Large array of GFETs for extracellular communication with neuronal cells

D. Kireev, J. Schnitker, S. Seyock, V. Maybeck, B. Wolfrum, A. Offenhäusser

Institute of Bioelectronics (PGI-8/ICS-8), Forschungszentrum Jülich, 52425 Jülich, Germany

Graphene has already shown its high ability for biosensing. Solution-gated graphene field effect transistors, which showed very high sensitivity in electrolytes [1], have another biologically important application: recording neuronal activity. Such devices exhibit very high signal-to-noise ratio for extracellular measurements [2].

The aim of this work is to optimize and scale both fabrication procedure and measurement system. When working with biological samples, there is a need in a large number of devices. High density of the devices is also preferable. Therefore we fabricate the devices on 4'' wafer, resulting in 50 chips, 11*11mm each. Each chip consequently embodies an array of 32 graphene FETs (see fig.1). The active area of the chip is around 2 mm^2 while each GFET's channel differs between 5 and 20 um with altered configurations.

Such devices, when used with the already developed multichannel measurements system make possible simultaneous measurement and stimulation of all 32 transistors in a time-scale. This makes possible to measure not just discrete spikes, but even propagation of the action potential through the neuronal network.

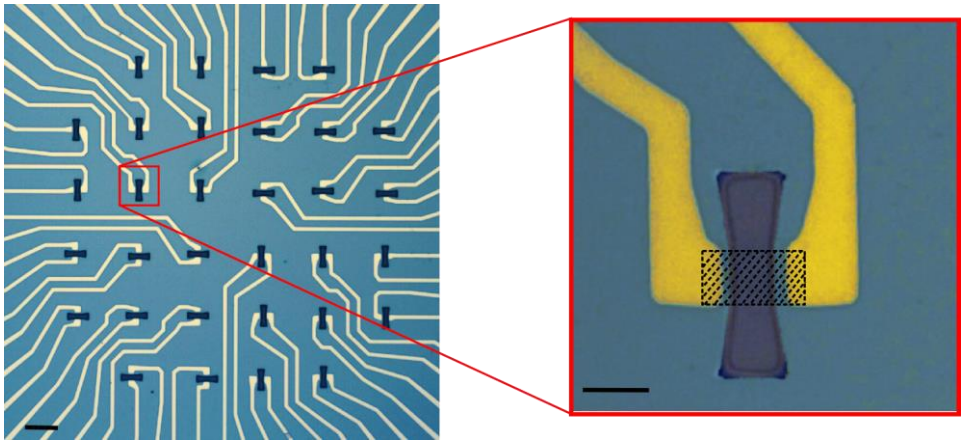

Fig. 1. The fake color optical image of the chip's active area. Black areas at the left figure are the openings in the SU-8 passivation. Dashed area at the right represents graphene underneath the structure. Scale bars are 100um and 20 um consequently.

[1] Dankerl, M., Hauf, M. V., Lippert, A., Hess, L. H., Birner, S., Sharp, I. D., Mahmood, A., Mallet, P., Veuillen, J.Y., Stutzmann, M., Garrido, J. A. Advanced Functional Materials, 20(18), 3117–3124. (2010)

[2] Hess, L. H., Jansen, M., Maybeck, V., Hauf, M. V, Seifert, M., Stutzmann, M., Sharp I. D., Offenhäusser A, Garrido, J. A., *Advanced materials*, 23(43), 5045–9 (2011)