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Direct Recording of Action Potentials of Cardiomyocytes Through Solution Processed Electrolyte-Gated Field-Effect Transistors

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To achieve intracellular recording of Action Potentials (APs) by using easily fabricated and processed devices is crucial in cardiology and neuroscience. Present tools and technology include invasive patch clamp technique, 3D nanostructures often combined with electro/opto poration methods and nanodevices such as nanowire field-effect transistors. However, most of these techniques either require complex manufacturing processes or require an external poration technique to access the intracellular space. Here, we present the spontaneous intracellular recording of cardiomyocyte cells using a cost-effective, co-planar Electrolyte Gated Field-Effect Transistor (EGFET) based on solution-processed polymer-wrapped monochiral single-walled carbon nanotubes (s-SWCNTs)[1]. To date, EGFETs have only been employed to record the extracellular potential of electrogenic cells.[2] In this work, we were able to record the intracellular APs of human induced pluripotent stem cells derived cardiomyocytes by simply turning on the transistor at its maximum transconductance. The ability to measure intracellular action potentials using extracellular EGFETs is attributed to the out-of-plane topography of s-SWCNTs and to the tight adhesion of cells on CNTs which may lead to engulfment or possibly to spontaneous internalization of the carbon nanotubes to the cell membrane. In addition, we will also demonstrate the successful employment of electroporation using planar EGFETs with significant device performance and cell viability. The simplicity of the device combined with the high signal to noise ratio opens up new opportunities for low-cost, reliable, and flexible biosensors for high quality recording of cellular action potentials.

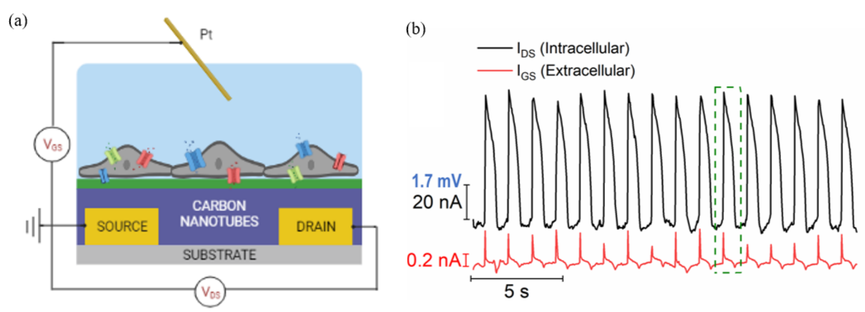

Figure: (a) Schematic of the Electrolyte Gated Field-Effect Transistor (EGFET) based on solution-processed polymer-wrapped monochiral single-walled carbon nanotubes (s-SWCNTs) coupled with cells. (b) Bioelectronic recording seen in the transistor current traces.

References

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2. Kyndiah, A. *et al.* Bioelectronic Recordings of Cardiomyocytes with Accumulation Mode Electrolyte Gated Organic Field Effect Transistors. *Biosens. Bioelectron.* **150**, 111844 (2020).