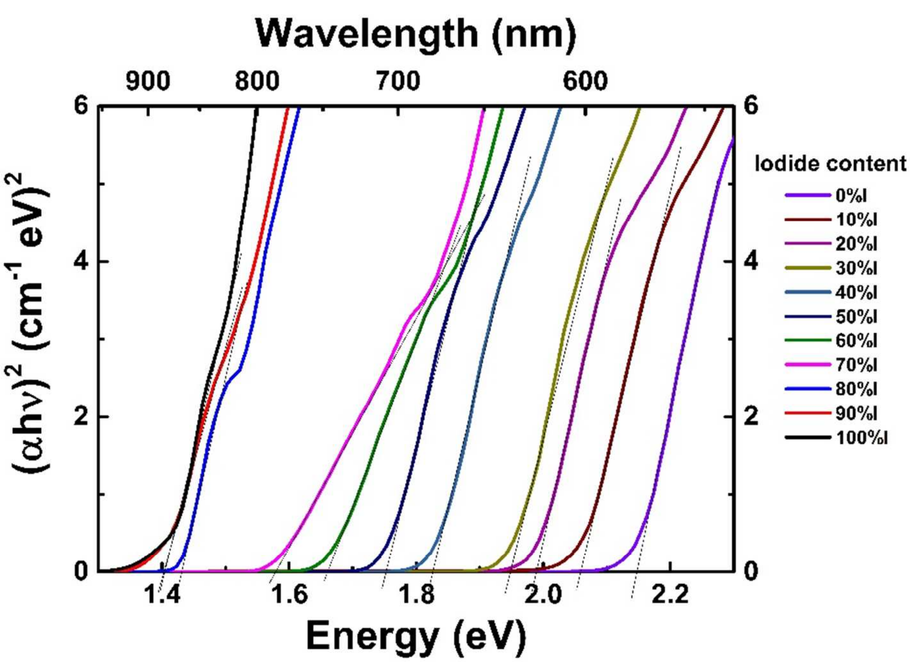


Figure S1: Tauc plot of normalised absorbance spectra, measured using PDS. The bandgap is read off the intersection of the interpolated absorption edge with the x-axis (grey lines).

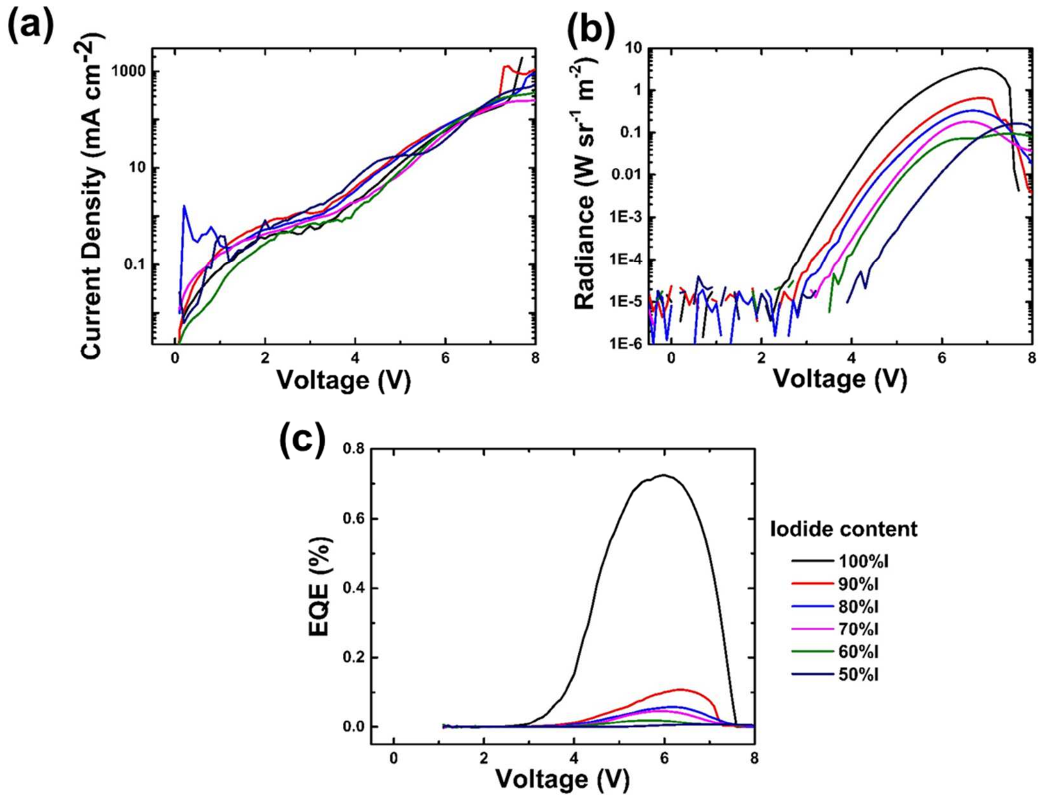


Figure S2: (a) Current density vs. voltage plots, (b) radiance vs. voltage plots, and (c) EQE vs. voltage plots of tin perovskite PeLEDs with different halide compositions (50-100% iodide).

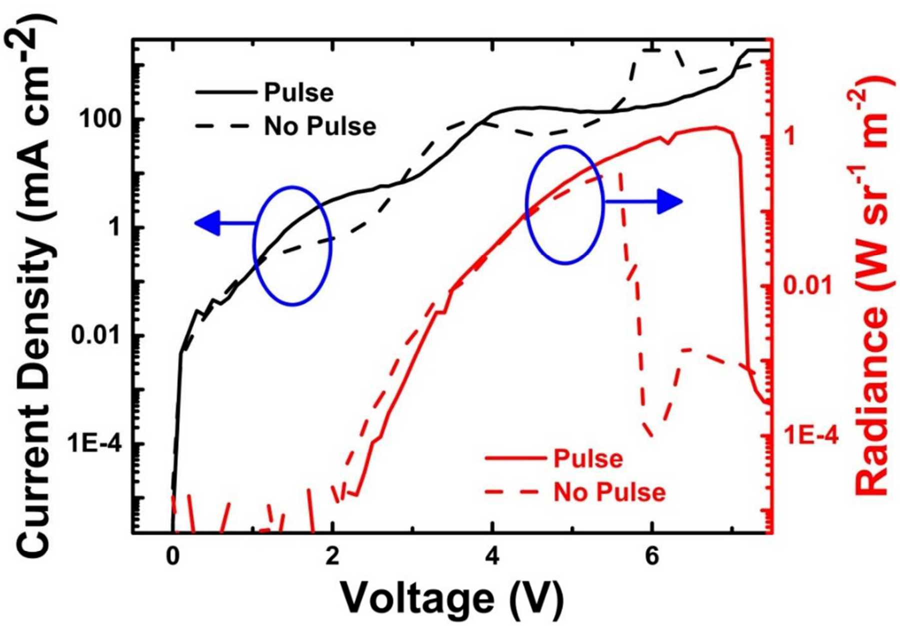


Figure S3: Figure shows the combined current density vs voltage and radiance vs voltage plots of 2 device pixels on the same device. One pixel is driven in stepped voltages with 3000 ms step width (dashed lines), and the other pixel is driven in voltage pulses (~750 ms pulse), followed by ~2250 ms off time (solid lines). The pulsing method allows the device pixel to cool between the pulses during the off state. This pulsing allows the device pixel to survive to a higher driving voltage and current density, compared to the non-pulsed device, hence showing that heating effects contribute to device degradation.

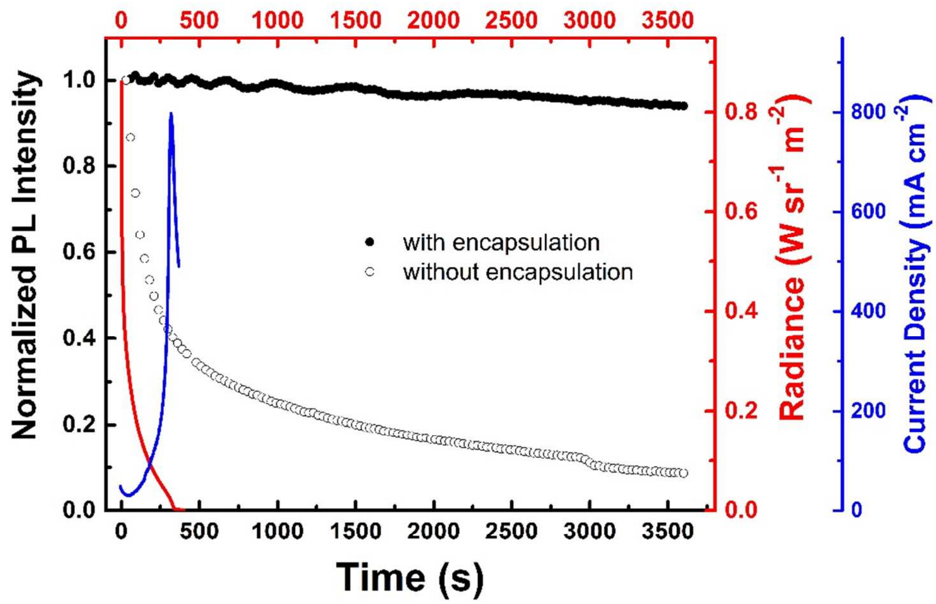
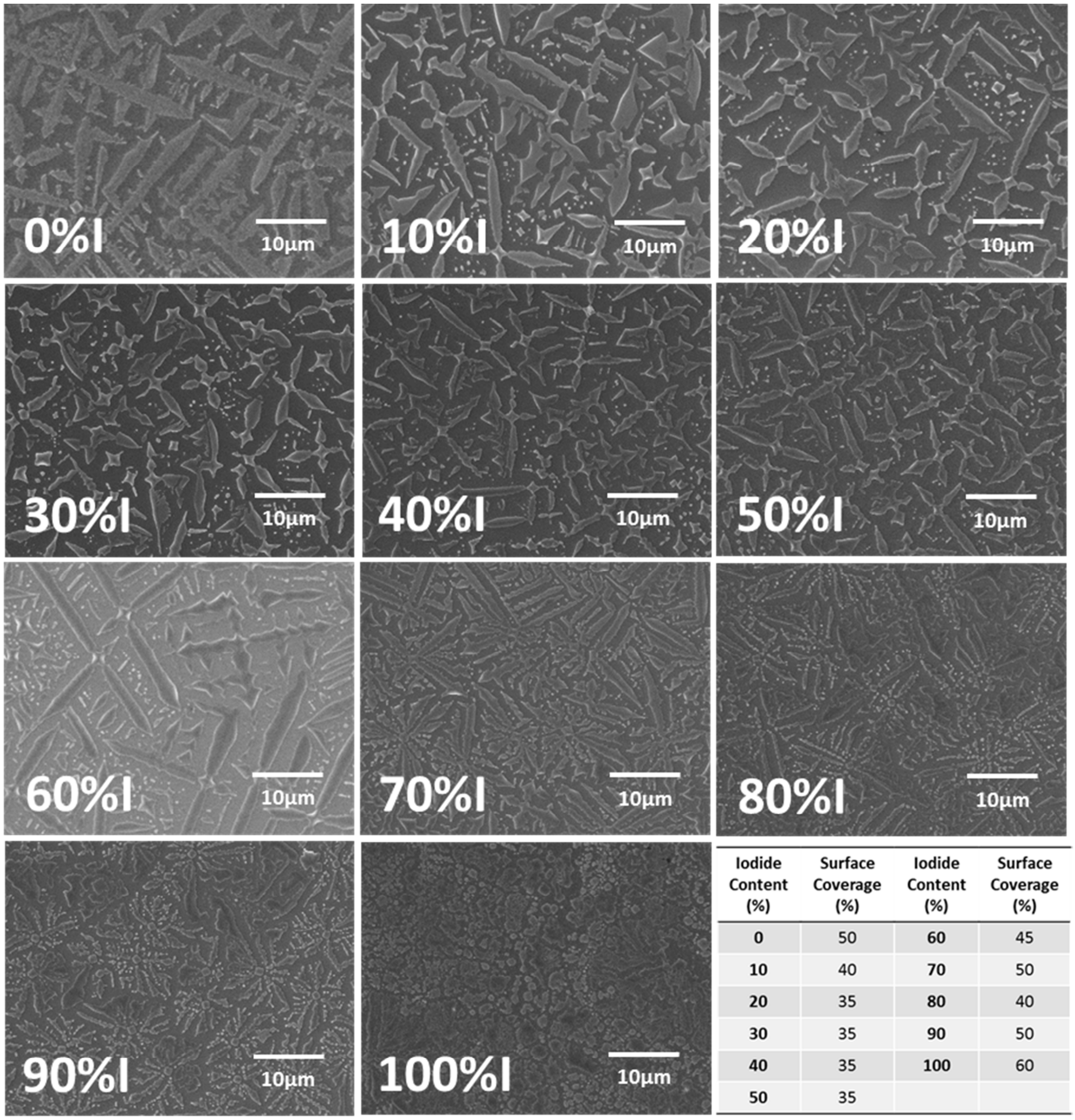


Figure S4. A 100% iodide PeLED (encapsulated with UV-cured epoxy glue and glass) was operated at a fixed voltage of 6V, and its radiance (red) and current density (blue) were plotted over time. The device radiance degraded rapidly and burned out within 6 minutes. This is accompanied by a massive increase in current density. The normalized PL intensity of a 100% iodide perovskite film, under a 100mW 532nm laser excitation, was plotted in the same graph for comparison (filled black spheres represent film which is encapsulated with a layer of PMMA and measured under nitrogen flow; unfilled black spheres represent non-encapsulated film which is measured in air). The encapsulated film showed a stable output over 1 hour while the non-encapsulated film degrades rapidly.



Iodide Content (%)	Surface Coverage (%)	Iodide Content (%)	Surface Coverage (%)
0	50	60	45
10	40	70	50
20	35	80	40
30	35	90	50
40	35	100	60
50	35		

Figure S5: SEM images of perovskite thin films with different halide compositions (0 – 100% iodide content). Table shows a summary of the percentage film coverage, as estimated from the SEM images. From these images, we estimate the surface coverage to be in the range of 35% to 50% for the bromide containing samples, but higher at 60% for the pure triiodide sample. Hence, even though the PL of the 100% iodide sample is only 3 times higher than the 90% sample, the EL of the 100% sample is a factor of 7 higher due to better surface coverage. A better film coverage ensures that more charges are injected into the perovskite, rather than leaked across the pinholes, thereby giving a higher EL efficiency.