Session 31: Sensors, MEMS, and BioMEMS– Devices for Biological Science, Medical Applications and Health Monitoring
Wednesday, December 17, 9:00 a.m.
Imperial Ballroom B
Co-Chairs: Carlotta Guiducci, Ecole Polytechnique Federale de Lausanne
Gary Fedder, Carnegie Mellon University

9:05 a.m.
31.1 Bio-MEMS towards Single-Molecular Characterization, H. Fujita, The University of Tokyo

MEMS devices, which are capable of handling fluids and as small as molecules, are utilized for handling and measuring bio molecules in the single molecular level. Silicon nano tweezers for DNA characterization, arrays of micro chambers for single molecular enzymology, and chips with linear bio molecular motors, were demonstrated.

9:30 a.m.
31.2 An AC and Phase Nanowire Sensing for Site-Binding Detection, M. Tartagni, M. Crescentini, M. Rossi, H. Morgan* and E. Sangiorgi, University of Bologna, *University of Southampton

Nanowire and nanoribbon sensing is mostly performed by means of quasi-static measurements (DC) that are unable to detect the time-dependant behavior of charges and their displacement at the interface. In this paper we propose a technique and a model for sensing nanowires in sinusoidal regimes (AC) that is able to capture both magnitude and phase information of the device response. The approach combines the advantages of complex impedance spectroscopy with the noise reduction performances of lock-in techniques. Experimental results achieved by using an integrated circuit (IC) interface reveal how different surface functionalizations showing the same DC output could be discerned by using the AC approach.

9:55 a.m.
31.3 MEMS for Cell Mechanobiology, B. Pruitt, Stanford University

To study how cells and tissues integrate mechanical signals requires specialized cell cultures systems and micromachined tools to stimulate and measure forces and displacements. A key feature of such experiments is the ability to observe cell outputs such as morphology, protein expression, electrophysiology, force generation or transcriptional activity.

10:20 a.m.
31.4 Organic Electrochemical Transistors for BioMEMS Applications, G. Malliaras, Ecole Nationale Supérieure des Mines

A visible trend over the past few years involves the application of organic electronic materials to the interface with biology, with applications both in sensing and actuation. Examples include biosensors, artificial muscles and neural interface devices. These materials offer an attractive combination of properties, including mechanical flexibility, enhanced biocompatibility, and capability for drug delivery. Most importantly, high ionic mobilities in organic films enable new ways of single transduction. An example of a device that takes advantage of these properties is the organic electrochemical transistor (OECT). In this device, ions from an electrolyte enter a conducting polymer channel and change its conductivity, hence the drain current. As such OECTs offer a convenient and powerful way to transduce ionic fluxes of biological origin. Here we report high performance OECTs that are integrated with mechanically flexible substrates and are used to record neural activity. Namely, we show that OECTs in contact with a brain can record neural activity with a higher signal-to-noise ratio than electrodes of the same size. We also show that OECTs can record brain activity in humans through the scull with high fidelity. As such, they promise to yield a new tool for neuroscience and enhance our understanding on how the brain works.

10:45 a.m.
31.5 Microfabricated Smart Lab-on-a-Tube (LOT) Probe for Monitoring Traumatic Brain Injury (TBI), C. Li, Z. Wu*, P. Wu, N. Bhattacharjee, J. Hartings**, R. Narayan* and C. Ahn, University of Cincinnati, *Feinstein Institute for Medical Research, **UC College of Medicine

The purpose of this research was to develop a novel multimodality lab-on-a-tube (LOT), smart catheter, which could accurately track multiple parameters in the injured brain. In addition, the ideal smart catheter would allow for drainage of excess cerebrospinal fluid (CSF) as a strategy to reduce intracranial pressure.

11:10 a.m.
31.6 Small Soft Safe Micromachines for Biomedical Applications, S. Konishi, Rtisumeikan University

This paper focuses on small, soft, and safe (S^3) micromachines for biomedical applications. Micromachines are small in nature. We have developed all polymer pneumatic balloon actuator (PBA) as S3 actuator. Novel technologies have been studied in our developmental process of S3 micromachines. S3 micromachines are based on their soft and flexible structure and safe driving principle. Polymers such as polyimide and PDMS (polydimethylsiloxane) allow soft and flexible structure. Pneumatic driving method can provide safe operation especially for medical application. The PBA-based medical micromachine was applied to a retractor for spacing in front of the endoscope at our early stage. This talk also presents the PBA as a surgical tool for a retinal pigment epithelium transplantation. As our recent works on S^3 micromachine, pharmaceutical and biological applications will be also presented.

11:35 a.m.
31.7 Biointegrated Systems with Unusual Stretchable Materials and Designs for Sensing and Therapy, R. Ghaffari, M. Raj, S. Patel, P. Wei, B. Zhang, X. Wang and B. Keen, MC10 Inc.

Advances in the microelectronics industry have driven important advances in smart medical devices and healthcare. However, there are significant limitations inherent in all standard forms of rigid electronics. These geometrical and mechanical constraints impose unique integration and therapeutic delivery challenges for medical devices. Here, we describe unusual materials and designs for skin-based systems that incorporate physiological sensors and actuators configured in stretchable formats. Quantitative analyses of performance and data transmission under mechanical stress, highlight the clinical utility of these systems in tracking patients with neuromuscular movement disorders. As demonstrations of this technology, we present representative examples of biointegrated systems that highlight previously unrealized functionality and performance coupled with extreme mechanical flexibility.