Towards flexible neural probes based on multiplexed active arrays of graphene transistors

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Graphene solution-gated field-effect transistors (g-SGFETs) have been previously reported to show outstanding capabilities for monitoring brain activity due to the biocompatibility, flexibility and unmatched electronic mobility of graphene [1]. Here we present our efforts for the implementation of this technology onto a flexible switching-matrix to overcome the intrinsic limitation introduced by the need of individual wiring of each sensor on the array in a non-multiplexed configuration. Such technology would pave the way to large-scale sensor arrays with high spatiotemporal resolution, vital for accurately mapping complex cognitive processes. Mapping such processes would allow the development of a new generation of brain-computer interfaces with advanced functionalities, for instance allowing precise control of external devices e.g. artificial limbs. First, the general concept is tested with off-array Si-based MOSFET switches to understand the requirements and limitations of the technology, presenting recordings of multiplexed g-SGFET arrays. Secondly, we evaluate the use of flexible on-array switches, aiming at reducing sensor crosstalk. To this end, molybdenum disulfide field-effect transistors (MoS_2-FETs) [2] are proposed for this application, assessing their performance in terms of homogeneity, noise and time response. Finally, the current development of a fully-integrated g-SGFET/ MoS_2-FET array is shown.

References

[1] C. Hébert et al., "Flexible Graphene Solution-Gated Field-Effect Transistors: Efficient Transducers for Micro-Electrocorticography," Adv. Funct. Mater., vol. 28, no. 12, pp. 1–15, 2018.

[2] Wachter, S. et al. A microprocessor based on a two-dimensional semiconductor. Nat. Commun. 8, 14948 doi: 10.1038/ncomms14948 (2017)

Figures

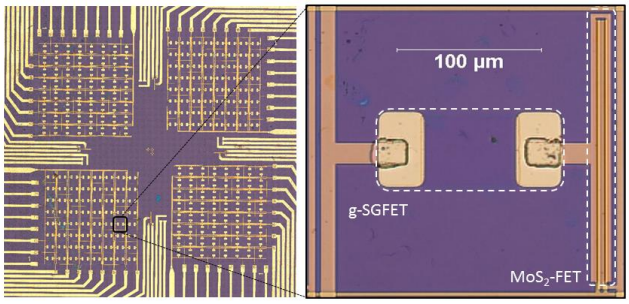

Figure 1: Multiplexed arrays of g-SGFET neural sensors using MoS_2-FET switches

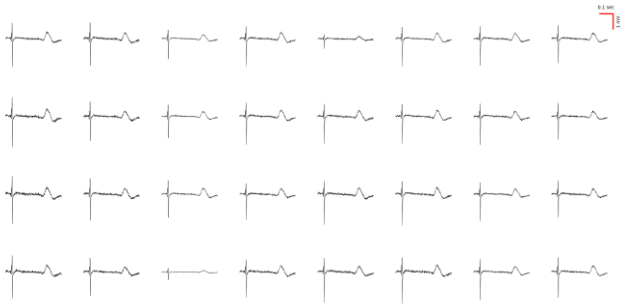

Figure 2: Simultaneous recording of neural signal in 32 sensors using time-division multiplexing

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