

A BIO-HYBRID PLATFORM USING THIN-FILM-TRANSISTOR ARRAYS AND A BIOMIMETIC NEURAL NETWORK

Anne-Claire Eiler,¹ Khoystate Farad,² Satoshi Ihida,¹ Hiroshi Toshiyoshi,¹ Timothée Levi,^{1,2} and Agnès Tixier-Mita¹

¹The University of Tokyo, Japan

²The University of Bordeaux, France

INTRODUCTION

Neurons and cardiac cells exhibit electrical activity, which is usually measured in-vitro using Multi-Electrode-Array (MEA) devices [1]. This work proposes a bio-hybrid platform which interfaces and evaluates with a biomimetic neural network new types of MEAs, made by Thin-Film-Transistor technology. Actually, it is the only technology, recently used for biological applications [2], which makes possible to reach around two orders of magnitude in term of density of sensing areas compared to MEAs. By combining a biomimetic device to this development, the authors investigated how neural biomimetic signals are sensed by the TFT array device, as a preliminary investigation before interfacing with biological cells.

METHODS

The bio-hybrid platform consists of four different parts connected as shown on Figure 1: (1) an FPGA neural biomimetic device; (2) the TFT array device controlled by (3) a control card system; (4) a measurement system. With (1), two types of signals were investigated with respect to the two action potentials of cortical neurons: one excitatory neuron (regular-spiking) and one inhibitory neuron (fast-spiking). The TFT array device (2) consists of a large and dense array of 100- μm -square microelectrodes, covered with a 0.1M solution of KCl, and individually controlled by an array of switch TFTs. The ON and OFF state of the switch TFTs was controlled by the control card (3). The input signal was applied to one microelectrode for stimulation, and the output signal was measured with an oscilloscope (4) on the next microelectrodes, or the USB-ME32 Multichannel System (MCS).

RESULTS

The output signal was first measured, at the next microelectrode, using an oscilloscope (Agilent MSOX2004A). It showed an attenuation of 35%, due to the high impedance of the TFTs, and a noise level around 30 mV. Next, the MCS system was used for array measurement. The input regular-spiking was chosen with amplitudes close to biological cell activities, and went from 100 mV to 400 mV (Figure 2). An attenuation of 1000 was obtained due to the data processing of the measurement system to improve drastically the signal-to-noise ratio. Both regular-spiking and fast-spiking signals have been successfully measured with the TFT array device. In addition, when moving away from the input microelectrode, a clear attenuation of the signal was observed.

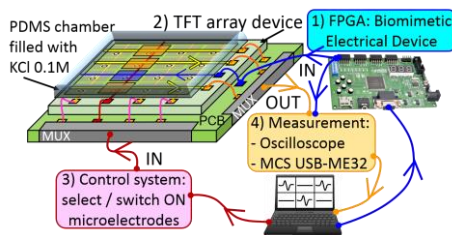


Figure 1: Scheme of the bio-hybrid platform

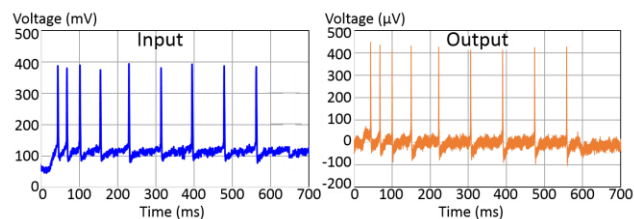


Figure 2: Example of measurement result with MCS system, for a biomimetic neural signal

CONCLUSIONS

The results show a good agreement in shape between the input and output signals. The interfacing between the biomimetic device and the TFT array device has been demonstrated. The next step will be the combination with biological cells to open new investigation paths for neural prosthesis modeling in biomedicine.

REFERENCES

- [1] M.E. Spira and A. Hai, "Multi-electrode array technologies for neuroscience and cardiology", *Nature Nanotechnology*, vol. 8, pp. 83-94, 2013.
- [2] A. Tixier-Mita, et al. "Review on thin-film transistor technology, its applications, and possible new applications to biological cells", *Japanese Journal of Applied Physics*, vol. 55, 04EA08, 2016.

KEYWORDS: Thin-Film-Transistor (TFT), Biomimetic Interface, Bio-microsystems, Neural Network