

Two-way Interface for Directing the Biological Signals

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INTRODUCTION: Electrical properties of hybrid structures consisting of arrays of nanowire field-effect transistors (FETs) integrated with the individual axons and dendrites of live mammalian neurons have been reported. Arrays of nanowire-neuron junctions enable simultaneous measurement of the rate, amplitude, and shape of signals propagating along individual axons and dendrites. Interfacing of nerve cells and FETs is determined by current flow along the electrical resistance of the cell-chip junction. A spectral power density of the junction is $5 \times 10^{-14} \text{ V}^2/\text{Hz}$ and can be interpreted as Nyquist noise of the cell-chip junction with a resistance of 3 MOhm by measuring the fluctuations of extracellular voltage with a low-noise transistor. The thermal noise allows us to elucidate the properties of cell adhesion and it sets a thermodynamical limit for the signal-to-noise ratio of neuroelectronic interfacing.

METHODS: Application variety of the novel superconducting, organic and CNT FETs allows us to design transducers of biosignals (BSs) (electronic, nerve, DNA, etc.) that transduce them into different quantities, including electric voltage, density of chemical and biomolecules. On the other hand, the said BSs can be controlled by the applied electrical signals, or bio and chemical mediums [1].

Microdevices with electroplated wire traces were etched with well-defined edges. These devices are implanted in living bodies to connect nerve tissue with electronics to record nerve cell activities or restore lost functions by stimulation of nerve cells. Electroplating of gold meets the requirements for producing neural implants with low-ohmic wire traces, because this technique allows the microfabrication of gold layers with a thickness of several micrometers and lateral dimensions in the same range. Hence the mechanical stability of the electroplated gold is sufficient for chronic implantation of the structures. The implantable microelectrodes for neural applications are based on thin-film polymer foils with embedded microelectrodes for both recording and stimulation.

RESULTS: The peak currents range of BS from 5 to 10 μA give a maximal output voltage V_{out} on absciss axis -5 to 5V also with the necessity of some its reducing it slightly by changing V_{DS} (bias)

of the FET's channel. A current which elicits an action potential in the neuron is 0.6 nA and will stimulate V_{out} of the transducer equal to 12 mV.

TF of this device will be similar to the previous one:

$$K_{cNW} = \frac{V_{\text{out}}}{V_{\text{sup}} Q + i} \Rightarrow \left[\frac{1B}{10^{-7} \text{ A}} \right] \cong 10^7 \left[\frac{B}{\text{A}} \right] \quad (1)$$

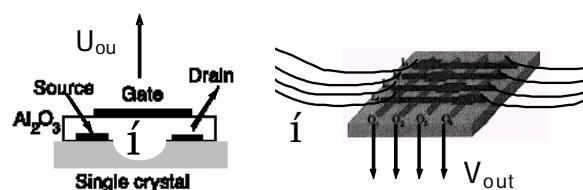


Fig. 1: An organic SuFET device and its electrodes (left); schematic of an interface in the parallel connection (right).

DISCUSSION & CONCLUSIONS: The described transducers designed on the basis of organic and nano superconducting FETs (SuFETs) are suitable for describing the wide range of BS dynamical parameters. It should be noticeable, that serial connection of the external pickup coils (PCs) allows us to gain some integrated signal, i.e., the whole sensing or control electronic or nerve impulses (NI), which spreads along the number of axons of the nerve fibre; the amount of ions passing through the PCs and the generalized BS passing through one or both spirals of DNA. When SuFET channel(s) of are implanted into the tissue or process we can acquire more precise data about the frequency distribution of NI, volume distribution of ionized molecules and detecting activity of individual nucleotids [2].

REFERENCES: ¹ R. Sklyar (2003) *A SuFET Based Either Implantable or Non-Invasive (Bio)Trans-ducer of Nerve Impulses*, 13th International Symposium on Measurement and Control in Robotics - ISMCR'03, Madrid, Spain: 121-6. ² Sklyar R. *Superconducting Organic and CNT FETs as a Biochemical Transducer* ISMCR 2004: 14th International Symposium on Measurement and Control in Robotics, 16-18 September 2004 - NASA Johnson Space Center, Houston, Texas, IEEE (ISMCR): section 24.