Bionanoelectronics with natural and artificial membrane transporters

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Abstract
Bioelectronic interfaces are beginning to generate an increasing interest in the biosecurity community and beyond. Such interfaces could play an important role in a varity of fields ranging from biodetection, biosensing and countermeasure development, to medical diagnostics and human-computer interactions. One of the promising routes to the next generation interfaces involves harnessing and mimicking biological functionality in electronic devices. I will present two examples of such approaches that we are currently developing at LLNL. The first example shows a general route for incorporating membrane proteins, which perform some of the key biological functions in a living cell, into nanoelectronic devices. To preserve protein functionality in the device, we use hierarchical assembly of lipid molecules and membrane proteins onto a nanowire transistor to create a 1-D bilayer device—a bioelectronic platform that can convert proton and ion transport events into electrical signals.[2] This presentation will present several examples of bioelectronic devices that use passive ion channels and active ATP and light-driven pumps,[1,3,4] as well as an extended version of the device that uses additional biological components to regulate the device performance.[1] The second example will show a recently developed nanoscale transport platform that replicates some of the key membrane protein transport characteristics in a structure based on a carbon nanotube. The biomimetic carbon nanotube porins (CNTPs) are capable of self-insertion into artificial lipid bilayers, as well as plasma membranes of live cells where they form well-defined nanoscale pores with interesting and useful transport characteristics.[5]
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Figures

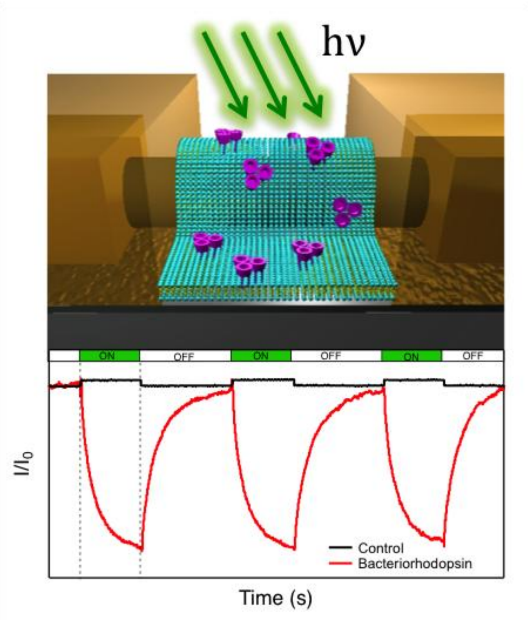

Figure 1: *Bionanoelectronic Si nanowire transistor that incorporates bacteriorhodopsin, a photoactivated proton pump proteins. Bottom graph shows the device signal recorded over several consecutive illumination cycles.*