Berkeley EECS Solid State Seminar, Mar. 9, 2018

Title:

Taking electrons out of bioelectronics: transistors, ion channels, and shark's electrosensors

Marco Rolandi
Chair and Associate Professor
Department of Electrical Engineering, University of California, Santa Cruz (USA)

Abstract:

The quest for smaller and faster computing has mostly focused on controlling the flow of electrons and holes in nanoscale structures. In living systems, ionic and protonic currents affect physiological function. As such, ionic and protonic devices offer exciting opportunities for bioelectronics. Proton transport in nature is important for ATP oxidative phosphorylation in mitochondria, light activated proton pumping in bacteriorhodopsin, and the antibiotic gramicidin. All these systems have in common networks of hydrogen bonds formed by water and biomolecules − proton wires. Protons hop along these wires according to the Grotthuss mechanism. In analogy with dopants in electronic semiconductors, in proton wires acids are H^+ donors and bases are H^+ acceptors to yield H^+ and OH^- (proton hole) conductors. I will discuss bioprotonic devices with biopolymer H^+ and OH^- conductors such as diodes, complementary transistors, resistive memories, which can be easily integrated in a flexible platform. These devices communicate with enzymes, ion channels, and cells to monitor and control physiological function. Finally, I will provide insights in the electrosensing organs of sharks and skates.

Biography:

Marco Rolandi, Ph.D., is Chair and Associate Professor of the Department of Electrical Engineering at the University of California, Santa Cruz. He is also co- founder of KitoTech Medical (2012) and Cruz Foam (2017). Prior to joining UCSC, Marco was an Assistant (2008-2014) and Associate Professor (2014-2015) of Materials Science and Engineering at the University of Washington (Seattle). He received his PhD in Applied Physics from Stanford University in 2000. His research focuses on bioelectronic systems and devices, biological materials, and their translational applications. His work on bioprotonic transistors was highlighted in *The New York Times, New Scientist, MRS 360, IEEE Spectrum, Materials Views, Engadget, Popular Science*, and several others. His work on shark's electrosensors was highlighted in The Washington Post, Popular Science, Motherboard, Physics World, and it was on the front page of Reddit. He is also interested in visual communication in science and engineering and his essay on how to prepare scientific figures was the most downloaded article in *Advanced Materials* during the fall of 2011 (> 10,000 times). He received a 3M Untenured Faculty Award (2010), an NSF-CAREER award (2012), and was selected as one of the TR-35 GI by the MIT Technology Review (Italy, 2012).

Web: https://rolandi.soe.ucsc.edu
Twitter: @RolandiGroup