

## Current modulation in an organic light-emitting diode (OLED)

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Organic light-emitting diodes (OLEDs) enable light weight components at low cost and are compatible with flexible substrates. They exhibit several advantages over light-emitting diodes (LEDs) currently used in the display. To achieve a pixel with active-matrix organic light-emitting diode (AMOLED) technology, the simplest design includes an OLED, a capacitance, a switch transistor, and a driver transistor. In order to simplify the design, the manufacturing steps and increase the lifetime of the pixels, it is possible to replace the couple OLED and driver transistor by a single component: a modulated OLED. The modulation is performed with a third electrode connected to the device. Concretely, the current in the OLED is modulated by the charge injection at one of the electrodes by means of a third electrode according to the principle of a transistor. This first electrode called source is the key element of the structure. This is a perforated electrode deposited on a dielectric material covering the third electrode called gate (Fig. 1a). It is the dielectric/source/semiconductor interface that will then determine the injection conditions. The operating principle is based on the creation of a Schottky barrier between the source electrode and the semiconductor. By bending the semiconductor band with an appropriate gate voltage, the potential barrier drops and allows the passage of charges [1]. It is therefore necessary to have a triple dielectric/source/semiconductor interface large enough to allow sufficient injection. The micro-structuration of the source electrode is thus essential. In our case, we fabricated a device with a source electrode made by photolithography with circular opening of radius 60  $\mu\text{m}$ . The characteristics obtained are those of an OLED but we have combined the possibility of current modulation thus creating a device halfway between an OLED and a transistor (Fig. 1b).

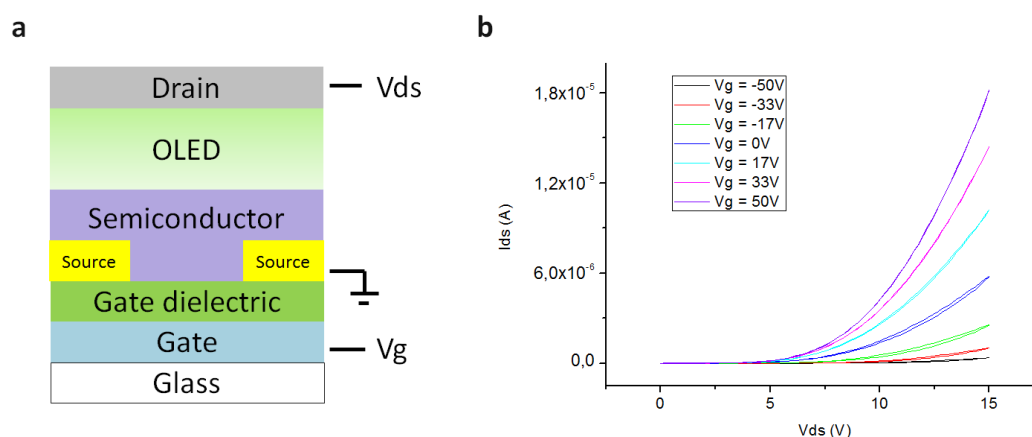


Fig. 1. A) Cross-sectional view of the OLED device that can be modulated by a third electrode. B) Current-voltage characteristic of a device based on PTCDI-C13 (*N, N'*-ditridecylperylene-3,4,9,10-tetracarboxylic diimide) at different gate voltages.

[1] H. Yu, S. Ho, N. Barange, R. Larrabee and F. So, *Org. Electron.* **55**, 126-132, (2018).