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An electrical model for silicon-nanowire electrodes in intracellular signal measurement in biological environments

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Measurement of small signals originating from ionic activity inside a biological cell known as action potential, poses a great challenge to biomedical scientists. The electrical signals of the biological cells result from exchange of ions through the cell membrane. The characteristics of action potentials may reveal a great deal of information about the causes and symptoms of abnormal cell behavior. Hence, it is imperative to capture high quality action potentials through the use of nano-sensors from within the cell. Recently, developments in silicon nanowires (SiNW) fabrication techniques have demonstrated a great potential for them to be used as nano-electrodes. Large-scale assembly and integration of addressable complementary silicon nanowires arrays have been demonstrated for multiplexed biosensor arrays. The fabrication process resulted in a high-yield, high performance devices arrays for chemical and biological detection. In this paper, we seek to model the electrical interface that is responsible for recording the biological signals. We present electrical equivalent circuits that model the boundary between the biological cell and the nanowire electrode. Impedance measurement curves of nanowires for various sizes of length and diameter have also been presented and discussed in this paper. The impedance graphs show a hyperbolic dependence of resistance on length and diameter of nanowires. This non-linear behavior may be mitigated in software algorithms when interpreting the measured cell signals. We believe that the proposed electrical model will lead to a more accurate characterization of NW biosensor arrays which are now integrated on disposable PCB interfaces. It will potentially evolve the sensor arrays into a controllable and scalable nanowire biosensor platform for clinical and point-of-care diagnostic applications in the near future.

Biography

Alex Hariz completed his MS in 1983 and PhD in 1989 in Department of Electrical Engineering at University of Southern California. He then completed his Post-doctoral Fellow position in Department of Physics at Simon Fraser University in Canada. He joined the University of South Australia in 1992, and is currently a Senior Lecturer in School of Engineering, teaching courses such as electronic devices, linear electronics, integrated circuits, and MEMS. His research activities include "Silicon microelectronics, micro-engineering of inertial sensors, micro-optics and fabrication of bio-MEMS sensors for use in biomedical applications". He is an Editorial Board Member of *Journal of International Decision Technologies.*

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