Interfacing Cells and Biomolecules with Floating Gate Ion Sensitive Transistors

Krishna Jayant
Cornell University, ECE

In this talk, I will briefly describe bio-electrical interfaces to cells and biomolecules with an emphasis on innovative sensing techniques and improved functionality using field effect transistor based detectors. The talk will be divided in three parts. In the first part, I will introduce the concept of a Programmable ISFET which is based on the principle of "Electrochemical Gating", a mechanism by which the exposed electrode/electrolyte interface charge can be electrically controlled. I will highlight through both simulation and experiment that this effect leads to surface pH tuning which helps establish a single transistor sensor/actuator hybrid. Given the dual gate feature of the device and the concept of capacitive amplification, implications on DNA sensing will be discussed. I will further describe how this approach can help realize on demand DNA adsorption and release creating a bidirectional DNA pixel. In the second part of the talk I will introduce a spectroscopy detection methodology in conjunction with self amplifying DNA origami to detect DNA interactions and sensing in highly saline environments potentially realizing ISFET based sensors operating above the Debye screening limit. In the third part, I will switch direction and describe our recent experiments on cell-transistor synaptic interactions with a focus on high temporal electrochemical recordings of exocytosis from electrically excitable and non-excitable cells corroborated with fluorescent readout.

Bio: Krishna Jayant completed his Bachelors in Electrical and Electronics Engineering from the National Institute of Technology Tiruchirappalli, India in 2005. From 2005to 2006 he was a research assistant at the Indian Institute of Science, Bangalore, India where he worked in the area of MEMS. In 2006 he joined the Advanced Research Center for Electronic Systems (ARCES) at the University of Bologna Italy, where he worked on Dielectrophoresis based Cell on Chip systems for isolation and manipulation of rare cancer cells. In the spring of 2008 he started his PhD under the supervision of Prof. Edwin C. Kan at Cornell where he investigates FET based sensors as cell and biomolecular interfaces. In 2012 he held a visiting PhD position at the Kavli Institute of Nanoscience at TU Delft where he worked in the group of Prof. Cees Dekker on graphene nanopores. His current research interests broadly include biophysical techniques, electrochemistry, nanoelectronic devices and integrated CMOS sensors.