Nanostructured Electrodes : New Bionic Interfaces

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The search for materials that effectively bridge the electronics – biology interface is challenging but is being pursued with relentless vigour. Such materials must possess a unique combination of electrical, mechanical and bioactive/biocompatible properties. The discovery of organic conducting materials has fuelled the enthusiasm of those involved in this search. These materials including inherently conducting polymers and carbon nanotubes can be configured as electrode materials that enable us to transcend the chasm that is the bionic interface. Compositions with all of the prerequisite properties have been produced in recent years. A further exciting aspect of these materials is their dynamic properties. The fact mechanical, electrical and bio properties can be altered in response to small electrical stimuli – makes them highly effective bionic materials. They can be tuned to interact with selected biomolecules even to the extent that antibody-antigen binding events can be controlled or release of biologically active molecules such as nerve growth factors can be triggered. Mammalian cells can be cultured on these new material platforms with electrical stimulation used to promote proliferation. At the skeletal level wearable sensors can be used to monitor human movement and artificial muscles based on organic conductors used to control this movement. Nanostructuring of these organic conductors has been shown to increase their effectiveness as bionic materials. Delving into the nanodomain it has recently been discovered that a concomitant improvement in both mechanical and electrical properties can be achieved with significant ramifications for artificial muscle design. Our recent results on the design and synthesis of organic conductor materials as well as the fabrication of devices that enable effective communication with biomolecules, mammalian cells (including nerve cells) and with skeletal systems for monitoring and controlling movement will be presented here.

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