FINAL PROGRAM

SOLID-STATE SENSORS, ACTUATORS, AND MICROSYSTEMS WORKSHOP

HILTON HEAD
Sonesta Resort
South Carolina, USA

2 – 6 June 2024

Sponsored by the

TRF
TRANSDUCER RESEARCH FOUNDATION
connecting big ideas and small tech
### PROGRAM-AT-A-GLANCE

#### Monday, 3 June

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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</thead>
<tbody>
<tr>
<td>07:00</td>
<td>Breakfast</td>
</tr>
<tr>
<td>07:45 - 08:15</td>
<td>Welcome</td>
</tr>
<tr>
<td>08:15 - 08:55</td>
<td>Plenary Speaker I - Cherie R. Kagan, Ph.D.</td>
</tr>
<tr>
<td></td>
<td>University of Pennsylvania, USA</td>
</tr>
<tr>
<td>08:55 - 10:15</td>
<td>Session 1 - Microsystems for Biosensing</td>
</tr>
<tr>
<td>10:15 - 10:44</td>
<td>Break and Tabletop Inspection</td>
</tr>
<tr>
<td>10:44 - 10:45</td>
<td>Wen Ko Technical Leaders Award Announcement</td>
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<tr>
<td>10:45 - 11:15</td>
<td>Invited Speaker I - Alissa M. Fitzgerald, Ph.D.</td>
</tr>
<tr>
<td>11:15 - 12:15</td>
<td>Session 2 - Industrial, Higher TRL Microsystems</td>
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<tr>
<td>12:15 - 12:20</td>
<td>Oliver Brand Remembrance</td>
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<tr>
<td>12:20 - 12:45</td>
<td>Poster Preview - Session 1</td>
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<tr>
<td>12:45 - 14:15</td>
<td>Networking Lunch</td>
</tr>
<tr>
<td>14:15 - 16:45</td>
<td>Poster Session 1 - Contributed and Late News</td>
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#### Tuesday, 4 June

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<tbody>
<tr>
<td>07:30</td>
<td>Breakfast</td>
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<tr>
<td>08:00</td>
<td>Announcements</td>
</tr>
<tr>
<td>08:05 - 08:45</td>
<td>Plenary Speaker II - Tobias Kippenberg, Ph.D.</td>
</tr>
<tr>
<td></td>
<td>EPFL, SWITZERLAND</td>
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<tr>
<td>08:45 - 09:45</td>
<td>Session 3 - Resonators, Oscillators and Micromotors</td>
</tr>
<tr>
<td>09:45 - 10:14</td>
<td>Break and Tabletop Inspection</td>
</tr>
<tr>
<td>10:14 - 10:15</td>
<td>Denice Denton Mentorship Award Announcement</td>
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<tr>
<td>10:15 - 10:45</td>
<td>Invited Speaker II - Michael Fonseca, Ph.D., StethX, USA</td>
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<tr>
<td>10:45 - 11:45</td>
<td>Session 4 - Chemical and Environmental Sensing</td>
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<tr>
<td>11:45 - 12:15</td>
<td>Hilton Head Education, History, and Conservation Talk</td>
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<td></td>
<td>Jan McKelvey, Lean Ensemble Theater, USA</td>
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<tr>
<td>12:15 - 13:30</td>
<td>Networking Lunch</td>
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<tr>
<td>14:00 - 19:00</td>
<td>MSIG Industry Session</td>
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<td></td>
<td>Beyond Technical Expertise</td>
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<td></td>
<td>Recreational &amp; Student Activities</td>
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<tr>
<td>19:00 - 22:00</td>
<td>Banquet</td>
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### Wednesday, 5 June

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<tr>
<td>07:15</td>
<td>Women in MEMS Breakfast</td>
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<tr>
<td>07:30</td>
<td>Breakfast</td>
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<tr>
<td>08:10</td>
<td>Announcements</td>
</tr>
<tr>
<td>08:15 - 08:55</td>
<td>Plenary Speaker III - Christopher J. Cannova M.D.</td>
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<td></td>
<td>Aligned Orthopedic Partners, USA</td>
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<tr>
<td>08:55 - 10:15</td>
<td>Session 5 - Medical MEMS</td>
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<tr>
<td>10:15 - 10:44</td>
<td>Break and Tabletop Inspection</td>
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<tr>
<td>10:44 - 10:45</td>
<td>Mark Shannon Grand Challenges Award Announcement</td>
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<tr>
<td>10:45 - 11:15</td>
<td>Invited Speaker III - Joshua Windmiller, Ph.D., Dexcom, USA</td>
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<tr>
<td>11:15 - 12:15</td>
<td>Session 6 - Novel Devices</td>
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<tr>
<td>12:15 - 13:00</td>
<td>Poster Preview - Session 2</td>
</tr>
<tr>
<td>13:00 - 14:30</td>
<td>Networking Lunch</td>
</tr>
<tr>
<td>14:30 - 17:00</td>
<td>Poster Session 2 - Contributed and Late News</td>
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<td>17:00 - 18:30</td>
<td>Free Time</td>
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<tr>
<td>18:30 - 19:30</td>
<td>Poster Session 3 and Reception</td>
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<tr>
<td>20:00 - 22:00</td>
<td>Rump Session</td>
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### Thursday, 6 June

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<td>08:10</td>
<td>Announcements</td>
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<tr>
<td>08:15 - 08:55</td>
<td>Plenary Speaker IV - Evelyn N. Wang, Ph.D.</td>
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<td></td>
<td>ARPA-E, USA</td>
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<tr>
<td>08:55 - 09:55</td>
<td>Session 7: Novel Devices and Processes</td>
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<tr>
<td>09:55 - 10:25</td>
<td>Break and Tabletop Inspection</td>
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<tr>
<td>10:25 - 10:55</td>
<td>Invited Speaker IV - Ginel Hill, SiTime, USA</td>
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<tr>
<td>10:55 - 11:55</td>
<td>Session 8 - Late News</td>
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<tr>
<td>11:55 - 12:30</td>
<td>Award Ceremony and Closing Remarks</td>
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<tr>
<td>12:30 - 14:00</td>
<td>Networking Lunch</td>
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<tr>
<td>14:00</td>
<td>Workshop Adjourns</td>
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## Technical Program

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All photos Courtesy of the Hilton Head Island Visitor & Convention Bureau
GENERAL INFORMATION

Wireless Internet Service
Wireless Internet will be available in the Workshop meeting space in the Sonesta Resort.

- Select "Sonesta Guest" from the list of available networks
- Scroll down to the third option “High Speed”

We ask that you limit your usage to be considerate of other attendees and please logout once you are finished. There is a bandwidth limit of 2 Mbps per device.

Meeting Room Logistics
Please contact the Workshop Registration Desk if you find the temperature in the room are uncomfortable, or you are unable to hear or see because of equipment difficulties.

Name Badges
All attendees, and their guests, must wear their name badge at all times to gain admission to all sessions and social functions.

Job Board
The Job Board will be located near the Workshop Registration Desk.

Chimes
The chimes will ring five minutes before the end of each scheduled break. The sessions will begin on time, so please return to the meeting room when you hear the chimes.

Hilton Head on Social Media
Don’t forget to follow and tag us on our social media platforms.

Please be courteous and don’t share unauthorized photos, defamatory statements, et cetera.
GUEST PACKAGES

Guest meal packages are available for purchase for all guests of attendees. The package includes the Sunday Welcome Reception, Guest Breakfast (Jasper Room, Second Floor, Monday - Thursday, 07:30 – 10:00), Lunches, and the Tuesday Banquet. Please visit the Workshop Registration Desk if you would like to purchase a guest package. Guests and children will not be admitted to social events without a badge. A name badge is required for anyone to attend the meal functions. Children under 6 are free but require a name badge. Please register them as well if you have not already done so.

SOCIAL EVENTS

Name badges are required for all Social Events, including guests and children.

Sunday Welcome Reception
The Welcome Reception will be held Sunday evening, 18:00 - 21:00 outside in the Pavilion.

Tuesday Banquet
The Banquet will be held on Tuesday evening, 19:00 - 22:00 outside in the Pavilion and is sponsored in part by:

Beach Volleyball
The Beach Volleyball tournament, sponsored by Analog Devices, will be held on Tuesday afternoon between 15:00 and 18:00. All levels of play will be integrated into this fun afternoon. Analog Devices will be supplying refreshments, so come out and play, or just come watch the fun. If you are interested in joining, please sign-up at the Workshop Registration Desk so we may get a headcount for refreshments.

Women in MEMS Breakfast
The Women in MEMS Breakfast will be on Wednesday from 07:15 - 08:10 in the Savannah Jr. Ballroom. Come meet new faces, catch up with old friends, and make connections. Students and first-time attendees are especially encouraged to attend and join the Women in MEMS Network. Breakfast will be served in the room.
**Student Networking Events**

**Lunches** - During lunch each day, there will be reserved tables in the outdoor pavilion for students to network and socialize.

**Sandcastle Building** – Join us Tuesday at 14:00 on the beach and compete in Sandcastle Building. You will form teams of students from different universities and compete for prizes and glory!

**Scavenger Hunt** – Join us on the student Slack channel ([https://hiltonheadworkshop.slack.com/](https://hiltonheadworkshop.slack.com/)) for a workshop scavenger hunt!
ORGANIZING COMMITTEE

Conference Chairs
General Chair  Jenna F. Chan, DEVCOM Army Research Laboratory, USA
Program Chair  Swaminathan Rajaraman, University of Central Florida, USA

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Hyowon (Hugh) Lee ........................................................... Purdue University, USA
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Kris Dorsey (Co-Chair) ..................................................... Northeastern University, USA

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Daniela Diaz-Alonso ....... Center for Engineering and Industrial Development, MEXICO
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40th Anniversary Committee
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Thomas W. Kenny ............................................................. Stanford University, USA
Khalil Najafi ..................................................................... University of Michigan, USA

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Ji Chang ....................................................... University of Central Florida, USA
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Thomas Li ........................................................ NXP Semiconductors, USA
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Oscar Vazquez Mena ...................................... University of California, San Diego, USA
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1. Sponsoring and organizing regional, national, and international conferences, meetings, workshops, and short courses in transducers, microsystems, and nanotechnology. Net proceeds raised during the sponsored events are retained and utilized by TRF to support future activities and initiatives.
2. Raising and administering the distribution of funds with the purpose of enhancing and encouraging advances in the fields of transducers, microsystems, and nanotechnology.
3. Fostering liaison between academic, industry, and government organizations to enhance cooperation and collaboration.
4. Providing mentoring and continuous education to students and young professionals in science, engineering, technology, and related fields.
5. Supporting research in the fields of microfabricated sensors, actuators, and mechanical components, as well as microsystems, nanosystems, and the underlying technologies that advance all of these fields, through scholarships, seed grants for new conferences and workshops, grants for student travel to conferences, and other means.

TRF welcomes inquiries from individuals and groups who wish to apply for TRF sponsorship of proposed topical workshops and conferences that are consistent with the TRF mission. If your organization would like to explore any of the options for TRF sponsorship or student travel grants, please contact a TRF Officer/Director, or email us at info@transducer-research-foundation.org for further information.

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Kensall D. Wise
COMMERCIAL SUPPORT

Special acknowledgement to the Transducer Research Foundation, Inc. for their educational grant funding support of this Workshop.

The Transducer Research Foundation, Inc. would also like to thank the following companies for their support, encouragement, and involvement in the 2024 Solid State Sensors, Actuators, and Microsystems Workshop.

TRF CORPORATE STEWARDSHIP SPONSORS

InvenSense, a TDK Group Company
1745 Technology Drive
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Established in 2003, A.M. Fitzgerald & Associates, LLC ("AMFitzgerald") provides expert MEMS product development services and solutions, including: custom MEMS design, emerging technology development, simulation, process integration, MEMS prototype fabrication, package and test, foundry selection and transfer with support through production, and strategy consulting.

IEEE MEMS Technical Community
ieeememstc.org

IEEE Micro Electro Mechanical Systems (MEMS) Technical Community will keep you abreast of the latest in MEMS ideas, designs, and manufacturing methodologies, many of which could very well spark new thinking and enable new capabilities in a myriad of IEEE fields. MEMS is an enabling technology harnessing the benefits of miniaturization in physical domains beyond the electrical and found in billions of devices today.

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Analogue Devices, Inc. (NASDAQ: ADI) is a global semiconductor leader that bridges the physical and digital worlds to enable breakthroughs at the Intelligent Edge. ADI combines analog, digital, and software technologies into solutions that help drive advancements in digitized factories, mobility, and digital healthcare, combat climate change, and reliably connect humans and the world.

University of Central Florida - College of Engineering and Computer Science is one of the nation’s largest producers of engineering and computer science talent. In fact, UCF is recognized as the nation’s #1 workforce supplier and a top-preferred supplier to the aerospace and defense industry.

Teledyne MEMS offers customers unmatched production capability from prototyping on 150mm wafers to volume 200mm production. With two Canadian locations, our scalable solutions enable your business goals.
Research at UF plays a significant role in advancing our fundamental understanding of the universe, generating creative breakthroughs that lead to technologies with positive benefit, creating opportunities for economic growth in the state, and changing the trajectory of young people through education.

The ECE Department at UF has a long and storied history—since 1909, we have been engineering impact and innovation while creating the best workforce in electrical and computer engineering for the state of Florida and for the nation. Our research, discoveries, and the resulting technologies continue to touch lives everywhere.

KLA Corporation is a leading supplier of wafer processing, process control and yield management solutions for the semiconductor and related nanoelectronics industries. KLA's products and services are used by bare wafer, IC, reticle and other manufacturers of materials and equipment around the world, from research and development to final volume manufacturing.
Microtech Ventures is focused on strategic venture capital, angel investing, and M&A advisory services. Our mission is to accelerate the development of sensors, MEMS, and microtechnologies for the advancement of civilization and creation of market value.

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Los Angeles, CA 90089 USA
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The Viterbi School of Engineering has at least four tenure track faculty members (in AME, BME and ECE departments) whose main research thrusts are in MEMS including but not limited to acoustic, biomedical, energy-harvesting, microfluidic and wearable MEMS.

Lam Research Corporation is a trusted global supplier of innovative wafer fabrication equipment and services to the semiconductor industry. Our broad portfolio of market-leading deposition, etch, strip, and wafer cleaning solutions helps customers achieve success on the wafer by enabling device features that are 1,000 times smaller than a grain of sand—it’s why nearly every chip today is built with Lam technology.
Silex Microsystems is the world’s largest pure-play MEMS foundry supporting the most innovative companies in the sensor, life sciences, consumer electronics, telecommunications, automotive, and industrial markets. Leveraging the industry’s most extensive line of MEMS manufacturing capabilities, Silex brings our customers products from inception to high-volume production in the shortest possible time.

Analog Devices, Inc. (NASDAQ: ADI) is a global semiconductor leader that bridges the physical and digital worlds to enable breakthroughs at the Intelligent Edge. ADI combines analog, digital, and software technologies into solutions that help drive advancements in digitized factories, mobility, and digital healthcare, combat climate change, and reliably connect humans and the world.

MEMStaff Inc. is the leading MEMS recruiting firm with a focus on MEMS technologies and a team possessing unmatched industry experience and more than a decade of recruiting success.
Zepsor Technologies is a tech startup commercializing event-driven sensing solutions for IoT, robotics and security applications. Zepsor's proprietary zero-power sensor technology offers uninterrupted operation and unprecedented accuracy.

BioCircuit Technologies makes medical devices for improved nerve repair and neural interfacing. Nerve Tape® is an implantable device for the sutureless repair of injured nerves.

Micromachines (ISSN 2072-666X) is a peer-reviewed open access journal on the science and technology of small structures, devices and systems, published monthly online by MDPI. Micromachines is indexed in EI, Scopus, PubMed and SCIE (Web of Science), and has an Impact Factor of 2.891 (2020).

The MEMS and Sensors Industry Group (MSIG) is a leading group of 150+ companies throughout the ecosystem who collaborate and share ideas to help ease the adoption of MEMS and sensors. Check out our website to learn more about how MSIG can help your company grow and prosper.
# Tabletop Exhibitors

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<th>EXHIBITORS</th>
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<tr>
<td>A.M. Fitzgerald &amp; Associates LLC</td>
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<td>700 Airport Blvd, Suite 270</td>
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<tr>
<td>Burlingame, CA 94010 USA</td>
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<tr>
<td>phone: 1-650-347-6367</td>
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<tr>
<td><a href="mailto:info@amfitzgerald.com">info@amfitzgerald.com</a></td>
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<td><a href="http://www.amfitzgerald.com">www.amfitzgerald.com</a></td>
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Established in 2003, A.M. Fitzgerald & Associates, LLC ("AMFitzgerald") provides expert MEMS product development services and solutions, including: custom MEMS design, emerging technology development, simulation, process integration, MEMS prototype fabrication, package and test, foundry selection and transfer with support through production, and strategy consulting.

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<th>DEEPLIGHT</th>
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<td>EPFL Innovation Park, Building A</td>
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<tr>
<td>Lausanne, 1015 SWITZERLAND</td>
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<td><a href="mailto:info@deeplight.ai">info@deeplight.ai</a></td>
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<th>EV Group, Inc.</th>
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<td>7700 S. River Parkway</td>
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<tr>
<td>Tempe, AZ 85284 USA</td>
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<tr>
<td>phone: +1-480-305-2400</td>
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<td><a href="mailto:salesnorthamerica@evgroup.com">salesnorthamerica@evgroup.com</a></td>
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<td><a href="http://www.evgroup.com">www.evgroup.com</a></td>
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EV Group (EVG) is a leading supplier of high-volume production equipment and process solutions for the manufacture of semiconductors, MEMS, power devices and nanotechnology devices.

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<th>Heidelberg Instruments Inc.</th>
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<tr>
<td>2539 West 237th Street, Suite A</td>
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<tr>
<td>Torrance, CA 90505 USA</td>
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<tr>
<td>phone: +1-310-212-5071</td>
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<td><a href="http://www.heidelberg-instruments.com">www.heidelberg-instruments.com</a></td>
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Heidelberg Instruments manufactures high-precision direct-write photolithography tools, from tabletop systems to high-speed large-area production equipment, serving over 50 countries in various nano- and micro-fabrication industries.
IEEE MEMS Technical Community .................................................... 14
ieeeememstc.org

IEEE Micro Electro Mechanical Systems (MEMS) Technical Community will keep you abreast of the latest in MEMS ideas, designs, and manufacturing methodologies, many of which could very well spark new thinking and enable new capabilities in a myriad of IEEE fields. MEMS is an enabling technology harnessing the benefits of miniaturization in physical domains beyond the electrical and found in billions of devices today.

Institute for NanoSystems Innovation (NanoSI) ................................. 10
at Northeastern University
360 Hungtington Avenue
Boston, MA 02115 USA
nanosi@northeastern.edu
nanosi.northeastern.edu

NanoSI is a global leader in semiconductor research, fostering Industry-University collaboration. Our research spans MEMS, semiconductor devices, circuits, enabling innovation in sensors, electronics, and wireless communication.

InvenSense, a TDK Group Company ................................................ 15
1745 Technology Drive
San Jose, CA 95110 USA
phone: 1-408-988-7339
inc.pr@tdk.com
invensense.tdk.com

InvenSense, a TDK Group company, is a world leading provider of SmartSensing platforms. InvenSense’s vision of Sensing Everything® targets the consumer electronics and industrial areas with integrated Motion, Sound, Pressure, and Ultrasonic solutions.

LioniX International ................................................................. 8
PO Box 456
Enschede, 7500 NETHERLANDS
www.lionix-international.com

LioniX International develops and produces customized MEMS solutions, including process development, mask design and prototyping, from proof-of-principle devices through medium-volume production.
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<td><a href="http://www.lynceetec.com">www.lynceetec.com</a></td>
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<tr>
<td>The world leader of patented Digital Holographic Microscope (DHM®) for 4D profilometry with unrivalled speed, sub-nanometer resolution and in-situ characterization for both in and out of plane.</td>
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<th>memsstar Ltd</th>
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<td>1 Fleming Road</td>
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<tr>
<td>Livingston, EH547BN UK</td>
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<td>phone: +44-150-624-3203</td>
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<td><a href="mailto:info@memsstar.com">info@memsstar.com</a></td>
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<td><a href="http://www.memsstar.com">www.memsstar.com</a></td>
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<td>memsstar is a leading supplier of vapour phase processing equipment for the global MEMS industry. With our class leading processing capability, we offer leading edge performance enabling the worlds most advanced MEMS devices. With solutions from lab to fab, contact us for your HF, XeF2 and SAM coating needs.</td>
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<th>Polytec, Inc.</th>
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<td>Irvine, CA 92618 USA</td>
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<td>phone: +1-949-9433033</td>
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<td><a href="mailto:info@polytec.com">info@polytec.com</a></td>
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<td><a href="http://www.polytec.com">www.polytec.com</a></td>
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<td>Polytec is the world’s leading supplier of high precision, non-contact, optical measurement solutions used in the research, development and production of MEMS Devices, Transducers, Resonators, Actuators, Sensors, Pumps and more. Our Laser Doppler Vibrometers rapidly measure vibration response in real-time with unparalleled sub-pm resolution. Polytec Micro systems are capable of measurements from 0 Hz to 6 GHz. Polytec recently introduced an Automated Mems Wafer Inspection system called VibroArc.</td>
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<th>Science Corporation</th>
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<td>3021 East Cornwallis Road</td>
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<tr>
<td>Durham, NC 27709 USA</td>
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<tr>
<td>phone: +1-510-871-2567</td>
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<td><a href="mailto:foundry@science.xyz">foundry@science.xyz</a></td>
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<td><a href="http://www.science.xyz">www.science.xyz</a></td>
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<tr>
<td>Science Foundry is your fastest path from MEMS design to device. Choose from our multi-project wafer offerings or ask about our vast array of custom process capabilities.</td>
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</table>
EXHIBITORS

SoftMEMS LLC ................................................................. 2
2391 Nobili Avenue
Santa Clara, CA 95051 USA
phone: +1-510-847-4170
info@softmems.com
www.softmems.com

SoftMEMS sells powerful, easy to use computer aided design (CAD) tools for the co-design and modeling of products and systems including MEMS and sensors, packaging and electronics.

SUSS MicroTec Inc. ............................................................ 7
2520 Palisades Drive
Corona, CA 92882 USA
phone: +1-951-817-3700
info@suss.com
www.suss.com

SUSS MicroTec provides solutions for semiconductor microstructuring, works on 3D integration, nanoimprint lithography, MEMS and LED processes and supports over 8,000 systems worldwide.
Tabletop Floor Plan
Santee Ballroom Foyer

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SoftMEMS LLC .................................................................................. 2
SUSS MicroTec Inc. ............................................................................. 7
DENICE DENTON MENTORSHIP AWARD

The Hilton Head Workshop is pleased to announce the 2024 Denice Denton Mentorship Award. This award recognizes long-term mentors with a proven record of mentoring researchers and engineers in the areas of interest to TRF.

The award is given in honor of Denice Denton (1959 - 2006), who earned her BS, MS and PhD in electrical engineering from the Massachusetts Institute of Technology, and then went on to a groundbreaking career in academia.

She was the first female engineer to receive tenure as a faculty member at the University of Wisconsin - Madison. At age 37 she was appointed Dean of Engineering at the University of Washington, one of the youngest as well as the first female dean of a top-ranked engineering program. While at UW, she was awarded the Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring. At 45 she was selected as the Chancellor of the University of California, Santa Cruz, the youngest and the first openly gay person to be appointed as Chancellor in the University of California system.

Denton was a prolific and influential mentor who not only supported colleagues but also remedied the marginalization of those not in positions of privilege and power, using strategies she developed while surmounting daunting professional obstacles of her own. She founded and sustained informal, lively peer support groups, made connections to advocates in positions of power, sought out and shared information about institutional procedures, and even helped with fundraising for legal fees in some cases. She lived out her ideal of institutions in which people could thrive personally as well as professionally.

In a speech to the National Academies, former Dept. of Health and Human Services Secretary Donna Shalala said of Denton, "She was bigger than life. She opened doors and stood in them to let others through."
The Hilton Head Workshop is pleased to announce the 2024 Mark Shannon Grand Challenges Award. This award recognizes the long-term contributions of members of our technical community with a vision to address humanity’s pressing issues.

The award is given in honor of Mark A. Shannon (1955 - 2012), who earned his BS, MS, and PhD degrees at the University of California, Berkeley, and was on the Mechanical and Systems Engineering faculty of the University of Illinois Urbana-Champaign.

Shannon was renowned for developing nanoscale, microscale, and mesoscale technologies that addressed the grand challenges of water purification and desalination, micro-fabrication, medicine, and energy production. His mission was to bring attention to and solve challenges with the world’s highly vulnerable freshwater resources. To this end, he invented new micro- and nano-fabrication methods that utilize electric fields, plasmas, and chemistry to create new NEMS, MEMS, and mesoscale energetic devices and water purification systems. In particular, he was co-inventor of a "molecular gate" that can move and filter materials at the molecular level.

A pillar of our Hilton Head community, his international reputation and passion for his work was evident whether he was teaching students or testifying before Congress, and his energy and tenacity attracted others from around the world to share his vision and work to solve society’s problems. By his side always was his wife Mona--the first and only love of his life--including at numerous Hilton Head meetings where she warmly created community. For those lucky enough to work with or know him, Shannon was best known for an unbridled enthusiasm for life, dedication and love for his family, and devotion to his students, even while gravely ill with amyotrophic lateral sclerosis (ALS), also known as Lou Gehrig’s disease. In commemorating Shannon’s passing, former UIUC Department Head Placid Ferreira shared: "A true visionary, Mark was an extraordinary person who dedicated his work and efforts to our students. He was an inspiration to all of us, and we will always remember his generosity and strength."
The Hilton Head Workshop is pleased to announce the 2024 Wen Ko Technical Leadership Award. This award recognizes researchers with an outstanding track-record of technical leadership and innovation in areas of interest to the TRF.

The award is given in honor of Wen Hsiung Ko (1923 - 2017), a member of the Electrical Engineering faculty of Case Western Reserve University (CWRU) from 1959 to his retirement in 1993.

A native of mainland China, Ko moved to Taiwan in the late 1940s and then to Cleveland in 1954, where he earned both his MS (1956) and PhD (1959) from the Case Institute of Technology.

An innovator in both electrical and biomedical engineering, he was a pioneer in microsensors, actuators, integrated microsystems, medical implants, telemetry and packaging. His body of work on physical and chemical (gas) microsensors in the early 1970s is one of the earliest efforts in the field. In the mid-1960s, his group demonstrated the first implantable muscle control system in living subjects.

A light to generations of young engineers, he advised more than 150 MS and PhD students. He established and led the Electronics Design Center at CWRU and was a Fellow of IEEE Biomedical Engineering Society and the American Institute of Medical and Biological Engineering. He was one of the founders of the Transducers Research Foundation and the Hilton Head Workshop series and served as TRF president from 1987 to 2004.

After retirement, Ko remained a research-active emeritus professor for another 11 years, serving as PI on an NIH R21 grant at the age of 89! Ko's children noted, "His spirit and intellect continued to be strong and curious up to the end."
JANUSZ BRYZEK ABUNDANCE THROUGH MEMS AWARD

The Janusz Bryzek Abundance through MEMS award seeks to recognize graduate or undergraduate students whose work best exemplifies the application of MEMS to Abundance. Abundance refers to a future in which all of humanity has access to clean water, food, energy, health care, housing, education and everything else to live an abundant fulfilling life due to rapid developments in exponential technologies including MEMS. Janusz Bryzek was a pioneering and prolific MEMS entrepreneur who started 11 companies and was committed to the vision of Abundance. This award, honoring Janusz' legacy, will recognize emerging researchers in MEMS and related fields whose work significantly contributes to the vision of Abundance.

Dr. Janusz Bryzek was a world-renowned pioneer in the field of micro-electromechanical systems (MEMS), founding and commercializing his MEMS passion vis-à-vis 11 companies over his 40 plus year career ... from pressure sensors to multiplexers, IMUs to ultrasonic imagers. An optimistic technology enthusiast, he envisioned the abundance of ubiquitous low-cost MEMS devices as a means of improving the quality of lives globally. As such, he operated at the convergence of MEMS, Entrepreneurism, and Abundance.
Microsystems & Nanoengineering, with a target for a high-end journal for years to come, seeks to promote research on all aspects of microsystems and nanoengineering from fundamental to applied research. This journal will provide a home for the latest research and a platform for more exchange and collaboration among scientists in the new multidisciplinary area. Submit your research today!

Micromachines (ISSN 2072-666X) is a peer-reviewed open access journal on the science and technology of small structures, devices and systems, published monthly online by MDPI. Micromachines is indexed in EI, Scopus, PubMed and SCIE (Web of Science), and has an Impact Factor of 2.891 (2020).
The U.S. Army Combat Capabilities Development Command (DEVCOM) Army Research Laboratory is the Army's corporate research laboratory strategically placed under the Army Futures Command. ARL is the Army's sole fundamental research laboratory focused on cutting-edge scientific discovery, technological innovation, and transition of knowledge products that offer unprecedented potential to improve the Army's chances of surviving and winning any future conflicts.

National Institutes of Health (NIH)
www.nih.gov/

The National Institutes of Health (NIH), a part of the U.S. Department of Health and Human Services, is the nation’s medical research agency — making important discoveries that improve health and save lives.
WORKSHOP 1: MEMS KNOW HOWE
Sunday - 10:00 - 15:00 - Savannah Jr. Ballroom

Professor Roger Howe, a leading figure in the field of Micro-Electro-Mechanical Systems (MEMS), is set to retire from Stanford University this year. In honor of his retirement, a symposium is being organized to celebrate his transformative contributions to MEMS technology.

The event will feature talks from Professor Howe's colleagues and students, who will highlight the various facets of his impact on the MEMS community. Specific focus areas will include surface micromachining, resonators, oscillators, inertial sensors, self-assembly processes, adhesion in microstructures, optical MEMS, biosensors, and other applications. The symposium aims to acknowledge Professor Howe's enduring influence on MEMS, offer insights into key advancements from both academia and industry, and inspire a new wave of pioneers in the field.

WORKSHOP 2: SMALL-SCALE ROBOTS: FROM ONE TO A SWARM
Sunday - 11:00 - 17:00 – Charleston Room, 2nd Floor

The research on small-scale robots has benefited tremendously from prior technological advances in MEMS. This journey started in 1980s where the vision of silicon chip-based robots with onboard sensors, actuators, and power supplies was proposed. Today, the challenge remains: how do we power these micro marvels and equip them with sufficient force to perform their tasks? The initial segment of this workshop will explore cutting-edge sensors and actuators, novel manufacturing methods, and creative strategies to address the energy limitations inherent in small-scale robotic systems.

The progress in small-scale robotics opens a dialogue about the creation of artificial agents that emulate the capabilities of their biological counterparts. In nature, the collective behaviors of simple agents—like ant colonies, bee hives, and schools of fish—illustrate how local interactions can lead to complex group dynamics, where the system as a whole is greater than the sum of its parts. Small-scale robots, with their compact dimensions and cost-effectiveness, serve as ideal platforms for exploring embodied and swarm intelligence. The workshop's second session will convene experts in swarm robotics, with a particular emphasis on micro-robots, to highlight the latest progress from theory to real-world applications in swarm design, fabrication, actuation, and coordination.
SEMI MSIG INDUSTRY SESSION:
NAVIGATING THE TRANSITION TO INDUSTRY
Tuesday - 14:00 - 16:00 - Santee Ballroom

Join us for an immersive Industry Session designed to help graduate students navigate the transition from academia to industry. This event is hosted by SEMI MEMS and Sensors Industry Group (MSIG), a trade organization that brings together key players from across the ecosystem to address common challenges, explore emerging trends, and drive industry growth.

Gain practical advice, success strategies, and learn about the nuances of industry roles that are often overlooked in academia, as well as the variety of roles both in and out of the fab. Learn how to leverage your academic background while adapting to the dynamic demands of the industry. Engage with seasoned industry executives as they share firsthand experiences and advice. Participate in breakout sessions facilitated by rising stars in the industry. Don’t miss this exclusive opportunity to expand your professional network, gain invaluable industry insights, and chart a successful career path in the MEMS and sensors sector.

BEYOND TECHNICAL EXPERTISE: DEALING WITH SOURCES OF PERSONAL AND PROFESSIONAL STRESS
Tuesday - 14:00 - 16:00 - Savannah Jr. Ballroom

We use short dramatizations supplemented with extensive discussion to explore stressful non-technical issues that often arise in the high-tech life. Specifically, we focus on three topics: power imbalance during peer review, when a junior investigator is asked to review a paper by a senior person, and there is a question of originality of the work; microaggressions, behaviors that create personal discomfort, whether intended or accidental; and the imposter syndrome, feelings of personal or professional inadequacy that can arise when exploring uncharted territory.

WEDNESDAY RUMP SESSION
Wednesday - 20:00 - 22:00 - Santee Ballroom

The 40th anniversary rump session hopes to capture classic aspects of the Hilton Head experience. To kick things off, attendees will be asked to test their knowledge on all aspects of microsystems, and Hilton Head. Try to find yourself in a diverse group to maximize your success! Amidst the trivia, serious discussion will be had on important topics in our field. Of course, no anniversary would be complete without special guests and toasts. As usual, snacks and beverages will be provided. So, you bring the Chips (Act), we will bring the salsa. This session is open to all attendees.
Sunday, 2 June
Workshop 1  MEMS Know Howe

10:00  HOWE MEMS REALLY TOOK OFF
Kurt Petersen, Silicon Valley Band of Angels, USA

MICROFABRICATED ELECTROSTATIC COMB DRIVE
William Tang, University of California, Irvine, USA

HOWE POLYSILICON SURFACE MICROMACHINING
TRANSFORMED INERTIAL MEMS
Michael Judy, Consultant, USA

INTEGRATION OF MEMS AND CMOS
Gary Fedder, Carnegie Mellon University, USA

ADHESION AND ADHESION REDUCTION PROCESSES IN
SURFACE MICROMECHANICAL STRUCTURES
Roya Maboudian, University of California, Berkeley, USA

MICROASSEMBLY PROCESSES
Karl Bohringer, University of Washington, USA

12:00  Lunch

13:00  MEMS RESONATORS AND OSCILLATORS
Clark Nguyen, University of California, Berkeley, USA

HOWE SILICON MEMS RESONATORS BEGAN THE PATH TO
TIMING PRODUCTS
Tom Kenny, Stanford University, USA

MEMS VIBRATORY GYROSCOPES ARE BECOMING 3D AND
ATOMICALLY PRECISE
Andrei Shkel, University of California, Irvine, USA

OPTICAL MEMS
Olav Solgaard, Stanford University, USA

APPLICATION OF ULTRATHIN ALD PLATES
Igor Bargatin, University of Pennsylvania, USA

SIMPLIFYING BIOASSAY DEVELOPMENT WITH QES
Chaitanya Gupta, Probius, USA

SUMMARY AND WRAP-UP
Roger Howe, Stanford University, USA

15:00  Adjourn
Workshop 2  Small-Scale Robots: From One to a Swarm

11:00  Morning Session

13:00  Lunch

15:30  Afternoon Session

17:00  Adjourn

Speakers:
Kristofer Pister, University of California, Berkeley, USA
Amit Lal, Cornell University, USA
Di Ni, Princeton University, USA
Steven Ceron, Massachusetts Institute of Technology, USA
Ronald Heisser, Massachusetts Institute of Technology, USA

18:00 - 21:00  Registration and Welcome Reception
2022 JCR Impact Factor

7.9 Q1

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Topics of Particular Interest

Including, but not limited to:

- Micro-nano sensors and actuators
- MEMS and NEMS materials, fabrication and packaging
- Applied sciences of micro-nano systems
- Micro-nano mechanics, structures and modeling

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Email: mine@aircas.ac.cn

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Monday, 3 June

07:00 Breakfast

07:45 Welcome
TRF President - Reza Ghodssi, University of Maryland
Workshop Chair - Jenna Chan, DEVCOM Army Research Laboratory
Program Chair - Swaminathan Rajaraman, University of Central Florida

Plenary Speaker I
Session Chair: Shawana Tabassum, University of Texas, Tyler, USA

08:15 IoT4Ag AGRICULTURAL LEAF AND SOIL SENSORS
Cherie R. Kagan, Ph.D., Roy H. Olsson, and Kevin T. Turner
University of Pennsylvania, USA

Session 1 - Microsystems for Biosensing
Session Chair: Igor Paprotny, University of Illinois, Chicago, USA

08:55 INGESTIBLE DEVICE FOR NOISE-RESILIENT BIOIMPEDANCE MONITORING IN GASTROINTESTINAL TRACT
Brian M. Holt¹, Justin M. Stine¹, Luke A. Beardslee¹,
Jay Pasricha², and Reza Ghodssi¹
¹University of Maryland, USA and ²Mayo Clinic, USA,

09:15 MICROFABRICATION AND CHARACTERIZATION OF A NOVEL 3D MITOCHONDRIA BIOSENSOR
Randall James, Isaac Johnson, Ji Chang, Jorge Manrique Castro,
and Swaminathan Rajaraman
University of Central Florida, USA

09:35 ELECTRONIC-FREE TRACEABLE SMART CAPSULE FOR GASTROINTESTINAL MICROBIOME SAMPLING
Devendra Sarnaik, Sina Nejati, Sarath Gopalakrishnan, Venkat Kasi,
Akshay Krishnakumar, Samuel Hyde, Robyn McCain, Kinam Park,
Jay S. Johnson, and Rahim Rahimi
Purdue University, USA

09:55 ULTRA-SENSITIVE ON-CHIP GRAPHENE-BASED ELECTRO-OPTIC SENSOR ARRAYS FOR MULTIPLEXED NEURAL SIGNAL DETECTION
Xiang Li, Zabir Ahmed, Harshvardhan Gupta, Kanika Sarna,
Vishal Jain, and Maysam Chamanzar
Carnegie Mellon University, USA

10:15 am Break and Tabletop Inspection
10:44 am  Wen Ko Technical Leadership Award Announcement

Invited Speaker I
Session Chair: Kirsten Kaplan, Facebook, USA

10:45  FORTY YEARS OF MEMS INNOVATION AT HILTON HEAD WORKSHOP: FROM EMERGING TECHNOLOGIES TO COMMERCIAL PRODUCTS
Alissa M. Fitzgerald, Ph.D., AMFitzgerald & Associates, LLC, USA

Session 2 - Industrial, Higher TRL Microsystems
Session Chair: Thomas Li, NXP Semiconductors, USA

11:15  CARDIOPULMONARY AUSCULTATION SYSTEM ENABLED BY A NOVEL BEYOND-RESONANCE SENSING ACCELEROMETER
Tzeno Galchev¹, Longwei Xiao², Wenyong Zhang², Haozhe Dong², Jianglei Zhang¹, James Lin¹, Zhengxin Zhao¹, Adam Spirer¹, Jin Peng¹, Hua Jiang¹, Khiem Nguyen¹, and Sam Zhang¹
¹Analog Devices Inc., USA, ²Catron Inc., USA, ³Sichuan University, CHINA, and ⁴Sichuan Provincial People’s Hospital, CHINA,

11:35  A MEMS-BASED ANALOG COMPUTER FOR EDGE AI COMPUTING
David Lin¹, Johan M. Reimann¹, Dorin E. Calbaza¹, Robert J. MacDonald¹, Zhihui Yang¹, Abdallah K. Alzubi², Mohammad S. Megdadi², and Fadi M. Alsalem²
¹GE Aerospace Research, USA and ²University of Nebraska-Lincoln, USA

11:55  NESTED-MEMS TEMPERATURE COMPENSATED SINGLE-CRYSTALLINE SILICON OSCILLATOR
Amir Rahafrooz, Diego Emilio Serrano, Ryan Hennessy, William McDonald, Duane Younkin, Kieran Nunan, Stanley Che, and Ijaz Jafri
Panasonic Massachusetts Laboratory, USA

12:15  Oliver Brand Remembrance

12:20  Poster Preview – Session 1
Session Chairs:
Hengky Chandrahalim, Air Force Institute of Technology, USA
Siddhartha Ghosh, Northeastern University, USA

12:45 -  Networking Lunch
14:15
Poster Session 1
Session Chair: Reza Ghodssi, University of Maryland, USA

14:15 Contributed and Late News
See page 13 for listing of poster presentations

16:45 pm End of Day
Tuesday, 4 June

07:30  Breakfast

08:00  Announcements

### Plenary Speaker II
Session Chair: Amit Lal, Cornell University, USA

08:05  HYBRID LOW LOSS INTEGRATED PHOTONICS: FROM CHIPSCALE FREQUENCY COMBS, FREQUENCY AGILE LASERS, ERM BIUM AMPLIFIERS TO CRYOGENIC QUANTUM INTERCONNECTS
Tobias Kippenberg, Ph.D.
Swiss Federal Institute of Technology Lausanne (EPFL), SWITZERLAND

### Session 3 - Resonators, Oscillators and Micromotors
Session Chairs: Azadeh Ansari, Georgia Institute of Technology, USA and Vikrant Gokhale, Navy Research Laboratory, USA

08:45  Q-ENHANCEMENT OF PIEZO-ON-SILICON MEMS RESONATORS THROUGH MODE-COUPLING AND TOPOLOGICAL TANK CONFIGURATIONS
Suaid Tariq Balghari, Abid Ali, and Frederic Nabki
Ecole de Technologie Superieure, CANADA

09:05  ULTRA-STABLE MEMS OSCILLATOR WITH 42 PPT FRACTIONAL FREQUENCY STABILITY AT 85 SECONDS
Jintark Kim¹, Rakibul Islam¹, Jiheng Jing¹, Jie Yan¹, Gabrielle Vukasin², Ryan Kwon², Saurabh Saxena¹,³, Thomas W. Kenny², Pavan K. Hanumolu¹, and Gaurav Bahl¹
¹University of Illinois, Urbana-Champaign, USA, ²Stanford University, USA, and ³ Indian Institute of Technology, INDIA

09:25  ANALOG MICRO DELTA (µ∆) MOTOR: COMPLIANT MECHANISM ENABLED MEMS BIDIRECTIONAL TRANSMISSION-CAPABLE GAP CLOSING ARRAY
Alexander N. Alvara, Yichen Liu, Liwei Lin, and Kristofer S. J. Pister
University of California, Berkeley, USA

9:55 am  Break and Tabletop Inspection
10:14 am  Denice Denton Mentorship Award Announcement

Invited Speaker II
Session Chair: Ravi Selvaganapathy, McMaster University, CANADA

10:15  CHANGING THE COURSE OF HEART FAILURE DISEASE MANAGEMENT USING MEMS – A CARDIOMEMS STORY
Michael A. Fonseca, Ph.D.
StethX Microsystems, USA

Session 4 - Chemical and Environmental Sensing
Session Chairs: Daniela Diaz-Alonso, Center for Engineering and Industrial Development (CIDESI), MEXICO and Rahim Rahimi, Purdue University, USA

10:45  AN ELECTROLYTIC-INDUCED BUBBLE-BASED DISSOLVED CO2 SENSOR
Steven Tran, Seungbeom Noh, and Hanseup Kim
University of Utah, USA

11:05  MULTI-MODAL MEMS SENSING MODULE FOR EXTRATERRESTRIAL OCEANOGRAPHIC EXPLORATION
Zhijian Hao¹, Yue Zheng¹, Ethan W. Schaler², and Azadeh Ansari¹
¹Georgia Institute of Technology, USA and
²Jet Propulsion Laboratory, California Institute of Technology, USA,

11:25  PAPER-BASED WEARABLE MOIST-ELECTRIC GENERATORS WITH EFFICIENT ATMOSPHERIC WATER CAPTURE
Yang Gao, Anwar Elhadad, and Seokheun Choi
State University of New York, Binghamton, USA

11:45  Hilton Head Education, History, and Conservation Talk
The Civil War on Hilton Head Island: Local History, National Impact, Enduring Legacy
Jan McKelvey
Lean Ensemble Theater, USA

12:15 - 13:30  Networking Lunch

14:00 - SEMI MSIG Industry Session:
16:00  Navigating the Transition to Industry

14:00 - Workshop: Beyond Technical Expertise: Dealing with
16:00  Sources of Personal and Professional Stress
14:00 - Recreational Activities (on your own)
19:00

18:00 - Student Sandcastle Building Event
19:00

19:00 - Banquet
22:00
Wednesday, 5 June

7:15 am  Women in MEMS Breakfast (Savannah Jr. Ballroom)

7:30 am  Breakfast

8:10 am  Announcements

Plenary Speaker III
Session Chair: Reza Ghodssi, University of Maryland, USA

08:15  SENSORS, ROBOTS, AND AI FEEDBACK DATA LOOPS: POWERING JOINT REPLACEMENT SURGERIES OF THE FUTURE
Christopher J. Cannova, M.D.
Aligned Orthopedic Partners, USA

Session 5 - Medical MEMS
Session Chairs: Kevin Daniels, University of Maryland, USA and Virgilio Valente, Toronto Metropolitan University, CANADA

08:55  AN APPROACH FOR 3D MICROPRINTING OF SOFT ROBOTIC BIOPSY TOOLS AT 1 FRENCH LENGTH SCALES VIA EX SITU DIRECT LASER WRITING
Sunandita Sarker¹ ², Declan Fitzgerald¹, Zachary Ferraro¹, Olivia M. Young¹, Bailey M. Felix¹, and Ryan D. Sochol¹
¹University of Maryland, USA and ²University of Massachusetts, USA

09:15  FLEXIBLE MICROINJECTOR FOR RAPID LOCALIZED DRUG DELIVERY FROM INGESTIBLE DEVICES
Joshua A. Levy, Michael A. Straker, and Reza Ghodssi
University of Maryland, USA

09:35  MAGNETIC FIELD SENSING WITH A MINIATURE ELECTRO-OPTIC SENSOR FOR INTERVENTIONAL MAGNETIC RESONANCE IMAGING
Alp A. Derin¹, Abhiram Pulavarthi¹, Jordan L. Edmunds², Jack Guida¹, Siddhartha Ghosh¹, and Soner Sonmezoglu¹
¹Northeastern University, USA and ²University of California, Berkeley, USA
09:55  ULTRASOUND-BASED TELEMETRY OF IMPLANTED MICROFLUIDICS FOR INTRACRANIAL PRESSURE SENSING
Cecilia A. Luna¹², Saeyoung Kim², Adeoye Olomodosi¹², Nicholas Au Yong¹², Brooks D. Lindsey¹², and David R. Myers¹²
¹Emory University, USA and ²Georgia Institute of Technology, USA,

10:15  Break and Tabletop Inspection

10:44  Mark Shannon Grand Challenges Award Announcement

Invited Speaker III
Session Chair: Shaurya Prakash, Ohio State University, USA

10:45  EMPOWERING PEOPLE TO TAKE CONTROL OF HEALTH
Joshua Windmiller, Ph.D.
Dexcom, USA

Session 6 - Novel Devices
Session Chair: Farnaz Niroui, Massachusetts Institute of Technology, USA

11:15  POSS-ENABLED MECHANICAL ENHANCEMENT FOR 3D-NANOPRINTED HIGH-ASPECT-RATIO MICROINJECTION NEEDLES
Adira Colton¹, Sunandita Sarker¹, A. Muhaymin Chowdhury¹, Prableen Chowdhary², Joshua A. Levy¹, Katie L. Rusland¹, Reza Ghodssi¹, Rachel Brewster², Kinneret Rand-Yadin³, and Ryan D. Sochol¹
¹University of Maryland, College Park, USA, ²University of Maryland, Baltimore County, USA, and ³SeeTrue Technology, LLC, USA

11:35  AFTER 90 YEARS: CMOS-BASED HAFNIA-ZIRCONIA NANOMECHANICAL RESONATOR EXCEEDING AT-CUT QUARTZ TEMPERATURE STABILITY
Troy Tharpe, Moumita Chakraborty, and Roozbeh Tabrizian
University of Florida, USA

11:55  ULTRACOMPACT AND HIGH-GAIN THIN-FILM BULK ACOUSTIC RESONATOR MAGNETOELECTRIC ANTENNA ARRAY
Bin Luo¹, Xianfeng Liang¹, Hualihao Chen¹, Neville Sun¹, Hwaider Lin², and Nian X. Sun¹
¹Northeastern University, USA and ²Winchester Technologies LLC, USA,
12:15  **Poster Preview – Session 2**  
Session Chairs:  
Mary Beth Galanko Klemash, DEVCOM Army Research Laboratory, USA  
Swaminathan Rajaraman, University of Central Florida, USA

13:00 - 14:30  **Networking Lunch**

14:30  **Poster Session 2**  
Session Chair: Jenna Chan, DEVCOM Army Research Laboratory, USA

14:30  **Contributed and Late News**

17:00 - 18:30  **Free Time**

18:30  **Poster Session 3 and Reception**  
Session Chair: Sina Askari, ECS/DARPA, USA

18:30  **Commercial and Open Posters**

20:00 - 22:00  **Rump Session**
Thursday, 6 June

07:30  Breakfast

08:10  Announcements

Plenary Speaker IV
Session Chair: Kari Moran, Naval Information Warfare Center Pacific, USA

08:15  MICRO INNOVATIONS, MACRO IMPACT: MEMS AT THE FOREFRONT OF OUR ENERGY FUTURE
Evelyn N. Wang, Ph.D.
ARPA-E, USA

Session 7 - Novel Devices and Processes
Session Chair: Logan Sorenson, HRL Laboratories, USA

08:55  FABRICATION OF SUPERHYDROPHOBIC STRUCTURES VIA AEROSOL JET PRINTING
Jace Rozsa¹, Ke Zhong¹, Dinesh K. Patel¹, Lining Yao², Mohammad F. Islam¹, and Gary K. Fedder¹
¹Carnegie Mellon University, USA and
²University of California, Berkeley, USA

09:15  TRANSLATION AND ELECTRICALLY CONTROLLED ROTATION OF LARGE ZEBRAFISH EMBRYO BY ACOUSTIC TWEEZERS
Baptiste Neff, Kianoush Sadeghian Esfahani, Akash Roy, Matin Barekatain, and Eun S. Kim
University of Southern California, Los Angeles, USA

09:35  LOCALIZED AND CONFORMAL STRAIN ENGINEERING OF 2D MATERIALS FOR SCALABLE, FUNCTIONAL DEVICES
Sarah O. Spector, Weikun Zhu, Alex Quach, Peter F. Satterthwaite, and Farnaz Niroui
Massachusetts Institute of Technology, USA

09:55  Break and Tabletop Inspection

Invited Speaker IV
Session Chair: Vladimir Aksyuk, National Institute of Standards and Technology, USA

10:25  DECADES OF MEMS TIMING
Ginel C. Hill, Ph.D., Gary K. Giust, and Markus Lutz
SiTime Corporation, USA
10:55  A NOVEL THIN FILM ENDOVASCULAR ELECTRODE ARRAY FOR MINIMALLY INVASIVE NEURAL RECORDING
Brianna Thielen¹, Huijing Xu¹, Pradeep Selvan², Charles Liu¹, William J. Mack¹, Dong Song¹, and Ellis Meng¹
¹University of Southern California, Los Angeles, USA and ²Lundquist Institute for Biomedical Innovation, USA

11:15  AN AGING COMPENSATED ALSCN-ON-SI BULK ACOUSTIC WAVE OSCILLATOR TOWARDS TACTICAL-GRADE CLOCK GENERATION
Banafsheh Jabbari, Shaurya Dabas, Dicheng Mo, Eitan. Hershkovitz, Honggyu Kim, and Roozbeh Tabrizian
University of Florida, USA

11:35  INGESTIBLE BIOIMPEDANCE SENSING DEVICE FOR LOCALIZED FEEDBACK-DRIVEN DRUG DELIVERY
Mateo W. Lim, Brian M. Holt, Joshua A. Levy, Justin M. Stine, Luke A. Beardslee, and Reza Ghodssi
University of Maryland, USA

12:10  Award Ceremony

12:10  Closing Remarks
Workshop Chair - Jenna Chan, DEVCOM Army Research Laboratory
Program Chair - Swaminathan Rajaraman, University of Central Florida

12:45 - Networking Lunch

14:15  Workshop Adjourns
Chemical or Biological Sensors, Actuators or Systems

**MP-01**  
A HIGHLY SENSITIVE FLEXIBLE AG NPS/MWCNTS/NAFION-RU(NH₃)₆³⁺/²⁺ ELECTRODE WITH SU-8 MICROPILLARS FOR REAL-TIME HYDROGEN SULFIDE MONITORING IN LIQUIDS  
Chih-Hsiang Su¹, Mu-Yi Fang¹, Ting-Wei Huang¹, Yu-Ting Cheng¹, Hsiao-En Tsai², and Yih-Shurng Chen²  
¹National Yang Ming Chiao Tung University, TAIWAN and  
²National Taiwan University Hospital (NTUH), TAIWAN

**MP-02**  
ADVANCED PAPER-BASED ORGANIC ELECTROCHEMICAL TRANSISTORS: A NOVEL APPROACH FOR RAPID POINT-OF-CARE ANTIBIOTIC SUSCEPTIBILITY TESTING  
Zahra Rafiee, Maryam Rezaie, and Seokheun Choi  
State University of New York, Binghamton, USA

**MP-03**  
DUAL-MODE SENSING PLATFORM FOR DETECTION OF INFLAMMATORY BIOMARKER IN MONITORING ORGAN TRANSPLANT REJECTION  
Atul Sharma, Nafize Ishtiaque Hossain, and Sameer Sonkusale  
Tufts University, USA

**MP-04**  
EXTENDED FLIGHT DURATION SMALL-SCALE QUADROTORs POWERED BY HIGH-ENERGY-DENSITY, HIGH-POWER-DENSITY MICRO ALUMINUM-AIR BATTERIES  
Yanghang Huang, Haoxuan Lyu, Mark G. Allen, and Sue Ann Bidstrup Allen  
University of Pennsylvania, USA

**MP-05**  
FLEXISENSE: PH-GUIDED PRECISION DRUG DELIVERY AND MONITORING USING FLEXIBLE ELECTRONIC TECHNOLOGY  
Akshay Krishnamummar, Masud Rana Muhammad, Sarath Gopalakrishnan, Jose Waimin, and Rahim Rahimi  
Purdue University, USA

**MP-06**  
INTEGRATION OF HYDROGEL MICROFIBERS FOR HYBRID LEAD SEQUESTRATION AND SENSING IN CROP PLANTS: A NOVEL APPROACH FOR PHYTOREMEDIATION  
Rhythem Tahrin, Francisco Perez, Mohammad Solaiman, Md Najmul Islam, Shah Zayed Riam, and Shawana Tabassum  
University of Texas, Tyler, USA
MP-07  NFC-ENABLING SMARTPHONE-BASED PORTABLE PHOTOTHERMAL SENSING INTEGRATED WITH PAPER-BASED MICROFLUIDIC DEVICES FOR ENZYME-FREE GLUCOSE DETECTION
Kawin Khachornsakkul, Ruben Del-Rio-Ruiz, Cihan Asci, and Sameer Sonkusale
Tufts University, USA

MP-08  PROBIOTIC-POWERED INGESTIBLE CAPSULES: A NOVEL APPROACH TO VIBRATIONAL THERAPY
Maryam Rezaie and Seokheun Choi
State University of New York, Binghamton, USA

MP-09  RAPID, LOW-COST CARBAPENEMASE DETECTION USING A SELF-COALESCING STICKER MICROFLUIDIC FOR ENHANCED MANAGEMENT OF CARBAPENEMASE-PRODUCING ORGANISMS IN HEALTHCARE SETTINGS
Anjana Dissanayaka¹,², Ali Haider³, Lily Kamat¹,², Priscilla Delgado¹,², Jesse Waggoner³, and David R. Myers¹,²
¹Emory University, USA, ²Georgia Institute of Technology, USA, and ³Emory University School of Medicine, USA

MP-10  FIBEROPTICS SERS BIOSENSORS FOR SALMONELLA SENSING
Mai Abuhelwa¹, Arshdeep Singh¹, Jiayu Liu¹, Mohammed Almalaysha¹, Kate E. Trout¹, Amit Morey², E. Kinzel³, Lakshmikantha H. Channaiah¹, and Mahmoud Almasri¹
¹University of Missouri, Columbia, USA, ²Auburn University, USA, and ³University of Notre Dame, USA

MP-11  ULTRA THIN SMART ELECTROPALATOGRAPHY SYSTEM TO ASSIST LINGUISTIC AND MEDICAL DIAGNOSIS
Ziqi Jia, Sunghyun Hwang, Saeyeong Jeon, Ariel David Cerpa, and Yong-Kyu “YK” Yoon
University of Florida, USA

Physical Sensors, Actuators, or Systems

MP-12  2 TO 16 GHZ FUNDAMENTAL SYMMETRIC MODE ACOUSTIC RESONATORS IN PIEZOELECTRIC THIN-FILM LITHIUM NIOBATE
Vakhtang Chulukhadze, Jack Kramer, Tzu-Hsuan Hsu, Omar Barrera, Ian Anderson, Sinwoo Cho, Joshua Campbell, and Ruochen Lu
University of Texas, Austin, USA
MP-13  A LOW-PHASE NOISE OSCILLATOR EMPLOYING CONTOUR-MODE LITHIUM TANTALATE RESONATORS WITH HIGH TURNOVER TEMPERATURE
Tanvir Hasan, Yasaman Majd, Hamed Atashbar, Hannaneh Mahdavi, Hakhamaneh Mansoorzare, and Reza Abdolvand
University of Central Florida, USA

MP-14  A PARAMETRIC FREQUENCY COMB GENERATOR IMPROVING BY 10X THE LIMIT-OF-DETECTION OF 120 MHZ ALSCN-BASED IR DETECTORS
Hussein M. E. Hussein¹, Farah Ben Ayed², Aurelio Venditti², Pietro Simeoni², Zhenyun Qian², Cristian Cassella¹, and Matteo Rinaldi²
¹Northeastern University, USA and ²NS&NS Laboratory & Institute of NanoSystems Innovation, USA

MP-15  AI-DRIVEN SCANNING GHZ ULTRASONIC IMAGING-BASED MEMS METROLOGY
Karan Jha¹, Anuj Baskota¹, Justin Kuo¹, Serhan Ardanuç¹, Scott Zimmerman¹, and Amit Lal¹,²
¹Geegah Inc, USA and ²Cornell University, USA

MP-16  CO-RESONANT CANTILEVERS AS HIGHLY SENSITIVE MASS SENSORS
Ioannis Lampouras and Julia Körner
Leibniz University Hannover, GERMANY

MP-17  DESIGN AND FABRICATION OF A NOVEL THERMALLY-ACTUATED NO ELECTRIC POWER EVENT-DRIVEN MEMS SENSOR FOR IOT APPLICATIONS
Dilan Ratnayake and Kevin M. Walsh
University of Louisville, USA

MP-18  DESIGN AND FABRICATION OF SWITCH BASED BIO-INSPIRED AIRFLOW SENSORS
Bram Miller, Regan Kubicek, and Sarah Bergbreiter
Carnegie Mellon University, USA

MP-19  ENHANCING TEMPERATURE STABILITY OF LAMÉ-MODE SILICON RESONATOR USING ELASTIC NONLINEARITY
Dicheng Mo, Shaurya Dabas, Banafsheh Jabbari, and Roozbeh Tabrizian
University of Florida, USA
MP-20 FLUX CONCENTRATOR OPTIMIZATION EXPLOITING SATURATION FOR MICROMACHINED AC MAGNETIC FIELD SENSORS
Xuan Wang, Sydney Sofronici, Roy H. Olsson, and Mark G. Allen
University of Pennsylvania, USA

MP-21 GRAVIMETRIC PARTICULATE MATTER SENSING WITH PIEZOELECTRIC PAPER
Anindya L. Roy, Kanagasubbulakshmi Sankaralingam, Konrad Walus, and Boris Stoeber
University of British Columbia, CANADA

MP-22 INTERNAL RESONANCE OF A T-SHAPED ELECTROSTATIC LEVITATION ACTUATOR
Mohammad Alzgool, Yu Tian, Mohammad Younis, and Shahrzad Towfighian
Binghamton University, USA

MP-23 MEMS LITHIUM NIOBATE TRANSFORMER FOR LOW FREQUENCY PASSIVE GAIN WITH HIGH CAPACITIVE LOADS IN ATMOSPHERE
Justin Phelps and Reza Abdolvand
University of Central Florida, USA

MP-24 MID-AIR PARTICLE MANIPULATIONS BY A 2x2 PMUT ARRAY
Wei Yue¹, Megan Teng¹, Yande Peng¹, Fan Xia¹, Peggy Tsao¹, Yuan Gao¹, Shinsuke Ikeuchi², Yasuhiro Aida², Seiji Umezawa², and Liwei Lin¹
¹University of California, Berkeley, USA and ²Murata Manufacturing Co., Ltd., JAPAN,

MP-25 NONLINEAR INTERNAL RESONANCE FOR GAS SENSING
Wagner B. Lenz¹, Rodrigo T. Rocha¹.², Fahimullah Khan¹.³, Carlos A. Grande¹, and Mohammad I. Younis¹.⁴
¹King Abdullah University of Science and Technology (KAUST), SAUDI ARABIA, ²Silicon Austria Labs (SAL), AUSTRIA, ³International Iberian Nanotechnology Laboratory Braga, PORTUGAL, and ⁴State University of New York, Binghamton, USA

MP-26 PARASITIC-IMMUNE REAL-TIME TRACKING OF A MEMS FREQUENCY REFERENCE
Jie Yan¹, Jintark Kim¹, Rakibul Islam¹, Jiheng Jing¹, Dongsuk D. Shin², Saurabh Saxena¹.³, Pavan Hanumolu¹, Thomas W. Kenny², and Gaurav Bahl¹
¹University of Illinois, Urbana-Champaign, USA, ²Stanford University, USA, and ³Indian Institute of Technology, INDIA
MP-27 SCANDIUM ALUMINUM NITRIDE OVERMODED BULK ACOUSTIC RESONATORS FOR FUTURE WIRELESS COMMUNICATION
Walter Gubinelli, Pietro Simeoni, Ryan Tetro, Luca Colombo, and Matteo Rinaldi
Northeastern University, USA

MP-28 SPARSE ARRAY OF THERMAL RESONATORS FOR INFRARED DETECTION AND IMAGING
Isabel H. Rodrigues¹, Clifford F. Frez¹, Savannah R. Eisner²,³, Debbie G. Senesky², and Mina Rais-Zadeh¹
¹California Institute of Technology, USA, ²Stanford University, USA, and ³Columbia University, USA

MP-29 TRAMPOLINE Si₃N₄ MAGNETOMETERS WITH 330 PT/√Hz SENSITIVITY
Massood Tabib-Azar and Brian Baker
University of Utah, USA

MP-30 ULTRA-WIDEBAND TAPERED TRANSDUCERS IN THIN-FILM LITHIUM NIOBATE ON SILICON CARBIDE
Jack Kramer, Tzu-Hsuan Hsu, Joshua Campbell, and Ruochen Lu
University of Texas, Austin, USA

Technology, Materials, Packaging, and CAD

MP-31 3D PRINTED MICRO LIQUID THERMAL REGULATOR (MLTR) FOR IN-VIVO CHRONIC PAIN APPLICATIONS
Jazune Madas, Andre Childs, Jichao Ma, Jin Chen, Lei Zhai, Zixi Jack Cheng, and Swaminathan Rajaraman
University of Central Florida, USA

MP-32 ADVANCING MILLIMETER-WAVE TECHNOLOGIES: HIGH-EFFICIENCY 3D AIR-LIFTED INDUCTORS FEATURING A HIGHLY MANUFACTURABLE CU/CO METACONDUCTOR
Saeyeong Jeon, Ariel David Cerpa, Alexander Wilcher, and Yong-Kyu Yoon
University of Florida, USA

MP-33 ANALYSIS OF DIFFERENT MICROFLUIDIC PIN-FIN STRUCTURES IN METAL ADDITIVELY MICROFABRICATED PACKAGES FOR THERMAL MANAGEMENT OF MICROSYSTEMS
Bhushan Lohani¹, Ryan M. Price², Peter Sanchez², and Robert C. Roberts²
¹Pennsylvania State University, USA and ²University of Texas, El Paso, USA
MP-34  ENABLING CUT-RESISTANT SUPERHYDROPHOBIC SURFACES USING A HIGHLY ENTANGLED SOFT POLYMERIC SUBSTRATE
Junc Cheng and Tingyi “Leo” Liu
University of Massachusetts, Amherst, USA

MP-35  HIGHLY EFFICIENT, FLEXIBLE, AND SELF-HEALABLE MOISTURE-DRIVEN ENERGY HARVESTER BASED ON 2D VANADIUM PENTOXIDE NANOSHEETS
Kundan Saha and Sameer Sonkusale
Tufts University, USA

MP-36  LONG-LASTING LEVOTHYROXINE SODIUM MICRONEEDLE PATCH FOR HASHIMOTO’S THYROIDITIS TREATMENT
Diana V. Rodriguez De Francisco, Edwin Davidson Barahona, Omar S. Cepeda Torres, and Swaminathan Rajaraman
University of Central Florida, USA

MP-37  ON-DEMAND TRANSDERMAL DRUG DELIVERY PLATFORM BASED ON HOLLOW-GROOVE MICRONEEDLE ARRAY
Jihyun Kim, Danilo M. dos Santos, Hasika Suresh, and Sameer Sonkusale
Tufts University, USA

MP-38  SHRINKABLE SILICONE THIN MEMBRANES AND THEIR INTEGRATION IN 3D PRINTED MICROFLUIDIC OXYGENATORS
Anand Sojan, Ponnambalam Ravi Selvaganapathy and Islam Hassan
McMaster University, CANADA

MP-39  SUPERHARMONIC RESONANT RESPONSE MEASUREMENT (SRRM): A NEW METHOD FOR MEASURING SPONTANEOUS POLARIZATION
Vishnu Kumar¹, Shreeraj Joshi¹, Sudhanshu Tiwari¹,², Upanya Khandelwal¹, Rudra Pratap¹,³, Pavan Nukala¹, and Saurabh Chandorkar¹
¹Indian Institute of Science, Bengaluru, INDIA, ²Purdue University, USA, and ³Plaksha University, INDIA

MP-40  TAILORING ENHANCEMENT OF SILICON DIOXIDE ADHESION TO POLYCARBONATE SUBSTRATES FOR 3D MICROELECTRODE ARRAYS (3D MEAS) AND OTHER BIOSENSORS
Surbhi Tidke, Omar S. Cepeda-Torres, Pablo Morales-Cruz, Brian E. Butkus, Andre Childs, and Swaminathan Rajaraman
University of Central Florida, USA
MP-41 TRANSFERRING SOFT DOUBLY RE-ENTRANT MICROSTRUCTURES FOR MECHANICALLY RESILIENT OMNIPHOBIC SURFACES
Qingyang Sun and Tingyi “Leo” Liu
University of Massachusetts, Amherst, USA

Late News - Chemical or Biological Sensors, Actuators or Systems

MP-43 FLEXIBLE BIODEGRADABLE LEAF-WEARABLE SENSOR FOR MONITORING STRESS-INDUCED METHANOL EMISSION FROM PLANTS
Elvis D. Sangmen¹, A K M Sarwar Inam¹, Shah Zayed Riam¹, Md. Najmul Islam¹, Ariba Siddiqui², Mitradip Bhattacharjee², and Shawana Tabassum¹
¹University of Texas, Tyler, USA and ²Indian Institute of Science Education and Research (IISER), INDIA

Late News - Physical Sensors, Actuators, or Systems

MP-44 INTEGRATION OF GRAPHENE-POLYMER HETEROSTRUCTURE MEMBRANES INTO A MULTI-USER MEMS FABRICATION PROCESS
Katherine Smith¹, Alaaeldin Elhady², Samed Kocer², Daniel M. Armada¹, Aidan Retallick¹, Matthias Heil¹, Eihab M. Abdel-Rahman², and Aravind Vijayaraghavan¹
¹University of Manchester, UK, and ²University of Waterloo, CANADA

MP-45 SENSITIVITY CONSIDERATIONS FOR A SMART HYDROGEL-BASED MICROSENSOR FOR CATHETER APPLICATIONS
Benozir Ahmed¹, Christopher F. Reiche¹, Florian Solzbacher¹, and Julia Körner¹,²
¹University of Utah, USA and ²Leibniz University Hannover, GERMANY

MP-46 X-BAND FREQUENCY SCALING OF A₀ AND S₀ FOCUSED LAMB MODES FOR ACOUSTIC DELAY LINES IN 30% SCANDIUM ALUMINUM NITRIDE
Jack Guida, Gabriel Giribaldi, Matteo Rinaldi, and Siddhartha Ghosh
Northeastern University, USA
MP-47 DEVELOPMENT OF ADVANCED DIABETIC ORTHOTICS: FROM FINITE ELEMENT MODELING TO PRESSURE SENSOR IMPLEMENTATION
Jorge Manrique Castro¹, Monisha Elumalai¹, Diana V. Rodriguez De Francisco¹, Isaac Johnson¹, Swaminathan Rajaraman¹, and Charles M. Didier¹,²
¹University of Central Florida, USA and
²Orthomerica Products Inc., USA

MP-48 FIRST CONTACT: DESIGN AND FABRICATION OF THE FIRST 3D PRINTED MEMS G-SWITCH
Regan Kubicek¹, Joshua Tyler², Harvey Tsang², Gabriel Smith², Daniel Jean², and Sarah Bergbreiter¹
¹Carnegie Mellon University, USA and
²DEVCOM Army Research Laboratory, USA

MP-49 TOPOLOGICALLY PROTECTED FANO RESONANCE IN A 80 MHZ SC-DOPED ALN THIN FILM RESONATOR WITH A QUALITY FACTOR LARGER THAN 10K
Xuanyi Zhao¹, Jacopo M. De Ponti², Tommaso Maggioli¹, Marco Colangelo¹, Richard Craster³, and Cristian Cassella¹
¹Northeastern University, USA, ²Polytechnic University of Milan, ITALY, and ³Imperial College London, UK
Chemical or Biological Sensors, Actuators or Systems

WP-01  A PIEZOELECTRIC MIDDLE-EAR MICROPHONE FOR COCHLEAR IMPLANTS
Emma F. Wawrzynek¹, John Z. Zhang¹, Ioannis Kymissis², Elizabeth S. Olson², Hideki Heidi Nakajima³,⁴, and Jeffrey H. Lang¹
¹Massachusetts Institute of Technology, USA, ²Columbia University, USA, ³Harvard University, USA, and ⁴Mass Eye and Ear, USA,

WP-02  AUTONOMOUS MICROFLUIDIC DEVICE FOR THE NAKED-EYE DETECTION OF BENZODIAZEPINES IN ADULTERATED BEVERAGES
Isabel Poves-Ruiz¹, Enrique Azuaje-Hualde¹, Igor Corchado-Gonzalez¹, Lourdes Basabe-Desmonts¹,², and Fernando Benito-Lopez¹
¹University of the Basque Country, SPAIN and ²IKERBASQUE, SPAIN

WP-03  ELECTROCHEMICAL SENSORS FOR HEAVY METAL DETECTION USING PYROLYTIC CARBON AND GOLD ELECTRODES
Yingming Xu, Peng Zhou, Terrence Simon, and Tianhong Cui
University of Minnesota, USA

WP-04  FABRICATION OF SUBMICRON TUNABLE METAMATERIAL INFRARED ABSORBERS FOR GAS SENSING USING OPTICAL CONTACT LITHOGRAPHY
Amirali Nikeghbal, Md Rabiul Hasan, Adwait Deshpande, Fatemeh Momeni, Seungbeom Noh, Hanseup Kim, and Carlos H. Mastrangelo
University of Utah, USA

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Purdue University, USA
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Ji Chang¹, Omar Cepeda-Torres¹, Saqib Shahzad¹, Guntis Rutins¹, Richard G. Blair¹, Swaminathan Rajaraman¹, and Laurene Tetard¹,²
¹University of Central Florida, USA and
²Université Claude Bernard Lyon, FRANCE

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Colleen A. Chemerka, Juan P. Botero-Torres, Navid Farhoudi, Pratay D. Kairy, Simon Binder, Florian Solzbacher, Lars B. Laurentius, and Christopher F. Reiche
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University of Cincinnati, USA

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Amani Salim¹, Farihin Adzlan¹, Haris Lotfi¹, Iman Ismail¹, Adam Zahanuddin¹, Sazwin Ishak¹, Malini Kanapathy¹, Pretha Selvam¹, Iqbal Shamsul¹, and D. Marshall Porterfield²
¹University Malaya, MALAYSIA and ²Purdue University, USA

WP-10 TRI-COMPARTMENT CHIP WITH MICROELECTRODE ARRAY AND DR1-GLASS GROOVES FOR NEURONAL CELL ALIGNMENT
Tomi Ryynänen, Chiara Fedele, Anna-Mari Moilanen, Jorma Viihinen, Lassi Sukki, Kaisa Tornberg, Saara Haikka, Susanna Narkilahti, Arri Priimagi, and Pasi Kallio
Tampere University, FINLAND

WP-11 VERTICAL MICRO-NANOCHANNEL INTEGRATION FOR RELATIVE SURFACE PROTEIN ABUNDANCE QUANTIFICATION ON LIPOSARCOMA EXTRACELLULAR VESICLES
Premanshu K. Singh, Ali F. Usmani, Patricia Sarchet, Raphael Pollock, and Shauuya Prakash
Ohio State University, USA
Physical Sensors, Actuators, or Systems

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Ratul Majumdar, Milos Zefran, and Igor Paprotny
University of Illinois, Chicago, USA

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University of California, Irvine, USA

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Mohammad Alzgool\textsuperscript{1}, Yu Tian\textsuperscript{1}, Benyamin Davaji\textsuperscript{2}, and Shahrzad Towfighian\textsuperscript{1}
\textsuperscript{1}Binghamton University, USA and \textsuperscript{2}Northeastern University, USA

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Md Iftekharul Islam\textsuperscript{1}, Amrid Amnache\textsuperscript{1}, Richard Beaudry\textsuperscript{2}, Maurice Delafosse\textsuperscript{2}, Serge Ecoffey\textsuperscript{1}, and Luc G. Fréchette\textsuperscript{1}
\textsuperscript{1}Université de Sherbrooke, CANADA and \textsuperscript{2}Digitto Technologies Inc., CANADA

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University of Washington, USA
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James M.L. Miller\textsuperscript{1}, Nicholas E. Bousse\textsuperscript{2}, Hyun-Keun Kwon\textsuperscript{3}, Gabrielle D. Vukasin\textsuperscript{4}, Steven W. Shaw\textsuperscript{5,6}, and Thomas W. Kenny\textsuperscript{2}
\textsuperscript{1}Trine University, USA, \textsuperscript{2}Stanford University, USA, \\
\textsuperscript{3}Apple Incorporated, USA, \textsuperscript{4}Robert Bosch Research and Technology Center, USA, \textsuperscript{5}Florida Institute of Technology, USA, and \\
\textsuperscript{6}Michigan State University, USA

WP-19 FLEXIBLE ELECTROMAGNETIC ACTUATORS FOR WEARABLE HAPTIC DEVICES
Naji Tarabay\textsuperscript{1}, Ananya Renuka Balakrishna\textsuperscript{2}, Tianshu Liu\textsuperscript{3}, Priyanshu Agarwal\textsuperscript{3}, and Camilo Velez\textsuperscript{1}
\textsuperscript{1}University of California, Irvine, USA, \textsuperscript{2}University of California, Santa Barbara, USA, and \\
\textsuperscript{3}Meta Platforms Inc., USA

WP-20 GENERALIZED MACHINE LEARNING METHOD TO EXTRACT FREQUENCY-COMPLIANCE COEFFICIENTS FROM MEMS RESONATOR MODEL
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\textsuperscript{1}St. Joseph Institution, SINGAPORE, \textsuperscript{2}Hwa Chong Institution, \\
SINGAPORE, and \textsuperscript{3}Agency for Science, Technology and Research (A*STAR), SINGAPORE

WP-21 IMPROVED PERFORMANCE OF PASSIVE LAYER-FREE CURVED PMUT ARRAY
Chichen Huang\textsuperscript{1}, Shubham Khandare\textsuperscript{2}, Sri-Rajasekhar Kothapalli\textsuperscript{2}, and Srinivas Tadigadapa\textsuperscript{1}
\textsuperscript{1}Northeastern University, USA and \textsuperscript{2}Pennsylvania State University, USA,

WP-22 MAGNETICALLY COUPLED RESONATORS FOR WIRELESS POWER TRANSMISSION TO INSECT SIZED FLAPPING WING ROBOTS
Johannes M. James, Xingyi Shi, Joshua R. Smith, and Sawyer B. Fuller
University of Washington, USA

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\textsuperscript{1}Indian Institute of Science, Bangalore, INDIA, \textsuperscript{2}Centre Apple, USA, \\
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Junyi Wang, Aobo Zhang, Diana Cantini, and Eun Sok Kim
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WP-25  OPERATING FREQUENCY RANGES OF ULTRASOUND-BASED IMPLANTABLE GLUCOSE-SENSITIVE RESONATORS FOR IMPROVED SENSITIVITY AND LINEARITY
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WP-26  PROBING NONLINEARITY IN SUPERLATTICE HAFNIA-ZIRCORIA-ALUMINA NANOELECTROMECHANICAL RESONATORS
S M Enamul Hoque Yousuf, Troy Tharpe, Roozbeh Tabrizian, and Philip X.-L. Feng
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Pei-Chi (Peggy) Tsao1, Megan Teng1, Yande Peng1, Vivek K. Premanadhan2, Ting Chen3, Samantha Averrit1, Wei Yue1, Jong Ha Park1, Huicong Deng3, Fan Xia1, Yuan Gao1, and Liwei Lin1
1University of California, Berkeley, USA,
2Synergy Marine Group, SINGAPORE, and
3University of Chinese Academy of Sciences, CHINA

WP-28  THE REALIZATION AND TESTING OF A SAPPHIRE PRESSURE SENSOR MANUFACTURED BY LASER MICROMACHINING AND THERMOCOMPRESSION BONDING
Austin L. Vera1, David A. Mills2, and Mark Sheplak1
1University of Florida, USA and
2Interdisciplinary Consulting Corporation, USA,

WP-29  ULTRA-COMPACT, LOW-NOISE, AMPLITUDE-SENSITIVE AND PHASE-SENSITIVE INTEGRATED THIN-FILM GIANT MAGNETOIMPEDANCE SENSORS
Bin Luo1, Xianfeng Liang1, Huaihao Chen1, Cai Müller2, Paul Raschdorf2, Phillip Durdaut2, Michael Höft2, Jeffrey McCord2, and Nian X. Sun1
1Northeastern University, USA and 2Kiel University, GERMANY,
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WP-30  A 13.56 MHZ METAMATERIAL VIA THE INCORPORATION OF POLYIMIDE BASED FPCB AND NIZN FERRITE FOR WIRELESS POWER TRANSMISSION ENHANCEMENT
Pin-Cheng Tseng, Mei-Syuan Wu, Wen-Hsiang Huang, Yu-Ting Cheng, Ming-Dou Ker, and Chung-Yu Wu
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Vincent Pares\textsuperscript{1}, Amrid Amnache\textsuperscript{1}, Romain Stricher\textsuperscript{1}, Simon Landry\textsuperscript{2}, Paul Gond-Charton\textsuperscript{2}, Thierry Courcier\textsuperscript{1}, Serge Ecoffey\textsuperscript{1}, and Luc G. Fréchette\textsuperscript{1}
\textsuperscript{1}Université de Sherbrooke, CANADA and \textsuperscript{2}Teledyne Dalsa Semiconducteur Inc. (TDSI), CANADA,

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\textsuperscript{1}Blackrock Neurotech, USA, \textsuperscript{2}University of Utah, USA, and \textsuperscript{3}University of Texas at Dallas, Richardson, USA

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\textsuperscript{1}University of Colorado Boulder, USA and \textsuperscript{2}Columbia University, USA
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Dean de Boer, Erwin Berenschot, and Niels Tas
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WP-38  STRETCHABLE EUTECTOFIBERS VIA ROTARY WET-SPINNING FOR WEARABLE STRAIN SENSORS
Danilo M. dos Santos¹, Jihyun Kim¹, Mario B. Wyrsch¹,², Mathias Bonmarin¹,², and Sameer Sonkusale¹
¹Tufts University, USA and ²Zurich University of Applied Sciences Technikumstrasse, SWITZERLAND,

WP-39  TAILORED FOREST MICRONEEDLES USING CROSS OVER LINES LASER LITHOGRAPHY FOR SIMULTANEOUS DELIVERY OF MULTIPLE DRUGS
Hasika Suresh, Danilo M. Dos Santos, Atul Sharma, Darian Myers, Sanjana Vissapragada, and Sameer Sonkusale
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Peter Sanchez, Ryan M. Price, and Robert C. Roberts
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WP-41  VARIABLE-SLOPE REFLECTIVE SURFACES FOR OPTICAL SYSTEM TESTING VIA NOVEL DIRECT LASER WRITING-BASED MICROREPLICATION
Declan M. Fitzgerald¹,², Ryan D. Sochol¹, and Anant Agrawal²
¹University of Maryland, USA and ²Food and Drug Administration, USA

Late News - Chemical or Biological Sensors, Actuators or Systems

WP-42  GLUCOSE FACTOR IN THE TEST OF ISCHEMIA HEART DISEASE FOR DIABETIC PATIENTS USING MOLECULARLY IMPRINTED POLYMER /METHYLENE BLUE SENSING ELECTRODES
Cheng-Yu Tsai¹, Yu-Ting Cheng¹, and Hsiao-En Tsai²
¹National Yang Ming Chiao Tung University, TAIWAN and ²National Taiwan University Hospital Hsin-Chu Branch, TAIWAN
MP-43  MICRONEEDLE-INTEGRATED ELECTROCHEMICAL SENSOR TOWARD DETECTION OF BASOLATERAL SEROTONIN IN THE GI TRACT
Sydney N. Overton, Joshua A. Levy, Michael A. Straker, Jinjing Han, and Reza Ghodssi
University of Maryland, USA

Late News - Physical Sensors, Actuators, or Systems

WP-44  HIGH-QUALITY FACTOR, HIGH TCF SCANDIUM ALUMINUM NITRIDE MEMS RESONATOR FOR LOW-NOISE INFRARED SENSING
Farah Ben Ayed, Aurelio Venditti, Pietro Simeoni, Zhenyun Qian, and Matteo Rinaldi
Northeastern University, USA

WP-45  LOW-POWER THERMOMECHANICAL MODULE FOR TARGETED INGESTIBLE DEVICE BIOPSY
Michael A. Straker, Joshua A. Levy, and Reza Ghodssi
University of Maryland, USA

WP-46  TEMPERATURE-INSENSITIVE 2D RESONANT GAP-BASED STRAIN SENSOR
Xintian Liu and Clark T.-C. Nguyen
University of California, Berkeley, USA

Late News - Technology, Materials, Packaging, and CAD

WP-47  A SELF-AMPLIFIED SILICON-GERMANIUM NANOMECHANICAL RESONATOR WITH PIEZORESISTIVE HEAT ENGINES
Faysal Hakim¹, Normarieli M. Passalacqua-Alvarado¹, Keshab R. Sapkota², Aleem Siddiqui², Xuebin Li³, Kevin S. Jones¹, George T. Wang³, and Roozbeh Tabrizian¹
¹University of Florida, USA, ²Sandia National Laboratories, USA, and ³Applied Materials, USA

WP-48  DIRECT VAN DER WAALS INTEGRATION OF 2D MATERIALS FOR HIGH-PERFORMANCE CHEMICAL SENSORS
Peter F. Satterthwaite, Sarah O. Spector, Jaekang Song, and Farnaz Niroui
Massachusetts Institute of Technology, USA
WP-49 MULTI-MATERIAL PALETTE FOR 3D MICROELECTRODE ARRAYS FOR A VARIETY OF 3D ELECTROGENIC MICROPHYSIOLOGICAL SYSTEMS
Omar S. Cepeda Torres, Connor Edmonds, Diana V. Rodríguez De Francisco, Edwin Davidson Barahona, Charles Didier, and Swaminathan Rajaraman
University of Central Florida, USA

WP-50 ULTRA-HIGH THERMAL CONVERSION EFFICIENCY IN A PROTOTYPE LIGHT SOURCE BASED ON PHONONIC MEMS STRUCTURE
Sunghyun Hwang, James D. Overmeyer, S M Enamul Hoque Yousuf, William N. Carr, Philip X.-L. Feng, and Yong-Kyu Yoon
1University of Florida, USA and 2Phononic MEMS Inc, USA

Poster Presentations - Session 3
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WCP-51 PIEZOELECTRIC MEMS-ACTUATORS BASED ON ALSC40%N AND PZT
Yanfen Zhai, Andrea Bancora, Andrey Voloshin, Anat Siddharth, Sébastien Leni, and Tobias J. Kippenberg
1DeepLight SA, SWITZERLAND and 2Swiss Federal Institute of Technology Lausanne (EPFL), SWITZERLAND

WCP-52 SENSIBLE SENSORS WITH UNINTERRUPTED OPERATION AND UNPRECEDENTED ACCURACY
Zhenyun Qian, Matteo Rinaldi, Nabid Hossain, and Kritank Kalyan Zepsor Technologies Inc., USA

Commercial - Technology, Materials, Packaging, and CAD

WCP-53 CUSTOMIZED MEMS SOLUTIONS FROM PROTOTYPE TO PRODUCTION VOLUMES
Arne Leinse and Albert Prak
LioniX International, BV, NETHERLANDS

WCP-54 DIE-TO-WAFER BONDING TECHNOLOGY FOR ADVANCED PACKAGING
Viorel Dragoi, Mariana Pires, and Tobias Wernicke
EV Group E. Thallner GmbH, AUSTRIA
WCP-55  HIGH-Q MEMS RESONATORS CHARACTERIZATION BY 4D DIGITAL HOLOGRAPHIC MICROSCOPE (DHM®)  
Frank Liu, François Mendels, Jean-Marc Collagrossi, Shenqi Xie, and Yves Emery  
Lyncee Tec SA, SWITZERLAND

WCP-56  JOIN THE IEEE MEMS TC!  
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WCP-57  MPO 100 - 3D LITHOGRAPHY SYSTEM FOR ADVANCING SENSORS AND ACTUATORS RESEARCH  
Yashica Brown, Benedikt Stender, and Willi Mantei  
Heidelberg Instruments, USA

WCP-58  THE COMPLETE DESIGN-TO-PRODUCTION SOLUTION FOR PZT MEMS  
Andrew O. Fung¹, Mario Kiuchi², Gen Matsuoka², Tsuyoshi Takemoto², and Alissa M. Fitzgerald¹  
¹A.M. Fitzgerald & Associates, LLC, USA and ²Sumitomo Precision Products Co., Ltd., JAPAN

WCP-59  BIOCOASTAL INSTITUTE FOR NANOSYSTEMS INNOVATION (NANOSI) LAUNCHES AT NORTHEASTERN UNIVERSITY  
Matteo Rinaldi and David Horsley  
Northeastern University, USA

Open Posters

WOP-01  A PCB BASED, LOW-COST, MEMS TACTILE DISPLAY FOR BRAILLE AND IMAGES  
Jonathan Bernstein¹, Maijie Xiang², and Robert White²  
¹Draper, USA and ²Tufts University, USA

WOP-02  ADVANCED MANUFACTURING LABORATORY AT THE UNIVERSITY OF MARYLAND  
Sydney N. Overton¹, Weijian Xian¹, Justin M. Stine¹, Jinjing Han¹, Kevin M. Daniels¹, and Reza Ghodssi¹  
University of Maryland, USA

WOP-03  BIOAERIUM : UBIQUITOUS MULTI-PATHOGEN SENSING FROM AIR USING NUCLEIC ACID AMPLIFICATION  
Nitin Jayakumar, Michael Caffrey, and Igor Paprotyny  
University of Illinois at Chicago, USA
WOP-04  CAPSULE SYSTEM TOWARD REAL-TIME ELECTROCHEMICAL DETECTION OF HYDROGEN SULFIDE IN THE GI TRACT
Justin M. Stine¹, Katie L. Ruland¹, Joshua A. Levy¹,
Luke A. Beardslee¹, Pankaj J. Pasricha², and Reza Ghodssi¹
¹University of Maryland, USA and ²Mayo Clinic Hospital, USA

WOP-05  HIGH POWER MEMS OHMIC CONTACT FROM DC TO MILLIMETER WAVE
Xu Zhu, Nicole D. Kerness, and Chris F. Keimel
Menlo Micro, USA

WOP-06  MEMS MEETS MAGNONICS
Sudhanshu Tiwari¹, Anuj Ashok¹, Connor James Devitt¹,
Wang Renyuan², and Sunil Bhave¹
¹Purdue University, USA and ²BAE Systems, USA

WOP-07  MICROSCALE pH GENERATION ON DEMAND: A PLATFORM FOR TUNING BIOMOLECULAR REACTIVITY
Nadia Fomina, Christopher Johnson, Young Shik Shin,
Gabrielle Vukasin, and Christoph Lang
Robert Bosch Research and Technology Center, USA

WOP-08  NANOFRAZOR TECHNOLOGY - FABRICATING ADVANCED 2D AND GRAYSCALE STRUCTURES USING THERMAL SCANNING PROBE LITHOGRAPHY AND DIRECT LASER SUBLIMATION
Nicholas Hendricks, Julia Stark, Myriam Käppeli, Jana Chaaban,
and Emine Çağin
Heidelberg Instruments Nano AG, SWITZERLAND

WOP-09  NANOSTRUCTURING GRAPHENE ON SILICON FOR ENHANCED SEMICONDUCTOR INTERCONNECTS
Amani Salim, Adam Zahanuddin, Farihin Adzlan, Pretha Selvam,
and Iqbal Shamsul
nanoSkunkWorkX, MALAYSIA

WOP-10  NEAR-ZERO STIFFNESS MEMS ACCELEROMETER WITH BUCKLING OF TUNABLE ELECTROTHERMAL MICROBEAMS
Chen Wang¹, Hussein Hussein², Rui Amendoeira Esteves¹,
Hossein Fariborzi³, and Michael Kraft¹
¹KU Leuven, BELGIUM, ²American University of Beirut, LEBANON, and ³King Abdullah University of Science and Technology, SAUDI ARABIA

WOP-11  NIH BRAIN BEHAVIOR QUANTIFICATION AND SYNCHRONIZATION SENSORS PROGRAM
Yvonne Bennett
National Institute of Mental Health, USA
WOP-12 QUADRUPLE MASS GYROSCOPE ANGLE RANDOM WALK REDUCTION THROUGH LINEARIZED TRANSDUCTION
Ryan Knight¹, Ryan Rudy¹, Jeffrey Pulsamp¹, Robert Benoit¹, Don DeVoe², and Esmond Lau³
¹DEVCOM Army Research Laboratory, USA, ²University of Maryland, USA, and ³Oak Ridge Associated Universities, USA

WOP-13 QUARTZ MEMS GYROSCOPES FOR INERTIAL NAVIGATION
Andrei M. Shkel, Austin R. Parrish, Eudald Sangenis, Lois Meira Lopez, Crystal Wai, and Amin Ebrahimzadeh
University of California, Irvine, USA

WOP-14 TOWARD MM-WAVE ACOUSTIC VIBRATION MEASUREMENTS WITH PULSED LASER INTERFEROMETRY
Marvin Schewe and Jason J. Gorman
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