

# **Sensors Expo & Conference 2011**

**Rosemont, Illinois, USA  
6-8 June 2011**

**ISBN: 978-1-61839-123-0**

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

Copyright© (2011) by Questex Media Group, Inc.  
All rights reserved.

Printed by Curran Associates, Inc. (2011)

For permission requests, please contact Questex Media Group, Inc.  
at the address below.

Questex Media Group, Inc.  
275 Grove Street, Suite 2-130  
Newton, Massachusetts 02466

Phone: (617) 219-8300  
Fax: (617) 219-8310

[www.questex.com](http://www.questex.com)

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2634  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

# TABLE OF CONTENTS

## SYMPOSIUM 1: MEMS COMMERCIALIZATION OPPORTUNITIES FOR SYSTEMS AND PRODUCTS

<b>MEMS Industry Overview: MEMS in the Mainstream.....</b>	1
<i>Karen Lightman</i>	
<b>Planning for MEMS Product Development.....</b>	14
<i>Alissa M. Fitzgerald</i>	
<b>From Prototype to Volume Production: A Roadmap for Success .....</b>	28
<i>Magnus Rimskog</i>	
<b>Packaging of HB LEDs with Integrated Beam-Shaping.....</b>	37
<i>Carsten Wesselkamp</i>	

## MEMS DESIGN, MATERIALS AND PROCESS TECHNOLOGY: INNOVATION MATTERS

<b>Coventor: The Leader in MEMS Design Automation Solutions .....</b>	42
<i>Steve Breit</i>	
<b>Precision Micro - Machining for MEMS &amp; Sensor Technologies.....</b>	45
<i>N/A</i>	
<b>MEMS Design, Materials and Process Technology: Innovation Matters .....</b>	48
<i>Jim Knutti, Petteri Piirinen, Tom Fote, Eric Pabo, Steven Breit</i>	
<b>Materials and Equipment Technologies Panel .....</b>	51
<i>Eric F. Pabo</i>	
<b>Okmetic in Brief.....</b>	53
<i>N/A</i>	
<b>MEMS Products - No Easy Answers! .....</b>	56
<i>Sarah Boisvert</i>	
<b>MEMS Entering Double Digit Growth Cycle.....</b>	63
<i>Richard Dixon</i>	
<b>New Business Models in the MEMS Industry .....</b>	74
<i>Laurent Robin</i>	
<b>Inertial MEMS Testing .....</b>	87
<i>Sascha Revel</i>	

## ADAPTING INFRASTRUCTURE TO A FABLESS AND FABLITE WORLD PANEL

<b>MEMS Industry Overview: Adapting Infrastructure to a Fabless and Fablite World .....</b>	97
<i>Karen Lightman</i>	
<b>Pioneers in Making the World a Smaller Place.....</b>	103
<i>Nancy Fares</i>	
<b>Adapting Infrastructure to a Fabless and Fablite World.....</b>	105
<i>Rob O'Reilly</i>	
<b>Welcome to General Electric: Measurement and Controls Sensing and Inspection Technologies .....</b>	109
<i>Calin Miclaus</i>	
<b>Adapting Infrastructure to a Fabless and Fablite World Panel .....</b>	113
<i>Bruno Filament</i>	

## SYMPOSIUM 2: POWER MANAGEMENT: ENERGY HARVESTING & STORAGE

<b>Power Management: Energy Harvesting &amp; Storage Symposium.....</b>	116
<i>Randy Frank</i>	
<b>Customer Education for Energy Harvesting Applications.....</b>	122
<i>Attila Lengyel</i>	
<b>Flight Testing of Energy Harvesting Wireless Sensing Networks on Rotorcraft <sup>(15,16)</sup> .....</b>	129
<i>Steve Arms</i>	

<b>Optimized, Low <math>\Delta T</math> Thermoelectric Energy Harvesters for Water, Air or Solid Heat Sources and Sinks.....</b>	165
<i>Robin McCarty</i>	
<b>RF Energy Harvesting: Theory to Deployment .....</b>	175
<i>Harry Ostaffe</i>	
<b>MEMS-based Piezoelectric Vibrational Energy Harvesting for Wireless Sensor Network Applications .....</b>	188
<i>Robert Andosca, Junru Wu</i>	
<b>Design Considerations for Thin-Film Thermoelectric Energy Harvesting in Wireless Sensor Applications.....</b>	203
<i>Dave Koester</i>	
<b>Leading Opportunities for Energy Harvesting .....</b>	212
<i>Stéphane Gervais-Ducouret, Ray Roop</i>	
<b>Practical Design Considerations for Thermal and Photovoltaic Energy Harvesting Applications: "Free", Unlimited, Zero Maintenance Energy...But the Laws of Physics Still Apply .....</b>	225
<i>Jim Noon</i>	
<b>Deeply Embedded Systems That Last Forever.....</b>	243
<i>Mark E. Buccini</i>	
<b>Autonomous Sensors for Building Automation.....</b>	258
<i>Joe Keating</i>	

### **SYMPORIUM 3: PERFORMANCE-BASED SENSOR SELECTION: GI-GO OR GI-GO? (GARBAGE IN – GARBAGE OUT, OR GOOD INPUT – GOOD OUTPUT?)**

<b>Performance Based Sensor Selection: GIGO or GIGO?.....</b>	267
<i>Jon Wilson</i>	

### **MEMS**

<b>MEMS Sensor Integration into Mobile Operating Systems.....</b>	352
<i>Kenneth P. Foust</i>	
<b>Providing the Infrastructure for Connecting to the World: One Sensor at a Time .....</b>	364
<i>C. Paul Christensen</i>	
<b>Sensor Platform: Benefits and Challenges for Sensor Network Application.....</b>	380
<i>Stéphane Gervais-Ducouret</i>	
<b>MEMS Product Development Case Study: From Concept to Foundry .....</b>	391
<i>Carolyn D. White</i>	
<b>Dicing of Sensitive MEMS Devices: Challenges and Solutions .....</b>	408
<i>F. Lewis, P. Wright, D. Martin, S. Michel, L. Ouellet</i>	

### **ENERGY HARVESTING**

<b>Practical Energy Harvesting Solutions for Perfect Wireless Sensing.....</b>	423
<i>Roy Freeland</i>	
<b>Implementing RF Energy Harvesting for Building and Industrial Automation .....</b>	436
<i>Harry Ostaffe</i>	
<b>Solid State Batteries for Bioenergy Harvesting Sensors.....</b>	448
<i>Steve Grady, Patrick Moran</i>	
<b>Infinite Runtime: Methods to Monitor Energy-Harvester State of Charge.....</b>	462
<i>Brant Ivey</i>	
<b>Power Budgets of Thermal Energy Harvesting.....</b>	472
<i>Burkhard Habbe</i>	
<b>Sensor to the Cloud Energy Harvesting.....</b>	490
<i>Roger B. Nessen</i>	
<b>Creating New Markets with Thermobility Thin-Film Thermoelectric Energy Harvesting .....</b>	502
<i>Jim Mundell</i>	

## **WIRELESS SENSOR NETWORKING**

<b>Wireless Sensor Networks: A Survey of Design Options.....</b>	514
<i>Greg Burneske</i>	
<b>Advancements in Low Power WiFi Technology: Leveraging Existing Wireless Infrastructures to Increase the Efficiency of WSN Deployments and Reduce Costs .....</b>	531
<i>Dan Piroli</i>	
<b>Provisioning ZigBee Networks.....</b>	547
<i>John Schwartz</i>	
<b>Green Intelligence: Wireless Sensor System Architectures.....</b>	559
<i>David Lamb, Zvi Huber, Sloane Six</i>	

## **WIRELESS SENSOR DATA**

<b>Moving Beyond Data to Sensor Information Networks.....</b>	575
<i>Jim Kokal</i>	
<b>Cloud Computing &amp; Web Services: An Easy Highway for Sensor Data .....</b>	589
<i>Joel K Young</i>	
<b>Synchronized Wireless Sensor Network for Simultaneous, Periodic, and Burst Data Acquisition .....</b>	607
<i>Steve Arms</i>	
<b>How Real-Time Visibility, Operational Agility and Flexibility is Changing the Data Acquisition Solutions Market.....</b>	673
<i>Tim Shea</i>	

## **NOVEL APPROACHES TO MEASUREMENT & DETECTION**

<b>Silicon Magnetic Sensors in Automotive and Consumer Applications: Markets and Prospects .....</b>	684
<i>Richard Dixon, Jérémie Bouchaud</i>	
<b>Designing High-Resolution Current Sensors for Measuring High-Speed Transient Currents With Wide Dynamic Range .....</b>	694
<i>Youbok Lee, Yang Zhen</i>	
<b>Novel, Cost Effective and Miniaturized Temperature and Gas Sensor Solutions for Wide Range Industrial Applications.....</b>	712
<i>N/A</i>	
<b>MEMS Accelerometers Conquer High-End Applications Traditionally Served By Electrochemical Devices .....</b>	732
<i>Philippe Krebs</i>	
<b>Effects of Mounting on Accelerometer Performance.....</b>	745
<i>Scott Mayo, Line Moisan</i>	

## **CUTTING EDGE APPLICATIONS AND TECHNOLOGIES**

<b>Looking Through the Crystal Ball: Mega Trends That Will Shape the Future of the World.....</b>	763
<i>Kiran Unni, Sarah Saatzer, Rajender Thusu</i>	
<b>Developing Motion Control and Pointing Apps for 3D-Like User Experiences .....</b>	789
<i>Charles W. K. Gritton</i>	

## **MOBILE SENSING**

<b>CELL-ALL: Ubiquitous Chemical Sensing.....</b>	818
<i>N/A</i>	
<b>Sensor Fusion and its Applications in Portable Devices .....</b>	828
<i>Jay Esfandyari</i>	
<b>Wireless MEMS Sensor Platform Compatible with Cell Phones and Laptops .....</b>	836
<i>Doug Sparks</i>	
<b>Author Index</b>	