Single-Step Electrochemical Assembly and Interconnecting of Diameter-Tunable Nanowires

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Background: The Directed Electrochemical Nanowire Assembly (DENA) technique is a single-step approach to fabricating metallic nanowires and interconnecting them with external circuitry or other objects. An alternating voltage is used to induce the crystallization (via non-stationary dendritic solidification) of metallic wires from aqueous solutions of simple salts. Hence, metallic cations are reduced and deposited on the solidification front during the negative half-cycle of the applied voltage signal.

Summary of the Technology: OSU researchers have recently expanded the DENA technique to enable the growth of non-metallic nanowires via oxidative deposition during the positive half-cycle of the applied voltage signal. In this effort, a solution of pyrrole and sodium dodecyl sulfate was deposited over a pair of on-chip electrodes, and a square wave signal was applied to one electrode while the other was grounded. The pyrrole molecules are oxidized during the positive half-cycle of the applied voltage-signal, leading to polymerization and growth of conducting polymer nanowires. Hence, individual polypyrrole wires may be grown from the tip of one electrode across the electrode gap and into contact with the tip of the other electrode. Like the metallic wires that are grown by the DENA technique, the diameter of these conducting polymer wires may be tuned by varying the voltage-frequency or the pyrrole-concentration: increasing the frequency reduces the wire-diameter. Additionally, the growth-path of the nanowire closely follows the line connecting the electrode tips, so the user may specify the growth-path in order to connect the nanowire to an interelectrode target. As such, we have employed the DENA-technique to establish electrical contact with single Dictyostelium cells that were cultured onto electrode arrays. This capability allows voltage-stimulation studies to be made on the single cellular and sub-cellular levels. Delivery of a steady voltage to the wire-cell contact point was found to induce a physiological response at that site: a spherical deformation of the cellular membrane.

Main Advantages of the Technology: This technology provides a means for growing nanowires along a specified growth path.

Potential Areas of Application:

- Cell-stimulation and signaling studies.
- Fabrication of conducting polymer-based electronics.

Patent Status: A provisional patent application has been filed.