Vertical Organic Light Emitting Transistors for Investigation of Charge Transport in Vertical Organic Field Effect Transistors

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Abstract

The vertical organic field effect transistor (VOFET) offers many technological advantages due to its very short geometric channel length. However, in contrast to the standard lateral organic field effect transistor (OFET), the basic physics and working principles are not yet well known. In this contribution, we investigate how and where in the device the channel forms, and how different parameters influence the channel. We compare results regarding the charge transport obtained from simulations with measured charge carrier density distributions. The latter ones are obtained from the light emission of vertical organic light emitting transistors (VOLETs). These devices are a combination of an organic light emitting diode (OLED) and a VOFET, which allow to locally resolve the current path via light emission. We show the dependence of the channel size and geometry on several parameters: the gate-source voltage, the drain-source voltage, and the source geometry, and compare them with the simulation data. The active area that contributes to the charge transport, determined by the so called channel depth, increases with higher gate-source voltage. The dependence on the drain-source voltage is more complicated. We give a first characterization based on the standard transistor output equations. A description of the charge path creation inside the vertical device is obtained. A better understanding of the basic phenomena of charge transport in such devices will grant new possibilities for further optimization and improvement.

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