Frontiers of More than Moore in Bioelectronics and the Required Metrology Needs

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ABSTRACT

Silicon‘s intersection with biology is a premise inherent in Moore's prediction. However, to realize this prediction, two grand challenge problems must be addressed - the biocompatibility of synthetic materials within the human body and the interfacing of solid state micro- and nano-electronic devices with the electronics of biological systems. Our center has concerned itself with these two grand challenge issues. We have sought to address these challenges through the exampled development of an implantable biochip for the measurement of physiological stress markers during trauma induced hemorrhage [1]. A fully implantable and rapidly deployable biosensor system for the measurement of lactate, glucose, pH, and oxygen with telemetered reporting of physiologic status is under development. Such a device is relevant for battlefield casualty care and management, mass casualty triage decision making, and of course, civilian trauma. The device can be rapidly administered to the hemorrhaging patient by a first responder, medic or EMT, to allow accrual of critical physiologic data to be used by the far-forward or emergency room trauma surgeon.

To address the needs of the system, we have developed soft, condensed, biomimetic but otherwise inherently electronically conductive materials to address the challenge of interfacing solid state devices with the electronics of the body, which is predominantly ionic [2]. These electroconductive hydrogels offer the potential for biocompatibility while sustaining electrical fidelity across the biological-to-solid state interface. We have developed nano-templated interfaces via the oriented immobilization of single walled carbon nanotubes (SWCNTs) onto metallic electrodes to engender reagentless, direct electron transfer between biological redox entities and solid state electrodes [3]. We have developed processing techniques to alter the time scale of assembly of large biomolecules such as enzymes and nanomaterials such as SWCNTs [4].

In addressing these challenges, metrology needs and opportunities are found in such widely diverse areas as single molecule counting and addressing, sustainable power requirements such as the development of implantable biofuel cells for the deployment of implantable biochips, and new manufacturing paradigms to address plura-biology needs on solid state devices.

Keywords: bioelectronics, nanometrology, biosensors, biochips, biointerfaces

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