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Vertical Organic Tunnel Field-Effect Transistor[1] SHIYI LIU, Kent State University, MAX L. TIETZE, King Abdullah University of Science and Technology, AKRAM AL-SHADEEDI, University of Baghdad, VIKASH KAPHLE, Kent State University, CHANGMIN KEUM, University of St Andrews, BJORN LUSSEM, Kent State University — Among the large number of different OFET designs, vertical OFETs stand out for their aggressively shortened channel length and the potential to be integrated vertically with devices such as organic OLEDs or photodiodes. However, it is challenging to control the leakage current between the drain and source by the gate electric field [Greenman, M. et al. Journal of Applied Physics, 121(20), 204503]. Here, to further optimize vertical OFET, we propose a novel OFET concept– vertical organic tunnel field-effect transistors (VOTFETs). To realize VOTFET, drain and source contacts are heterogeneously doped in a Pentacene-based vertical OFET, which forms a p-i-n structure. Depending on the mechanism of charge carrier injection, the transistor can work in two distinct modes – forward and backward (tunneling). The injection of charge carriers is systematically investigated, which shows that charge carriers are injected by Zener tunneling in the tunneling mode. A comparison to the lateral OFET shows that the VOTFET has an improved performance. Overall, VOTEFTs provide new ways to optimize the performance of organic transistor. Furthermore, the device principles discussed here can be applied to other material systems, broadening the impact of the results.

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