Electrohydrodynamic jet Printed Quantum Dot Micro/nanopatterns for Applications of Light-Emitting Diodes

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Quantum dot light-emitting diodes (QD LEDs) are of interest due to their wide-range color tunability, high brightness, and narrow emission bandwidth. Challenges remain, however, in achieving optimized control of light emission and in forming the necessary multilayer device structures. Electrohydrodynamic jet (e-jet) printing is a printing technology where the printed liquid is driven by an electric field. When it exceeds a critical limit, the stress from the surface charge repulsion at the cone apex exceeds the surface tension and a droplet of fluid is emitted towards the grounded substrate.

Here we demonstrate materials and operating conditions that allow for high-resolution printing of layers of quantum dots (QDs) with precise control over thickness and submicron lateral resolution and capabilities for use as active layers of QD light-emitting diodes (LEDs). The shapes and thicknesses of the QD patterns exhibit systematic dependence on the dimensions of the printing nozzle and the ink composition in ways that allow nearly arbitrary, systematic control when exploited in a fully automated printing tool. Fig. 1 demonstrates the ability of e-jet printing to form diverse patterns of multiple types of QDs with good registration. Here, solutions of QDs in organic solvents (dichlorobenzene) serve as the inks.

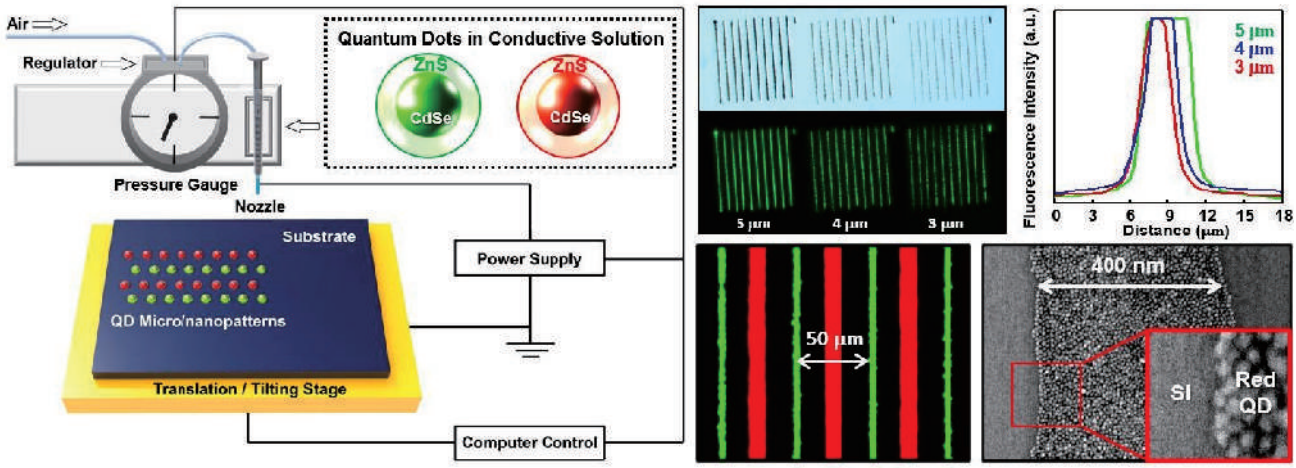

Fig. 1. The schematic illustration of electrohydrodynamic jet (e-jet) printer and e-jet printed heterogeneous QDs array for quantum dot light-emitting diodes (QD LEDs).

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