Session 29: Sensors, MEMS, and BioMEMS - Biosensors and Neural Interfaces
Wednesday, December 5, 9:00 AM
Continental Ballroom 1-3
Co-Chairs: D. Kuzum, University of California, San Diego
B. Boyanav, Illumina

9:05 AM - 9:30 AM
29.1 A CMOS Proximity Capacitance Image Sensor with 16µm Pixel Pitch, 0.1aF Detection Accuracy and 60 Frames Per Second, *M. Yamamoto, R. Kuroda, M. Suzuki, T. Goto, H. Hamori*, S. Murakami*, T. Yasuda*, and S. Sugawa, Tohoku University, *OHT Inc.*

A 16µm pixel pitch 60 frames per second CMOS proximity capacitance image sensor fabricated by a 0.18µm CMOS process technology is presented. By the introduction of noise cancelling operation, both fixed pattern noise and kTC noise are significantly reduced, resulting in the 0.1aF detection accuracy. Proximity capacitance imaging results using the developed sensor are also demonstrated.

9:30 AM - 9:55 AM
29.2 3D Expandable Microwire Electrode Arrays Made of Programmable Shape Memory Materials, *R. Zhao, X. Liu, Y. Lu, C. Ren, A. Mehrsa, T. Komiyama and D. Kuzum, University of California San Diego*

Nitinol is biocompatible and widely used in biomedical applications. Here we demonstrate 3D expandable nitinol microwire electrode arrays that can be programmed to conform to the brain vasculature, minimizing blood vessel damage during implantation. In in vivo experiments, our microwire arrays detect single spikes and neural potentials without tissue damage.

9:55 AM - 10:20 AM
29.3 Bio-inspired 3D neural electrodes for the peripheral nerves stimulation using shape memory polymers, *Y. Zhang, N. Zheng*, Y. Ma, T. Xie* and X. Feng, Tsinghua University, *Zhejiang University*

To minimize the mechanical mismatch and facilitate the surgical implantation, bio-inspired 3D neural electrodes that fabricated based on traditional planar processing are proposed, which can be introduced into the body in planar state and self-climb to the 3D peripheral nerves. In vivo animal experiments has demonstrated the potential clinical utility.

10:20 AM - 10:45 AM
29.4 Fabrication and Characterization of 3D Multi-Electrode Array on Flexible Substrate for *In Vivo* EMG Recording from Expiratory Muscle of Songbird, *M. Zia, B. Chung, S. J. Sober*, and M. S. Bakir, Georgia Institute of Technology,*Emory University*

This work presents fabrication and characterization of flexible three-dimensional (3D) multi-electrode arrays (MEAs) capable of high signal-to-noise (SNR) electromyogram (EMG) recordings from the expiratory muscle of a songbird. The fabrication utilizes a photoresist reflow process to obtain 3D structures to serve as the electrodes. A polyimide base with a PDMS top insulation was utilized to ensure flexibility and biocompatibility of the fabricated 3D MEA devices. SNR measurements from the fabricated 3D electrode show up to a 7x improvement as compared to the 2D MEAs.

10:45 AM - 11:10 AM
29.5 Bioelectronics at the Single Molecule Level (Invited), *O. Tolga Gul, K. M. Pugliese*, Y. Choi*, A. J. Rajapakse*, C. J. Lau*, N. Kumar*, K. N. Gabriel*, D. Marushchak*, T. J. Olsen*, D. Pan*, G. A. Weiss*, and P. G. Collins*, Ankara Hacı Bayram Veli University, *University of California at Irvine*

Bioelectronic devices built with single molecules of a protein, enzyme, or aptamer represent a new class of hybrid electronics. When biofunctionalization of nanoscale conductors is reduced to one molecule, that molecule's dynamic activity can be transduced into a large amplitude, high bandwidth electronic output. The resulting single-molecule devices bridge solid state electronics with the world of chemical activity and biological complexity, and they represent a far-reaching, transformative opportunity for molecular electronics. For example, they can capture the dynamic signals generated as target molecules arrive, activate, or bind; and quantitatively reveal the timing, thermodynamics, and rate distributions of complex chemical events like protein-protein recognition, enzymatic activation, or pharmaceutical inhibition. Here, we review recent progress making single-molecule bioelectronic devices using carbon nanotubes as the connective wiring to DNA polymerase I, an example enzyme having complex functionality. The results show how single-molecule bioelectronics can reveal biochemical activity with bond-by-bond resolution.

11:10 AM - 11:35 AM

29.6 Si Nanowire Biosensors Using a FinFET Fabrication Process for Real Time Monitoring Cellular Ion Actitivies, *Q. Zhang, H. Tu, H. Yin*, F. Wei, H. Zhao, C. Xue**, Q. Wei, Z. Zhang*, X. Zhang, S. Zhang, Q. Han**, Y. Li*, R. C. Zhao**, J. Yan***, J. Li*, and W. Wang*, General Research Institute for Nonferrous Metals, *Institute of Microelectronics, CAS, **School of Basic Medicine Peking Union Medical College, ***North China University of Technology*

In this paper, a biocompatible biosensor based on horizontal Si nanowire (NW) array field-effect transistor (FET) has been fabricated by the feasible spacer image transfer (SIT) process. The Si NW FET as biosensor is proposed for the real-time cellular Ca2+ monitoring for mesenchymal stem cells (MSCs), which presents fast-responded and high-sensitive characteristics. Compared with the conventional sensing techniques, the Si NW biosensor exhibits non-invasive, biocompatible and reliable advantages. This will help us to further understand the mechanism of cellular ion activities and provides a promising method for the cell-level diagnose and therapy.

11:35 AM - 12:00 PM

29.7 A Flexible, Heterogeneously Integrated Wireless Powered System for Bio-Implantable Applications using Fan-Out Wafer-Level Packaging, *G. Ezhilarasu, A. Hanna, R. Irwin, A. Alam, and S. S. Iyer, University of California*

Fan-Out Wafer-Level Packaging (FOWLP) is used to fabricate a near field wireless implantable system on an ultra-flexible (~5mm bending radius) & biocompatible elastomeric substrate. A µLED is powered wirelessly with an efficiency > 15% @ 1cm transmit distance. The implantable system is only ~535µm thick with a diameter <2cm.