# Solution-processed and high-performance light-emitting diodes based on quantum dots

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Solution-processed optoelectronic and electronic devices are attractive owning to the advantages of fabricating low-cost and large-area devices and the compatibility with light-weight and flexible plastic substrates. Solution-processed light emitting diodes (LEDs) utilizing conjugated polymers or quantum dots (QDs) as emitters have attracted great interest over the past two decades[1,2].

QDs are solution-processed semiconductor nanocrystals, which promise size-tunable emission-wavelengths, narrow emission linewidths, nearly-unity photoluminance (PL) quantum yield, and inherent photophysical stability. In order to fully exploit the superior optical properties of QDs, a number of device structures were developed and various materials, including small molecules, conjugated polymers and inorganic oxides, were explored as charge transport interlayers. However, until very recently, the overall performance of quantum-dot based LED (QLED) is far behind expectations (see Fig. 1 for the peak external quantum efficiency (EQE) of QLEDs).

Here we report a solution-processed multi-layer QLED with outstanding performance and excellent reproducibility[3]. Our QLED device show fine color-saturated emission. The symmetric emission peak at 640 nm with a narrow full-width-at-half-maximum of 28 nm corresponds to Commission Internationale de l'Eclairage (CIE) color coordinates of (0.71, 0.29), is ideal for display applications. The QLED exhibits high EQE up to 20.5%, low efficiency roll-off (>15% of EQE at 100 mA cm$^{-2}$), and a long operational lifetime of more than 100,000 hours at 100 cd m$^{-2}$, making this device the best-performing solution-processed red LED to date and comparable to the state-of-art vacuum-deposited OLEDs.

The exceptional optoelectronic performance is achieved by inserting an insulating interlayer between the QD layer and the oxide electron transport interlayer (ETL) to preserve the superior optical properties of the QDs and ensure charge balance in the devices without sacrificing charge injection efficiency. We anticipate that our results will be a starting point for further research, leading to high-performance and all-solution-processed QLEDs ideal for next-generation display and solid-state lighting technologies.

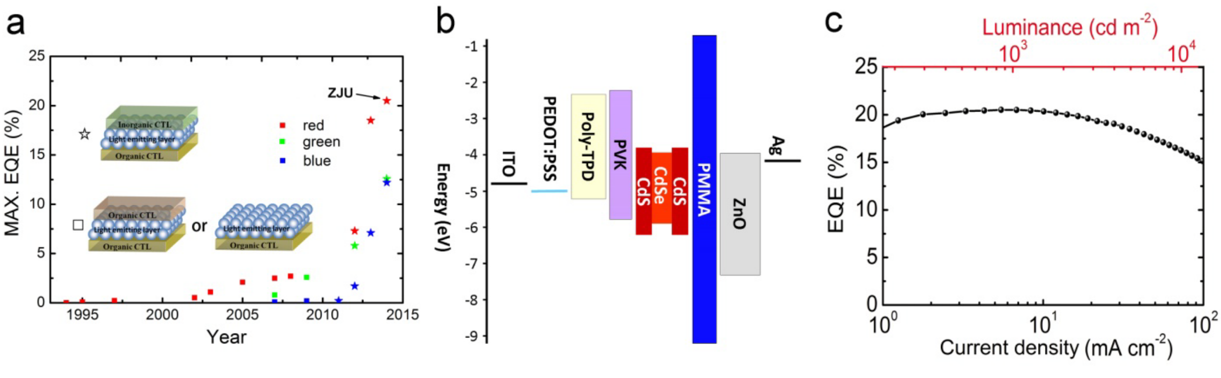


**Fig. 1. a, Progression of QLED performance over time in terms of peak EQE. b, Flat-band energy level diagram. c, EQE versus current density and luminance for the device with the best efficiency.**

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