Opto-evoked neurotransmitter release detection with graphene aptasensor multitransistor arrays

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Neural interfaces, bridging brain physiology and external electronic devices, allow brain function monitoring for neurochemistry research or clinical purposes. Despite recent advances in monitoring electrical brain activity, measuring chemical neurotransmission remains a significant challenge. We recently developed a platform for robust and ultrasensitive detection of dopamine [1], an essential neurotransmitter that underlies several brain disorders, based on graphene multitransistor arrays (gMTAs) functionalized with a selective DNA aptamer. Not only did we achieve the lowest limit-of-detection ever reported (1 aM), but we could also detect dopamine with great sensitivity in complex samples such as artificial cerebral spinal fluid and brain homogenate, including in a mouse model of Parkinson's Disease. Herein, we present a novel nanobioelectronic neural interface based on gMTAs that allows monitoring of neurotransmitter opto-evoked release in ex vivo brain slices of transgenic mice. Optimizing our gMTAs' fabrication process [1,2], we developed an interface with higher sensor density that accommodates mice's brain slices and allows optogenetic modulation through integrated micro-LEDs. The platform presented in this work can lead the way to novel neurotransmitter sensors suitable for real-world academic and pre-clinical pharmaceutical research and clinical diagnosis.

References

[1] Abrantes, Mafalda, et al. "Ultrasensitive dopamine detection with graphene aptasensor multitransistor arrays." Journal of Nanobiotechnology 20.1 (2022): 495.
[2] Cabral, Patrícia D., et al. "Clean-room lithographical processes for the fabrication of graphene biosensors." Materials 13.24 (2020): 5728.

Figures

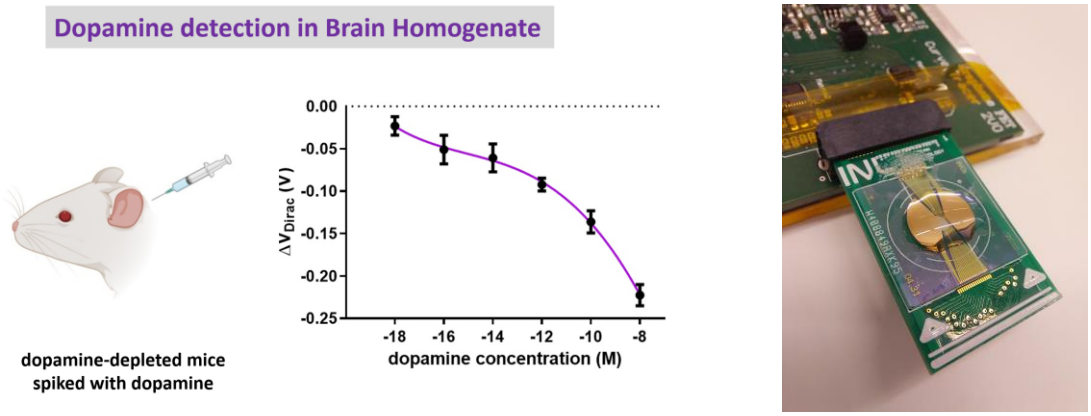

Figure 1: Dopamine detection in brain homogenate with gMTAs (left). Graphene nanobiosensing platform for opto-evoked neurotransmitter detection (right).