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BIOLOGICAL + CHEMICAL SENSORS SUMMIT 2016

December 5–7 • Marriott San Diego
La Jolla, CA, USA

CONFERENCE TRACKS

- BIOLOGICAL AND CHEMICAL SENSORS FOR **HEALTHCARE APPLICATIONS**
- BIOLOGICAL AND CHEMICAL SENSORS FOR **EMERGING APPLICATIONS**

TUTORIAL

- SENSOR MARKET OVERVIEW

CO-LOCATED SYMPOSIUM

- IMPLANTABLE BIOMEDICAL SYSTEMS

KEYNOTE PRESENTATIONS

Micro and Nanoscale Printing of Sensor Platforms for Pathogen Detection and Physiological Monitoring AHMED BUSNAINA, PH.D., NORTHEASTERN UNIVERSITY

Securing the New Wearables World GARY DAVIS, INTEL SECURITY

Biological & Chemical Sensors for Emerging Applications PETER EMANUEL, PH.D., US ARMY

Improving Therapeutic Outcomes and Lowering Costs Through Wireless Bioelectronics ADA POON, PH.D, STANFORD UNIVERSITY

Artificial Intelligence in Behavioral Health CHRIS POULIN, MICROSOFT

The Intelligent Home, Medical Sensors—Nudging Towards Better Health and Healthcare NICK VAN TERHEYDEN, M.D., DELL

Final Weeks to Register!

FINAL AGENDA

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Hotel & Travel

Conference Venue and Hotel:
Marriott San Diego La Jolla
4240 La Jolla Drive
La Jolla, CA 92037
Phone: 858-587-1414

Discounted Room Rate: $199 s/d

Discounted Reservation Cutoff Date: November 8, 2016

Reservations and Additional Travel Information:
Go to the travel page of SensorsGlobalSummit.com

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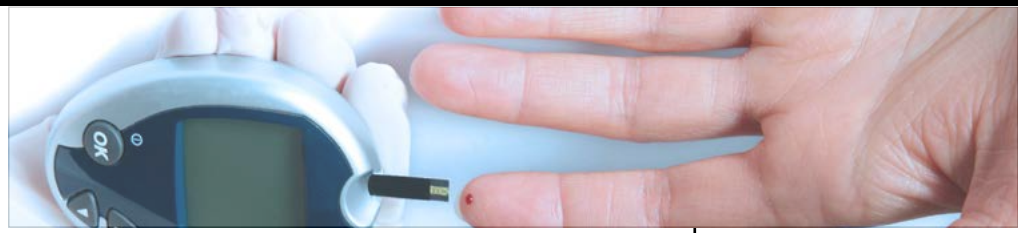
Low cost materials *and advances in nano and micro fabrication techniques within the manufacturing process have led to significant increases in the commercialization of biological and chemical sensors for healthcare applications. The increases in demand for diagnostics and measuring devices such as glucose monitoring, pacemakers and other implantables and wearables have helped to create a significant marketplace for this commercialization. This conference track will examine the latest advancements in research, development and engineering and will provide attendees with the state of the art in biosensors development for healthcare.*

TRACK 1 • DECEMBER 5-6, 2016

BIOLOGICAL AND CHEMICAL SENSORS FOR **HEALTHCARE APPLICATIONS**



MONDAY, DECEMBER 5, 2016

8:00 am Conference Registration and Morning Coffee

8:55 Chairperson's Opening Remarks
Kalle Levon, Ph.D., Research Professor, Chemical and Biomolecular Engineering Department, New York University

OPENING KEYNOTE PRESENTATIONS

9:00 The Intelligent Home, Medical Sensors – Nudging towards Better Health and Healthcare

Nick van Terheyden, M.D., CMO, Dell
This presentation will discuss the cultural, market and regulatory forces that are driving change, and how we are actively enhancing development, implementation and adopting novel technologies, services, and applications that will revolutionize information-driven care, that results in improved patient outcomes and overall cost savings worldwide.

9:30 Artificial Intelligence in Behavioral Health

Chris Poulin, Data Solution Architect, Microsoft
The Durkheim Project was a DARPA sponsored behavioral analytics project running from 2011-2015. In this talk, we will discuss the data collection methods, the machine learning algorithms, and the health related intelligence resulting from the system. Implications for current and future work in the field will also be discussed.

SENSORS ROADMAP FOR HEALTHCARE

10:00 Sensing is the Future of Health Care: Technology Road Mapping Helps Find the Way
Noa Ghersin, Analyst, Lux Research Inc
Wireless communication standards have evolved to allow sensors on or around patients to securely transmit data, greatly improving patient mobility and sensor utility. At the same time, significant increases in computing power are enabling automatic analysis of sensor data, while the advent of networking and cloud computing allows users to store and access data from almost anywhere. Understanding which technologies to develop and how to position them in the right market segments is paramount to success for companies looking to capitalize on the future growth.

10:30 Coffee Break with Exhibit & Poster Viewing

ADVANCED MATERIALS, DESIGN & MODELING FOR BIOSENSORS

11:00 Organic Semiconductor Coatings on Floating and Extended Gate FETs for Disease Detection
Kalle Levon, Ph.D., Research Professor, Chemical and Biomolecular Engineering Department, New York University
Organic semiconductors provide excellent surfaces for biomolecular binding analyses because the conjugation of ligands is easy with the organic molecules, the surface area can be maximized with nano structures and the band gap control offers additional electronic amplification. We shall present effective gas analysis based on acid/base reactions and counter ion interactions and also results from monitoring enzymatic reaction utilizing the redox reaction on the surface.

11:30 Transdermal Microneedle Sensors to Measure Biomarker Signatures
Ronen Polsky, Ph.D., Principal Member of Technical Staff, Department of Physical, Biological, and Chemical Microsensors, Sandia National Laboratories
The realization of a microneedle transdermal diagnostic platform has a wide range of applications including sports medicine, medical triage scenarios, and point-of-care diagnostics. I will describe work that (1) explores what needle geometries are best suited to penetrate the dermis and extract interstitial fluid (IF) with minimal discomfort, (2) identify select biomarkers that are accessible in IF and understand how interstitial levels correlate with clinically-relevant blood/plasma levels, and (3) design integrated sensor transducers that can detect biomarkers from extracted IF.

REGULATORY CHALLENGES TO COMMERCIALIZATION

12:00 pm Regulatory Considerations for Commercialization of Medical Devices
Orlando Lopez, Ph.D., Biomedical Engineer, Lead Regulatory Reviewer, Office of Device Evaluation, FDA
Discussion of the FDA regulatory process and associated considerations for taking a new medical device to market. Specific emphasis will be given to performance testing considerations needed to demonstrate safety and effectiveness of sensor-based devices.

12:30 Luncheon Presentation *(Sponsorship Opportunity Available)* **or Enjoy Lunch on Your Own**

NEXT GENERATION WEARABLES

1:55 Chairperson's Remarks
Nick van Terheyden, M.D., CMO, Dell

2:00 Healthcare Applications of Wearable Sensors & Systems and Wearable Patient Monitoring for Low Acuity Hospital Settings, Challenges and Opportunities
Rasoul Yousefi, Ph.D., Algorithms|Technology Development, RMS - Patient Monitoring & Recovery – MITG, Medtronic
Wearable monitoring is going beyond consumer electronics, and hospitals around the world are adopting wearable devices to reduce overall cost of care delivery. In this talk, I will review opportunities for outcome-driven wearable monitoring of patients in the general care floor with respect to the value-based healthcare system. Technical Challenges in research and development of wearable monitoring solutions will be discussed and state-of-the-art solutions and future trends will be presented.

2:30 Wearable Sensor Technologies: Their Future in Patient / Clinician Decision Making
Christopher M. Hartshorn, Ph.D., Program Manager, Office of Cancer Nanotechnology Research, National Cancer Institute

Cover

Sponsor & Exhibit Opportunities

Hotel & Travel Information

Agenda

Healthcare Applications

Emerging Applications

Symposium

Tutorial

Registration Information

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Wearable technologies for the consumer market have recently seen widespread adoption with a massive increase in sales of more than 180% in 2015. These wearable devices are designed to measure multiple human performance-based metrics via built-in and/or external sensors, continuously. This talk will focus on several large scale initiatives at the National Institutes of Health and attempt to chart the path forward relative to these questions.

3:00 Sponsored Presentation *(Opportunity Available)*

3:30 Refreshment Break with Exhibit & Poster Viewing

4:00 Wearable Transdermal Biosensors: Understanding the Chemical Self
Joshua Windmiller, Ph.D., CTO & Founder, Biolinq Technologies, Inc.
This talk highlights the development of a novel class of minimally-invasive electrochemical biosensors that facilitate the quantification of relevant metabolomic, electrolytic, hormonal, and neurochemical information in a continuous, real-time fashion. Fabricated through manufacturing processes that are scalable, cost-effective, and have a minimum environmental footprint, these novel biosensing modalities seek to bridge the gap between analytical-grade instrumentation typically found in the hospital laboratory and user requirements for unobtrusive, low-profile, skin-applied devices able to deliver timely, clinically-accurate, and actionable information using existing wirelessly-enabled wearable and mobile platforms.

4:30 Wearable Biosensors for Longitudinal Monitoring
Shekhar Bhansali, Ph.D., Alcatel-Lucent Professor & Chair, Electrical and Computer Engineering Department, Florida International University
Recent advances in sensing technologies are enabling a new class of wearable sensors that can continuously monitor both physiology and biochemistry of the patient in their native environment unobtrusively. This talk shares the recent developments in wearable sensing technologies, with an emphasis on wearable biosensing technologies, and introduces various use cases where these technologies can disruptively change health outcomes.

5:00 Welcome Reception with Exhibit & Poster Viewing

6:00 End of Day & Tutorial Registration

6:30-8:30 Tutorial: Sensor Data Management*

**Separate registration required. See page 7 for details.*

TUESDAY, DECEMBER 6, 2016

8:00 am Morning Coffee

8:25 Chairperson's Opening Remarks
Christopher M. Hartshorn, Ph.D., Program Manager, Office of Cancer Nanotechnology Research, National Cancer Institute

KEYNOTE PRESENTATIONS

8:30 Securing the New Wearables World

Gary Davis, Vice President, Intel
Wearables are opening up new pathways that facilitate the tracking, sharing and storing of consumers' personal health, location and daily activity data. Someone's heart rate, blood pressure, finances, demographics and daily routine, including exercise habits and commuting patterns, are being collected and used to improve everyday life. By effectively addressing the security vulnerabilities, privacy concerns and regulation issues that come with the evolving wearable industry, this brave new world can be enjoyed by all.

9:00 The Latest Sensor Design and Method/ Algorithm to Advance Glucose Sensor Accuracy
Ping Wu, Ph.D., Principal Staff Scientist, Bayer Healthcare

APPLICATIONS AND MARKET (Ingested, Transcutaneous & *in vitro* Sensor Systems)

9:30 Reduced Compound Consummation with a Microscale Calorimeter Based on Nanohole Array Sensors
Gregory Kowalski, Ph.D., Associate Professor, Mechanical & Industrial Engineering, Northeastern University
The features of this calorimeter make it attractive to the drug discovery process as well as having a potential for high throughput screening which would provide key information earlier in the testing process and for multiplexing experiments. Experimental results for the EDTA – CaCl2 as well as simulation confirming the developed algorithms for determining the enthalpy of reaction, the equilibrium constant and the change in Gibbs energy are presented.

10:00 Sponsored Presentation *(Opportunity Available)*

10:15 Coffee Break with Exhibit & Poster Viewing

APPLICATIONS AND MARKET (Cont.)

11:00 Waterborne Pathogen Detection Using a Smartphone-Based Fluorescence Microscope and Machine Learning
Hatice Ceylan Koydemir, Ph.D., Postdoctoral Researcher, Electrical Engineering, UCLA
Giardia lamblia is a waterborne parasite that causes an intestinal infection, known as giardiasis, and it is found not only in countries with inadequate sanitation and unsafe water but also streams and lakes of developed countries. Here we present a cost-effective and field portable mobile-phone based fluorescence microscopy platform that is well beyond of technology readiness level of 5.

11:30 Mobile Spions: Composite Micro Particles for Local Sensing
Michael Koehler, Ph.D., Professor, Physical Chemistry and Microreaction Technology, Technical University, Ilmenau, Germany
Special architectures of composite micro and nanoparticles are usable as miniaturized mobile sensors. They can be applied as "spion-like" transducers in tissues, cells and microfluidic compartments. New technologies allow the generation of these composed particles with very high homogeneity. The lecture will introduce the concept and will give examples for synthesis of sensor particles and their application in chemistry, for monitoring of cell cultures and toxicity studies.

12:00 pm A Colorimetric Microplate Reader for Point-of-Care ELISA Quantification
Qingshan Wei, Ph.D., Postdoctoral Scholar, Bioengineering Department, Electrical Engineering Department, University of California, Los Angeles
We developed a cost-effective and handheld smartphone-based colorimetric microplate reader for rapid digitization and quantification of immunoserology-related ELISA tests in a conventional 96-well plate format. Using this post-of-care (POC) testing platform, we quantified four different FDA-approved ELISA tests (mumps IgG, measles IgG, and herpes simplex virus IgG (HSV-1 and HSV-2)) in a clinical microbiology lab using 1138 remnant patient samples (roughly 50% training and 50% testing), and achieved >~99% accuracy for each ELISA test.

12:30 Luncheon Presentation *(Sponsorship Opportunity Available)* **or Enjoy Lunch on Your Own**

1:00 Close of Biological and Chemical Sensors for Healthcare Applications

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Emerging applications for *sensors in environmental, defense, energy and food safety applications have experienced enormous market growth over the last 10 years. This conference track will examine these emerging sensor markets and will showcase the latest technological advancements in materials, design, modeling and engineering.*

TRACK 2 • DECEMBER 6-7, 2016

BIOLOGICAL AND CHEMICAL SENSORS FOR **EMERGING APPLICATIONS**

TUESDAY, DECEMBER 6, 2016

1:15 pm Conference Registration

1:55 Chairperson's Opening Remarks
Ahmed Busnaina, Ph.D., Director, National Science Foundation Nanoscale Science and Engineering Center, Northeastern University

OPENING KEYNOTE PRESENTATION

2:00 Biological & Chemical Sensors for Emerging Applications

Peter Emanuel, Ph.D., BioScience Division Chief, Research & Technology, US Army ECBC

We will be presenting development work from a collaborative team that is exploring the use of colorimetric sensor arrays composed of up to 100 reactive dyes. The dyes respond individually to volatile organic compounds (VOCS) that evolve from chemical agents (such as sarin or VX) or from growing bacteria (such as anthrax). Devices that read and compare the collective dye responses and compare against agent libraries allow for small devices that identify liquids and vapors and communicate with Smartphones to create a family of homeland defense tools.

EMERGING MARKET OVERVIEW

2:30 The Nanosensors Signature Initiative: A Coordinated Federal Effort to Amplify the Development and Commercialization of Nanosensors
Lisa Friedersdorf, Deputy Director, National Nanotechnology Coordination Office, National Nanotechnology Initiative

Federal agencies participating in the Nanotechnology Signature Initiative (the Sensors NSI) address both the opportunity of using nanotechnology to advance sensor development and the challenges of developing sensors to keep pace with the increasingly widespread use of engineered nanomaterials. Recent efforts by the Sensors NSI aimed at promoting the successful development and commercialization of nanosensors will be discussed.

ADVANCED MATERIALS, DESIGN & MODELING FOR EMERGING APPLICATIONS

3:00 Mobile Spions: Composite Micro Particles for Local Sensing
J. Michael Koehler, Ph.D., Head of the Department of Physical Chemistry and Microreaction Technology, Technical University of Ilmenau, Germany

Special architectures of composite micro and nanoparticles are usable as miniaturized mobile sensors. They can be applied as "spion-like" transducers in tissues, cells and microfluidic compartments. New technologies allow the generation of these composed particles with very high homogeneity. The lecture will introduce the concept and will give examples for synthesis of sensor particles and their application in chemistry, for monitoring of cell cultures and toxicity studies.

3:30 Sponsored Presentation *(Opportunity Available)*

3:45 Refreshment Break with Exhibit & Poster Viewing

4:15 Ultra-Low Power MEMS Gas Sensors and Efficient Pre-Concentration Using Microfluidic Devices for Salmonella
Peter Hesketh, Ph.D., Professor, Mechanical Engineering, Georgia Institute of Technology

A MEMS based thermal conductivity detector has been developed for ultra-low power gas sensing. Combined with a MEMS-GC, it provides a portable method for detection of VOCs. Magnetic bead and magnetically actuated cilia offer a novel approach to sample pre-concentration when detection of low concentration of Salmonella is required for food safety applications.

4:45 Printable/Flexible/Stretchable Sensors: Technologies and Applications for Emerging Applications
Roger Grace, President, Roger Grace Associates

To be presented will be a brief inventory of several interesting printed, flexible and stretchable (P/F/S) sensor technologies currently under development or in production worldwide by commercial organizations that specifically address biomedical bedside as well as portable/wearable applications. Also to be addressed will be flexible circuit platforms and their associated interconnectivity issues as part of this smart sensor-based system integration approach.

5:15 End of Day

5:30 Tutorial Registration

6:00-8:00 Tutorial: Sensor Market Overview*
**Separate registration required. See page 7 for details.*

WEDNESDAY, DECEMBER 7, 2016

8:30 am Morning Coffee

8:55 Chairperson's Opening Remarks
Roger Grace, President, Roger Grace Associates

KEYNOTE PRESENTATIONS

9:00 Micro and Nanoscale Printing of Sensor Platforms for Pathogen Detection and Physiological Monitoring

Ahmed Busnaina, Ph.D., Director, National Science Foundation Nanoscale Science and Engineering Center, Northeastern University

Invention at the nanoscale promises to revolutionize novel biosensors for pathogen detection and monitoring of a large number of biomarkers. Nanoscale Science and Engineering Center for High-rate Nano Manufacturing (CHN) has developed an entirely new nanoscale printing technology that created a novel biosensor platform for real-time pathogen monitoring and for wearable sensors to monitor physiologic state. For example, the CHN is developing applications for wearable sensors that could be used as an electronic skin or for physiological monitoring as well as environmental monitoring.

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APPLICATIONS AND MARKET

9:30 Wearable Textile Electronics for Medical Sensing and RF Communications
*John Volakis, Ph.D., Professor, Chope Chair, Electrical & Computer Engineering Department and Director, Electroscience Lab, Ohio State University**
This presentation will cover a new class of textile-based electronics whose RF resolution and accuracy will provide companies a viable alternative to standard printed circuit boards. Applications to sensor connectivity and body area networks will be discussed as well. *In collaboration with Asimina Kiourti.

10:00 Sponsored Presentation *(Opportunity Available)*

10:30 Coffee Break with Exhibit & Poster Viewing

11:00 Highly Efficient Sensor Data Processing in Deeply Embedded Systems
Mark Buccini, Director, Business Unit Strategy, Texas Instruments
This presentation describes novel techniques useful in reducing sensor data processing power consumption in deeply embedded systems across a range of portable health care, wearable and connected IoT battery-powered applications. The presentation builds through a series of examples, a complete deeply embedded sensor processing system including the power source, sensor, data converter, MCU and user interface. Using the techniques discussed, a working ultra-low power deeply embedded sensor sampling system utilizing off-the-shelf components will be demonstrated live as part of this interactive paper presentation.

11:30 All Printed Stretchable Self-Repaired Wearable Electrochemical Sensors
Joseph Wang, Ph.D., SAIC Endowed Chair, Distinguished Professor, Chair of Nanoengineering, University of California San Diego
This talk will discuss novel ink materials that impart high stretchability and self-healing onto skin-worn electrochemical sensors. The resulting sensors can withstand remarkable mechanical strains without compromising their sensing performance.

12:00 pm Wearable Electronics: Mapping RFID Technology to Opportunities
Edwin Kan, Ph.D., Professor, School of Electrical and Computer Engineering, Cornell University
Embedded electronics on a garment can bring forth ambient intelligence and personalized comfort that could not be achieved before. First, we will introduce the design of garment cooling and heating to achieve personal thermal comfort. An active thermoelectric unit on a belt will pair with passive temperature sensing to control the next-to-skin temperature. Second, we will use garment tags to monitor the indoor occupants in an obscure manner, including 3D gesture interface and sleep monitoring. Through these two full examples, we can also better understand the technical requirements, operational constraints and cost structure in many other promising applications in wearable electronics.

12:30 Luncheon Presentation *(Sponsorship Opportunity Available)* **or Enjoy Lunch on Your Own**

APPLICATIONS AND MARKET (Cont.)

1:55 Chairperson's Remarks
Mark Buccini, Director, Business Unit Strategy, Texas Instruments

2:00 Sensor Data Reliability and Management
Ray Huang, Principal Engineer, Exponent
Self-generated data that originates from wearable or mobile devices potentially enables predictive and prescriptive, customized treatment of individuals. The reliability of this data will largely impact the ability to accurately predict and forecast a medical condition. In this talk, we will address sources of data variation, drift, corruption, loss, and discuss various aspects of hardware testing strategies and algorithm implementations at the design and prototyping state to alleviate some of these issues.

2:30 Lensfree On-Chip Biomedical Imaging Using Cost-Effective Image Sensors
Yibo Zhang, Department of Electrical Engineering, UCLA
Rapid increase in mega pixel counts and the reducing costs of optoelectronic image sensors as well as the exponential improvements in computation capabilities of consumer electronic devices have enabled high-throughput biomedical imaging without lenses – lens-free microscopy. This emerging technology is useful for point-of-care diagnostics, digital pathology, disease monitoring and healthcare in resource-limited settings.

3:00 Refreshment Break with Exhibit & Poster Viewing

3:30 Emerging Applications in Wearables for Real-Time Biosurveillance
David L. Hirschberg, Ph.D., Lecturer and Scientist, Department of Interdisciplinary Arts and Sciences and the Institute of Global Engagement, University of Washington, Tacoma

4:00 PANEL DISCUSSION: Sensor Commercialization - Challenges and Opportunities
Moderator:
Lisa Friedersdorf, Deputy Director, National Nanotechnology Coordination Office, National Nanotechnology Initiative
This panel will focus on the identification and discussion of challenges that are faced by the sensor development community during the fabrication, integration, and commercialization of sensors. The National Nanotechnology Coordination Office (NNCO) provides technical and administrative support to the Nanoscale Science, Engineering, and Technology (NSET) Subcommittee, serves as a central point of contact for Federal nanotechnology R&D activities, and provides public outreach on behalf of the National Nanotechnology Initiative.

5:00 Close of Conference

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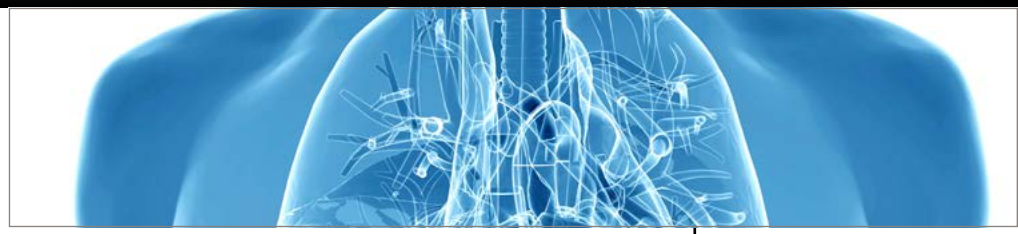
IMPLANTABLE BIOMEDICAL SYSTEMS DECEMBER 7, 2016



Wireless Charging & Communications for Implantable Medical Devices

The market demand for implantable biomedical systems continues to grow at a significant pace. Solving the technological hurdles of miniaturization, power supply and efficient interfaces between the implants and external devices is critical to the growth of the market. This symposium will examine the latest advances in manufacturing, wireless charging and communications for implantable biomedical systems from both a theoretical and practical standpoint.

WEDNESDAY, DECEMBER 7, 2016

8:15 am Registration and Morning Coffee

8:55 Chairperson's Opening Remarks
Bill von Novak, Principal Engineer, Qualcomm

9:00 KEYNOTE PRESENTATION: Improving Therapeutic Outcomes and Lowering Costs through Wireless Bioelectronics

Ada Poon, Ph.D., Associate Professor of Electrochemistry, Stanford University
Electronic devices are very good at supporting control and feedback. They will offer the potential for a closed-loop system that could improve therapeutic outcomes and lower the overall healthcare cost. In this talk, I will go over a few biomedical applications where I believe that wireless and semiconductor technologies could play an important role.

9:30 Neuromodulation System Considerations for Miniaturized Bioelectronic Medicines

Rizwan Bashirullah, Director of Device Technologies, GlaxoSmithKline Bioelectronics
The development of chronically stable interfaces, tailored for small autonomic nerves in the viscera, is a critical focus of Bioelectronics medicine as part of the overall aim to develop step-change, wirelessly enabled, miniaturized, and personalized implantable medicines. This talk will focus on neuromodulation device technology needs and considerations for implantable bioelectronic medicines.

ADVANCED COMMUNICATIONS FOR IMPLANTABLES

10:00 Ultrasonically Powered mm-Sized Implantable Devices with Applications in Closed-Loop Neuromodulation
Amin Arbabian, Ph.D., Assistant Professor, Department of Electrical Engineering, Stanford University
This talk investigates fundamental issues associated with power transfer to mm-sized implantable devices using acoustic waves in the ultrasonic range since this enables wavelengths comparable to the size of the implant, which allows focusing of the energy at the device site, leading to a higher link efficiency and lower heating in surrounding tissue as compared to RF powering techniques.

10:30 Coffee Break with Exhibit & Poster Viewing

11:00 The Challenges of Wireless Power and Data Transfer for Active Implantable Devices
Heather Dunn, Senior Director of Technology, Cirtec Medical Systems
As active implantable devices become smaller and integrate more monitoring functions, the demand for efficient power and data transfer between devices and outside accessories is increasing. This talk will provide an overview of the particular challenges of performing power and data transfer with implanted devices. This will include material selection, packaging, tissue interaction, and user concerns.

WIRELESS CHARGING FOR IMPLANTABLES

11:30 Transcutaneous Power of Single-Chip Implants
Patrick Mercier, Ph.D., Professor, Electrical and Computer Engineering, Associate Director, Center for Wearable Sensors, University of California, San Diego
A new class of implant where all necessary functionality is integrated onto a single microchip will be presented. The proposed method enables ultra-high density integration of electrodes with active electronics, and through wireless powering and communication, can enable modular designs that can scale across large anatomical areas. The presentation will specifically discuss challenges and solutions in transcutaneous wireless power transfer when the power receiving coil is integrated directly on the microchip itself.

12:00 Wireless Power for Medical Implants
Bill von Novak, Principal Engineer, Qualcomm
Wireless power is nearly a requirement for implantable medical devices for reasons of safety, longevity and effectiveness. This presentation will discuss the various modalities of wireless power transfer for medical implants, and discuss the tradeoffs involved in each one.

12:30 Luncheon Presentation *(Sponsorship Opportunity Available)* **or Enjoy Lunch on Your Own**

WIRELESS CHARGING FOR IMPLANTABLES (Cont.)

1:55 Chairperson's Remarks
Ada Poon, Ph.D., Associate Professor of Electrochemistry, Stanford University

2:00 FEATURED PRESENTATION: Wireless Power Transfer for Deeply Implanted IMDs

Keith Maile, Ph.D., Fellow Engineer, Boston Scientific
Over the years, a number of Implantable Medical Device (IMD) products have been introduced which utilize wireless power transfer such as inductive means. However, most of these devices are only implanted at shallow depths (e.g. subcutaneously). Unlike shallow IMDs, the transfer of power to deeply implanted medical devices has additional challenges in technical (modality, efficiency, etc.) and regulatory (FDA, FCC) spaces. The goal of this work is to compare a few of the available technologies for a deeply-implanted IMD.

2:30 Efficiency Optimization for Low-Power Density Far-Field Wireless Powering
Zoya Popovic, Ph.D., Professor, Department of Electrical, Computer and Energy Engineering, University of Colorado Boulder
This talk will overview the design approach for a wireless powering system in low power density far-field wireless sensor applications. The system design and characterization starting from the antenna integrated with a rectifier, usually operated in an ISM band, to the power management and storage, will be described. Examples at 1.9GHz, 2.45GHz and 5.8GHz at power densities as low as 1 uW/cm^2 will be discussed.

3:00 Refreshment Break with Exhibit & Poster Viewing

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3:30 Design Objectives and Power Limitations of Human Implantable Wireless Power Transfer Systems
Christopher H. Kwan, Department of Electrical and Electronic Engineering, Imperial College London, United Kingdom
Wireless power transfer (WPT) can provide a practical solution to powering implanted devices without requiring a power cable to puncture the skin. Whilst maximizing link efficiency is normally the design aim of a WPT system in free space, there may be more suitable objectives if a receiver is implanted inside a patient, especially for devices with higher power consumption. This paper proposes alternative design principles to minimize the adverse effects of such a WPT system on the human body.

4:00 Power Transfer Prediction Tool for Medical Implants
Elias Wilken-Resman, Ph.D. Candidate, Department of Electrical and Computer Engineering, University of Illinois
Medical implants often benefit from wireless power, but it can be difficult to ensure that all potential locations/orientations within a patient will allow sufficient coupling for effective power transfer. This talk presents a tool that can be used to ensure that a given level of power can be maintained within the implant, given a potential implant volume and set of potential orientations.

SAFETY AND REGULATORY COMPLIANCE

4:30 The Challenge of Evaluating Safety and Regulatory Requirements
Nathan Jeong, Senior Staff Engineer, Qualcomm
Designing an implantable device requires to meet various domestic or international regulatory specifications. In this talk, a brief summary of challenges of simulating and building a human tissue phantom is discussed. Measurement and simulation results are shown with some examples.

5:00 Close of Symposium

TUTORIAL

TUTORIAL: SENSOR MARKET OVERVIEW*

TUESDAY, DECEMBER 6 | 6:00-8:00 PM

Sensing the Market Opportunity in Digital Health & Wellness
Tutorial Presenter: Noa Ghersin, Analyst, Lux Research Inc
Successful commercialization of sensors in health and wellness markets is achieved when technological feasibility, economic practicality, and market need intersect. As the shift toward patient-centric health care continues with an increasing focus on early diagnostics, preventative approaches, and wellness, the new generation of devices shouldering the technological weight of this evolution increasingly deploy sensors to stay ahead of the curve. Making right choices regarding the market opportunity, business models, and pricing strategies in target markets is critical to successful commercialization; however, those decisions need to be made in early stages of development amid significant uncertainty. This tutorial will address current and future market trends and their impact on the size of the market opportunity in health and wellness, with a focus on developing a commercialization strategy that can bear fruits in clinical and consumer markets alike.

**Separate registration required.*

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BIOLOGICAL + CHEMICAL SENSORS SUMMIT 2016

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Monday-Tuesday AM, December 5th-6th	Tuesday PM-Wednesday, December 6th-7th	Wednesday, December 7th
T1: Biological & Chemical Sensors for Healthcare Applications	T2: Biological & Chemical Sensors for Emerging Applications	S1: Implantable Biomedical Systems
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~~TUT1: Sensor Data Management for Healthcare & Emerging Applications~~	TUT2: Sensor Market Overview: Sensing the Market Opportunity in Digital Health & Wellness	

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