Using interdigitated organic electrochemical transistors as electrophysiological and biochemical sensors

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Organic electrochemical transistors (OECTs) have emerged as versatile electrophysiological sensors due to their high transconductance, biocompatibility, and transparent channel material. High maximum transconductances were demonstrated facilitating extracellular recordings from electrogenic cells. However, this often requires large channel dimensions which impedes high transistor densities. To improve the device performance and density, we used interdigitated OECTs (iOECTs), which feature high transconductances at small device areas. Superior device performance was achieved by systematically optimizing the electrode layout regarding channel length, number of electrode digits, and electrode width. Interestingly, the maximum transconductance does not straightforwardly scale with the channel width-to-length ratio, which is different from planar OECTs.[1] We used optimized iOECTs for recording action potentials of cardiomyocyte-like HL-1 cells. Furthermore, we embedded the iOECTs in a matrix of polyimide to achieve flexible and transparent bioelectronic devices. These sensors exhibited electrical characteristics similar to those of solid-substrate devices even after experiencing extremely high bending strain.[2]

Finally, we used these devices to detect neurotransmitter dopamine and ATP, which play an important role not only for signal transmission in the central nervous system but also for cardiovascular, neurodegenerative, and immune deficiency diseases. Our novel aptasensor possessed ultralow detection limits, which were several orders of magnitude lower than those of the same aptasensors using an amperometric transducer principle.[3]

Our results demonstrate that interdigitated OECTs meet two requirements of both electrophysiological and biochemical sensors, namely high device performance and small channel dimensions, and might represent the optimal transducer to integrate these two types of sensors on one chip.

1 Liang, Y. et al. *Advanced Functional Materials* 2019, 29, 1902085.

2 Liang, Y. et al. *Advanced healthcare materials* 2018, 7, 1800304.

3 Liang, Y. et al. Biosensors and Bioelectronics 2019, 144, 111668.