Simulation of Organic Permeable Base Transistor

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The Organic Permeable Base Transistor (PBT) is an interesting device concept where a perforated and insulated Base electrode is placed in the middle between Emitter and Collector[1]. Thus, the Base acts as the control electrode, regulating the current flowing through the openings of this electrode.

The openings are assumed to be cylindrical, therefore the geometry of the problem is addressed by a three-dimensional drift-diffusion simulation with cylindrical symmetry. This simulation gives insights into the processes occuring in the PBT and allows for obtaining a detailed understanding of the operation mechanism.

As one of the main results, the operation of the PBT can be divided into two major regimes: At low current densities, the applied Base potential controls the number of charges that can pass through an opening. That means, the opening is the current limiting factor and this regime leads to an exponential current-voltage characteristics. At higher current densities, the opening does not act as a bottleneck any more. Instead, the intrinsic semiconductor cannot provide more current, manifesting in the on-state in the current-voltage characteristics.

The simulation shows an accumulation of charge carriers in front of the Base insulation, forming a highly conductive charge channel allowing for an efficient lateral transport of charges towards the next opening. It is found, that this process can make even a tiny opening gather charge carriers from a much larger area of the intrinsic semiconductor. This important result not only shows, that the PBT can still be operated at high current densities when openings are far away from each other, but also has an impact on every system where an active area shall be confined by using an insulator.

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References

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