SMART STRUCTURES + NONDESTRUCTIVE EVALUATION

Technologies for nondestructive evaluation, structural health monitoring, advanced materials, and engineered biorobotics

Conferences and Courses: 26–30 April 2020
Anaheim Marriott, Anaheim, California, USA

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#SPIESmart
The meeting that combines two cutting-edge technology areas: the world of advanced smart materials, and the broad range of NDE and structural health monitoring systems.

26–30 April 2020
Anaheim Marriott, Anaheim, California, USA

One Week
Many Opportunities

- Cutting-edge research
- World-class speakers
- Training and education
- Focused technical topics

Register Today
spie.org/SS20program
SPIE, the international society for optics and photonics, was founded in 1955 to advance light-based technologies. Serving more than 264,000 constituents from approximately 166 countries, the not-for-profit society advances emerging technologies through interdisciplinary information exchange, continuing education, publications, patent precedent, and career and professional growth. In 2019, SPIE provided $5 million in support of education and outreach programs.

Co-located in 2020: SPIE Smart Structures + Nondestructive Evaluation will be right next door to SPIE Defense + Commercial Sensing this year. Technical registration for either symposium gives you access to both meetings. Explore the DCS exhibition to see over 300 companies in the sensors industry.

Everything you need to know about the meeting and Anaheim is online

- Up-to-date paper listings and session times
- Hotel, travel, and complete registration information
- Schedule your week: MySchedule Tool and SPIE Conference app
- Information about local travel options

Reserve Hotel Rooms by: 1 APRIL 2020
Registration Rates Increase after: 25 MARCH 2020

Program Current as of: 11 December 2019

Meet · Connect · Learn
Join us at the leading event for advanced materials and structural health monitoring.

Plenary Presentations
pages 6-7
Don't miss these world-class speakers discussing the latest advances and most promising breakthroughs.

Special Events
page 8–11
Join your peers and colleagues at these special events including the Welcome Reception, Student Lunch with the Experts, and more.

Award Announcements
page 12
Don't miss the award presentations at 2020 Smart Structures + Nondestructive Evaluation.

Plan to Participate
26–30 April 2020
Anaheim, California, USA
Conferences: Hear the latest advancements in sensing and measurement with advanced materials, and smart systems.

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EAP-in-Action Demonstration Session
page 13–15

This Session highlights some of the unique capabilities and applications of Electroactive Polymers (EAP). Attendees can view live demonstrations of these materials in action.
Make plans to attend

The Organizing Committee of SPIE’s 27th Annual International Symposium on Smart Structures + Nondestructive Evaluation invites you to attend this year’s meeting. This unique symposium offers many opportunities to network with colleagues from a variety of disciplines in academia, industry, and government from all over the world.

Organized in nine parallel conferences, SS/NDE brings together emerging technologies and advanced research in instrumentation, sensing, and measurement science with advanced materials, diagnostics, and smart systems. Engineers and researchers from government, military, academia and the commercial sector will discuss the current status and future directions of smart structures and materials, NDE, and health monitoring. Case studies, emerging research agendas, and innovative new technologies will be presented.

The Symposium covers all aspects of the evolving fields of materials, enabling technologies, sensor/actuator design, and applications of these technologies to cover the whole spectrum of life in the 21st century, including commercial, medical, aerospace, Smart Cities, and Industry 4.0. It also includes several conferences on NDE and structural health monitoring: safety, security, characterization of materials, detection of materials defects and degradation, evaluation of the state of damage to enable reliable component failure prediction, application of micro- and nanomaterial systems, energy systems, and infrastructure.

This meeting is a showcase for multidisciplinary research and provides an excellent opportunity to explore new research areas by teaming with new partners from many fields. We look forward to seeing you in Anaheim!
### COURSES

**COURSES WILL BE HELD** the day prior to the technical conferences on Sunday 26 April 2020.

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**Monday Plenary Session**

**Monday 27 April 2020 · 8:25 AM – 10:00 AM**

*Session Chairs: Zoubeida Ounaies, The Pennsylvania State Univ. (USA) and Hoon Sohn, KAIST (Korea, Republic of)*

**8:25 AM – 8:30 AM:**
- 2020 NDE Lifetime Achievement Award presented to Francesco Lanza Di Scalea, Univ. of California, San Diego (USA)
- 2020 SSM Lifetime Achievement Award presented to George A. Lesieutre, The Pennsylvania State Univ. (USA)

**8:30 AM – 9:15 AM:**
**ADDITIVE-MANUFACTURING-DRIVEN SENSING TECHNOLOGY FOR NEW ERA OF STRUCTURAL HEALTH MONITORING: FROM DISTRIBUTED TO DISPERSED SENSING**

**Zhongqing Su**
The Hong Kong Polytechnic Univ. (Hong Kong, China)

**Abstract:** Additive manufacturing approaches, from spray-coating through drop-on-demand inkjet printing to noncontact aerosol jet printing, are used hierarchically to fabricate ultralight, flexible, nanocomposite sensors with the ability to respond precisely to high-frequency guided ultrasonic waves up to 1.5 MHz. The nanostructure of the sensors is morphologically optimized to facilitate triggering of a local quantum tunneling effect when modulated by ultrasonic waves. This study has spotlighted a new breed of functional composites with an endowed capability of self-health monitoring without using external sensors, cables, and wires. Not only does it reduce the weight and volume penalties to composites, it also minimizes possible mechanical degradation due to sensor intrusion, blazing a trail in developing “sensor-free” SHM for composites.

**Biography:** Prof. Zhongqing Su is a Professor of Mechanical Engineering at the Hong Kong Polytechnic University, and the current Editor-in-Chief of Ultrasonics. His research group focuses on wave-based SHM, ultrasonics, sensors, and composites. He earned his Ph.D. in 2004 from the University of Sydney, Australia. He is also an Associate Editor for SHMII, ASME JNDE, and was a Subject Editor of JSV (2016-2018). He was the Chair of the 7th Asia-Pacific Workshop on SHM, and is the Co-Chair of the SPIE Health Monitoring of Structural and Biological Systems IX conference. He was the recipient of “SHM - Person of the Year” Award in 2012.

**9:15 AM – 10:00 AM:**
**STRETCHABLE ELECTRONICS FOR UBIQUITOUS PHYSIOLOGICAL MONITORING**

**Michelle Khine**
Univ. of California, Irvine (USA)

**Abstract:** While great advances in medicine has been made in the past century, the overall infrastructure of the healthcare system has not progressed. Patients (who are not feeling well) are still expected to travel to a centralized location for discrete, reactionary based care where the healthcare provider only has a brief window to assess the patient’s health. Unless the symptoms are overt at the time of examination, the subjective evaluation relies heavily on the self-reporting of symptoms from the patient. This often results in delayed or improper diagnoses. In contrast, we know that physiological signals precede clinical deterioration. We have developed a suite of low-cost, unobtrusive, Band-Aid-like physiological sensors to continuously monitor patients' cardiovascular and pulmonary functions. We seek to continuously quantify subtle physiological changes to predict, and eventually prevent, the onset of acute clinical events.

**Biography:** Michelle Khine, Ph.D. is a Professor of Biomedical Engineering at UC Irvine. She is the founding Director of Faculty Innovation at the Samuels School of Engineering and founding Director of BioENGINE (BioEngineering Innovation and Entrepreneurship) at UC Irvine. Prior to joining UC Irvine, she was an Assistant & Founding Professor at UC Merced. Michelle received her BS and MS from UC Berkeley in Mechanical Engineering and her PhD in Bioengineering from UC Berkeley and UCSF. She is the Scientific Founder of 6 start-up companies. Michelle was the recipient of the TR35 Award and named one of Forbes ‘10 Revolutionaries’ in 2009 and by Fast Company Magazine as one of the ‘100 Most Creative People in Business’ in 2011. She was awarded the NIH New Innovator’s Award, was named a finalist in the World Technology Awards for Materials, and was named by Marie-Claire magazine as ‘Women on Top: Top Scientist’. She was named Innovator of the Year 2017 for the Samuels School of Engineering at UC Irvine. Michelle is a Fellow of AIMBE (American Institute of Medical and Biological Engineering) and well as a Fellow of the National Academy of Inventors.

**Tuesday Plenary Session**

**Tuesday 28 April 2020 · 8:30 AM - 10:00 AM**

*Session Chairs: Zoubeida Ounaies, The Pennsylvania State Univ. (USA) and Hoon Sohn, KAIST (Korea, Republic of)*

**8:30 AM – 9:15 AM:**
**AEROSPACE MATERIALS 2030: CHALLENGES AND OPPORTUNITIES**

**Richard A. Vaia**
Air Force Research Lab. (USA)

**Abstract:** Over a hundred years ago, the pioneers of aviation took flight in no small part due to material innovations ranging from novel casting of the aluminum engine block to judicious selection of natural materials. Unquestionably, the future of aerospace will look as different from today as the Wright Flyer and Curtiss June Bug differ from UAVs and F35s. However, the role of materials will remain unchanged; they will be the crucial ingredient that enables these future machines to push the performance envelope and become active partners with the human operator. The presentation will share thoughts on how the materials enterprise could accelerate this future through convergence of innovations in biotechnology, nanotechnology, automation, artificial intelligence, and informatics.

**Biography:** Dr. Richard A. Vaia is the Senior Technologist for Emergent Material Systems in the Air Force Research Laboratory (AFRL). He has published more than 250 articles on nanomaterials, with honors including the AF McLucas Award for Basic Research, ACS Doolittle Award, Air Force Outstanding Scientist, DARPA Service Chief Fellow, and Fellow of the Materials Research Society, American Physical Society, American Chemical Society, NextFlex, and AFRL.
9:15 AM – 10:00 AM:
3D CONCRETE PRINTING: PAST, PRESENT, AND FUTURE

Richard Buswell
Loughborough Univ. (United Kingdom)

Abstract: Digital Fabrication with Concrete (DFC) encompasses 3D Concrete Printing (3DCP) and many other on-site and off-site fabrication methods. DFC is beginning to move from an era of invention and demonstration to one of reality. It has only been 15 years since inception and yet printing offices, houses and bridges are just some of the applications that are being demonstrated at full scale. But this is not all DFC has to offer. Some of the greatest challenges face the production and maintenance of the built environment to deliver continual improvement with less material and ever decreasing skilled labour. Automation of construction manufacturing will be critical if we are to realise Industry 4.0, providing greater productivity while reducing uncertainty and cost. DFC is at the vanguard of this aspiration and this session will take you through the technologies, the achievements and provide the future outlook for these techniques.

Biography: Richard Buswell is a Professor of Building Systems Engineering at Loughborough University in the UK and is a recognised pioneer of 3D Concrete printing. He led the development of the first off-site, large-scale additive manufacturing process that used concrete, producing world first demonstrators, the seminal material science in the field and a start-up initiative to bring the technology into the sector.

Wednesday
Plenary Session
Wednesday 29 April 2020 · 8:15 AM - 10:00 AM

Session Chairs: Zoubeida Ounaies, The Pennsylvania State Univ. (USA) and Hoon Sohn, KAIST (Korea, Republic of)

8:15 AM – 8:30 AM:
• SPIE Best Student Paper Awards
• EAP-In-Action Demonstration Awards
• Bioinspiration, Biomimetics, and Bioreplication Best Student Paper Awards: In Memory of H. Don Wolpert

8:30 AM – 9:15 AM:
GENERATION OF HIGHER HARMONICS AND THEIR APPLICATION TO MATERIAL CHARACTERIZATION

Laurence J. Jacobs
Georgia Institute of Technology (USA)

Abstract: Predictive health monitoring will require the development of advanced sensing techniques capable of providing quantitative information on the damage state of structural materials. Second harmonic generation techniques can measure absolute, strength-based material parameters which can be coupled with uncertainty models to enable accurate and quantitative life prediction. Starting at the material level, this talk will examine a combination of sensing techniques and physics-based models to characterize damage in metals. These second harmonic techniques are acoustic-wave-based, so component interrogation can be performed with bulk, surface, and guided waves using the same underlying material physics. The talk will consider applications to characterize fatigue damage, thermal embrittlement, irradiation damage, and sensitization.

Biography: Prof. Laurence J. Jacobs is Associate Dean for Academic Affairs of the College of Engineering at the Georgia Institute of Technology, and Professor of Civil and Environmental Engineering and Mechanical Engineering. Professor Jacobs’ research focuses on the development of quantitative methodologies for the nondestructive evaluation and life prediction of structural materials.

9:15 AM – 10:00 AM:
INTEGRATIVE SMART SYSTEMS: A CALL TO ACTION

Diann E. Brei
Univ. of Michigan

Abstract: All around us our world is undergoing rapid transformative change, from energy to mobility to manufacturing. To meet volatile needs, there is a growing demand for integrative thinking. Integrative thinking is systematically integrating disparate disciplines to effectively tackle complex engineering problems. For decades, the field of Smart Materials and Structures has fostered an integrative mindset – it is in our DNA. Yet, while our field has made great strides in research, successful transition and adoption of technology in the field still tends to be a challenge. Highlighting several integrative smart systems from the past to the future, this talk is designed to provoke a conversation within the community with the hopes to inspire the advocacy of our integrative thinking beyond our field to empower solutions to the most pressing problems of today.

Biography: Dr. Diann Brei is the Chair of the Integrative Systems + Design Division and Professor of Mechanical Engineering at the University of Michigan. She received her PhD (1993) in Mechanical Engineering and her BSE (1988) in Computer Systems Engineering (1988). Her research is focused on the underling design science and device innovation using smart materials. Her smart material architectural models along with her multi-domain, multi-stage design methods have set the foundation for a successful translational research and development paradigm adopted by industries in the automotive, medical and aerospace sectors.
Bio-inspired, Biomimetics, and Bioreplication
Conference 11377 Monday Keynote Presentation
Monday 27 April · 10:30 AM – 11:10 AM

Complex functional materials and structures: from synthetic biology to metamaterials to soft robotics
Nakhlah C. Goulbourne, The National Science Foundation (USA)

On-demand material behavior, or functionality, has long been a target in modern engineering. The ability to design, synthesize, generate, control, and predict the response of functional materials and structures is an overarching goal pulling together expertise and ideas from various subfields. The fundamental scientific questions probed are different depending on whether you are a chemist, materials scientist, or aerospace engineer. From programmable materials and structures to integrated computing and evolutionary materials, reaching this target on a grand scale will require the early integration of science and engineering. Advances in data sciences has created the potential for us to accelerate the rate of knowledge transfer across the traditional boundaries as well as fundamentally change the way we carry out research. In this presentation, we discuss research trends in functional materials from the CMG Mechanics of Materials and Structures program perspective. We will show recent examples from synthetic biology to metamaterials to soft robotics where many opportunities and challenges remain. We will discuss the role of data sciences and interdisciplinary teaming in carrying innovation across length and time scales and towards truly transformative research. Relevant NSF funding opportunities that are sparsely used by the community will be shared. Finally, we point to future directions for technological innovations powered by functional materials.

Biography: Nakhlah C. Goulbourne is NSF program director for the Mechanics of Materials and Structures program (MoMS). Her program supports research related to the mechanics of deformable materials and structures. Current program areas include but are not limited to soft materials, low dimensional/nanomaterials, architected materials, computational mechanics and multi-scale modeling, multiphysics phenomena, constitutive modeling of metals/glasses/ceramics, composites, and related areas. Dr. Goulbourne is Associate Professor of Aerospace Engineering at the University of Michigan in Ann Arbor. She received her B.A. degree in Physics from Middlebury College, and M.S. and Ph.D. degrees in Mechanical Engineering from the Pennsylvania State University. She received the NSF CAREER award in 2008. Prior to joining the University of Michigan in 2009, she was Assistant Professor of Mechanical Engineering at Virginia Polytechnic Institute and State University. Over the last 15 years she has built a diverse research portfolio that is reflective of her general interest in science and engineering solutions to advanced materials research.
This program is current as of 11 December 2019. Find complete, up-to-date information and create your personalized schedule at spie.org/ss20program.

**Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems**

Conference 11379 Monday Keynote Presentation
Monday 27 April 2020 · 10:30 AM - 11:10 AM

**Strategies for the design and operation of resilient extraterrestrial habitats**

Shirley J. Dyke, Purdue Univ. (USA)

Deep space habitats require groundbreaking technological advances to overcome the unprecedented demands introduced by isolation and extreme environments. An Earth-independent permanent extraterrestrial habitat system must function as intended under continuous disruptive conditions. Designing for the demands that extreme environments will place on long-term deep space habitats, such as wild temperature fluctuations, galactic cosmic rays, destructive dust, meteoroid impacts (direct or indirect), vibrations, and solar particle events, represents one of the greatest challenges in this endeavor. This context necessitates that we target resilience in the design and operation of deep space habitat systems. Yet, resilience is not simply robustness or redundancy. Instead, it is a comprehensive approach that accounts for disruptions through the design process and adapts to them in operation. We currently lack the frameworks and technologies needed to achieve a high level of resilience in a habitat system and to function autonomously under a variety of unmanned and manned operating modes. The vision for the Resilient ExtraTerrestrial Habitats Institute (RETHi) is to enable the design and realization of smart and resilient space habitats. These SmartHabs will leverage innovative technologies to provide situational awareness and autonomy, allowing them to adapt, absorb and rapidly recover from expected and unexpected disruptions to the deep space habitat systems without fundamental changes in function or sacrifices in safety. Our Cyber-physical Testbed will integrate strategically-selected physical models with computational (virtual) models to systematically develop, deploy, and validate principles of resilience and autonomous detection and corrective capabilities. With such coupled physical-virtual simulation capabilities, RETHi will be able to explore a wide variety of SmartHab configurations and operating modes to investigate a wide range of research questions. Our aim is to establish RETHi as a focal point for partnerships between private industry, public institutions, other STSI institutes, and NASA.

**Electroactive Polymer Actuators and Devices (EAPAD)**

Conference 11375 Monday Keynote Presentation
Monday 27 April 2020 · 10:50 AM - 11:30 AM

**Novel field robots and robotic exoskeletons: design, integration, and applications**

Pinhas Ben-Tzvi, Virginia Tech (USA)

As natural and man-made disasters occur, from earthquakes, tornados, and hurricanes to chemical spills and nuclear meltdowns, there is a need for field robotic systems that are able to respond in these hazardous and dangerous environments. This talk will start with presenting a novel hybrid mechanism robot whereby the locomotion and manipulation platforms are designed as one entity to support both locomotion and manipulation symbiotically. Experimental results demonstrate the robot’s unique capabilities, such as traversing challenging obstacles and manipulating various payloads. The talk will also describe recent results on the design and control of bio-inspired robotic tails capable of stabilizing and maneuvering legged robots. Finally, the talk will describe research on robotic exoskeletons for applications including gesture-based mobile robotic tele-operation and upper-extremity hand rehabilitation with autonomous grasping.

**Biography:** Dr. Pinhas Ben-Tzvi is an Associate Professor of Mechanical Engineering and Electrical and Computer Engineering, and the founding Director of the Robotics and Mechatronics Laboratory at Virginia Tech. He received the B.S. degree (Summa Cum Laude) in Mechanical Engineering from the Technion – Israel Institute of Technology and the M.S. and Ph.D. degrees in Mechanical Engineering from the University of Toronto. Dr. Ben-Tzvi’s current research interests are in robotics and intelligent autonomous systems, human-robot interactions, robotic vision and visual servoing/odometry, machine learning, mechatronics design, systems dynamics & control, mechanism design & system integration, and novel sensing & actuation. His research program has been supported by NSF, NIH, DARPA, ONR, US Navy, US Army Medical Research and Material Command (USAMRMC), and US Naval Oceanographic Office (NAVO). He has authored and co-authored more than 150 peer-reviewed journal articles and refereed papers in conference proceedings and is the named inventor on at least twelve U.S. patents and patent applications. He is the recipient of the 2019 College of Engineering Excellence in Teaching Award from Virginia Tech in recognition of his extraordinary performance in teaching, 2018 College of Engineering Faculty Fellow Award from Virginia Tech in recognition of his extraordinary performance in research, the 2013 GWU Outstanding Young Researcher Award and the 2013 GWU Outstanding Young Teacher Award, as well as several other honors and awards. Dr. Ben-Tzvi is a Technical Editor for the IEEE/ASME Transactions on Mechatronics, Associate Editor for IEEE Robotics and Automation Magazine, Associate Editor for ASME Journal of Mechanisms and Robotics, and Associate Editor for the Int’l Journal of Control, Automation and Systems, and served as an Associate Editor for IEEE ICRA 2013-2018. He is also active in the professional community, such as organizing conferences and workshops. Dr. Ben-Tzvi is a senior member of IEEE and a member of ASME.

**Active and Passive Smart Structures and Integrated Systems**

Conference 11376 Tuesday Keynote Presentation
Tuesday 28 April 2020 · 10:30 AM – 11:10 AM

**Wave propagation imaging and its applications to structural evaluation**

Jung-Ryul Lee, KAIST (Korea, Republic of)

In this presentation, principles visualizing propagation of structurally guided waves are first introduced and then several setups and their features are explained. For decades, various wave propagation imaging systems have been developed and commercialized for different fields like laser induced ultrasound, microwave, pyroshock, and acoustic emission. Depending on the structures and materials, system variation, especially scanning mechanism is also interested and some examples on real world applications of these systems deepen understanding on the applicability and provides inspiration on potential applications. Lastly, suggestion on the smart hangar and smart twin will be followed.

**Biography:** J R Lee (Jung-Ryul Lee) is KAIST-appointed chaired professor of the department of aerospace engineering, South Korea where he joined in 2015. He received his MS from KAIST in Korea, and Ph.D from Ecole Nationale Superieure Des Mines de Saint-Etienne in France in 2004. Before joining KAIST, he has
Nonreciprocal phononic systems: from table-top demos to RF devices

Chiara Daraio, Caltech (USA)

Acoustic waves in a linear time-invariant medium are generally reciprocal. However, reciprocity can break down in a time-variant system. We first demonstrated non-reciprocity experimentally in a dynamic, one-dimensional phononic crystal, where the local elastic properties are dependent on time. We extended this work to different platforms, controlling longitudinal, flexural and surface acoustic waves. In an effort towards miniaturization, we designed nanoelectromechanical systems (NEMS) consisting of mechanically coupled, free-standing nanomembranes with circular clamped boundaries. The application of a d.c. gate voltage creates voltage-dependent on-site potentials, which can significantly shift the stiffness of the local resonators and the frequency bands of the device. We demonstrated operation of these systems in the radiofrequency (RF) domain (10–30 MHz). These NEMS were also used for the first experimental realization of topological nanoelectromechanical metamaterials with protected edge states. These on-chip, integrated acoustic components could be used for unidirectional waveguides and compact delay lines for high-frequency signal-processing applications.

Biography: Prof. Chiara Daraio received her undergraduate degree in Mechanical Engineering from the Universita’ Politecnica delle Marche, Italy (2001). She received her M.S. (2003) and Ph.D. degrees (2006) in Materials Science and Engineering from the University of California, San Diego. She joined the Aeronautics and Applied Physics departments of the California Institute of Technology (Caltech) in fall of 2006 and was promoted full professor in 2010. From January 2013 to August 2016, she joined the department of Mechanical and Process Engineering at ETH Zürich, with a chair in Mechanics and Materials. She returned at Caltech in August 2016, as a Professor of Mechanical Engineering and Applied Physics. She received a Presidential Early Career Award from President Obama (PECASE) in 2012, was elected as a Sloan Research Fellow in 2011 and received an ONR Young Investigator Award in 2010. She is also a winner of the NSF CAREER award (2009), of the Richard Von Mises Prize (2008).

An industrial perspective of the NDT 4.0: current challenges and possible solutions

Mostafa Hasanian, MISTRAS Group, Inc. (USA)

We present the use of machine learning for data processing and flaw clustering of ultrasonic NDT data. The developed machine learning tools for smart NDT are presented, and case studies are demonstrated. In addition, the integration of a network of sensors on a bridge through the Internet of Things (IoT) is illustrated by including the methodology and details of the project. Finally, some particular challenges in NDT 4.0 are presented, and possible solutions are given.

Biography: Dr. Mostafa Hasanian is a scientist in MISTRAS group with research area of NDT automation and additive manufacturing. He graduated from Penn State University with major in Ultrasonics. He was involved in several projects using ultrasonic and laser for material characterization and nondestructive testing. His current active research area is focused on smart systems and machine learning.

Poster Session

Wednesday 29 April 2020 · 6:00 PM - 8:00 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, ask questions, and enjoy the refreshments. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster session.

Poster Set-Up/Viewing:
Wednesday, 29 April, 10:00 AM - 4:00 PM

Panel Discussion: Critical Problems in NDE/SHM

Thursday 30 April 2020 · 8:40 am to 10:00 am

Confirmed panelists: Branko Gilsco, Princeton Univ. (USA); Chih-Hung Chiang, Chaoyang Univ. of Technology (Taiwan)
NSF Program Director
One-on-One Meetings for Early Career Professionals

Monday 27 April 2020 · 11:50 AM - 1:20 PM
Location: Grand Ballroom G

Potential and existing early career PIs will have the opportunity to discuss one-on-one their research proposal ideas and questions about the CMMI MoMS (Civil, Mechanical and Manufacturing Innovation / Mechanics of Materials and Structures) program in particular, and NSF scope in general with the program director. Given the strict limit on the meeting time of 15 minutes, PIs are advised to prepare talking points in advance.

These one-on-one meetings are available for Early Career Professionals who have technical registration badges only. Meetings will be scheduled on a first-come first-serve basis. Email Megan Artz (MeganA@spie.org) for details and scheduling.

Dr. Nakiah Goulbourne is NSF program director for the Mechanics of Materials and Structures program (MoMS). The program supports research related to the mechanics of deformable materials and structures. Current program areas include but are not limited to soft materials, low dimensional/nanomaterials, architected materials, computational mechanics and multi-scale modeling, multiphysics phenomena, constitutive modeling of metals/glasses/ceramics, composites, and related areas.

All-Symposium Welcome Reception

Monday 27 April 2020 · 6:00 PM - 7:30 PM

The Welcome Reception will be a shared event with the Defense + Commercial Sensing symposium. All attendees are invited to relax, socialize, and enjoy refreshments. Please remember to wear your conference registration badges. Dress is casual.

Lunch with the Experts - A Student Networking Event

Tuesday 28 April 2020 · 12:30 PM - 1:30 PM

Open to Student Attendees

Seating is limited. Enjoy a casual meal with colleagues at this engaging networking opportunity. Hosted by SPIE Student Services, this event features experts willing to share their experience and wisdom on career paths in optics and photonics. Seating is limited and will be granted on a first-come, first-served basis.

Women’s Networking Reception

Tuesday 28 April 2020 · 5:30 PM - 7:00 PM

Open to women attendees with a paid registration badge. Come discuss topics about gender equity with your colleagues during this relaxed reception.

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**SCIENCE is for everyone**

**EQUITY**
Is access to opportunities, fair treatment, and advancement for all people; it’s about eliminating barriers that prevent full participation.

**DIVERSITY**
Includes all the ways in which people differ—identity markers such as race, ethnicity, gender, ability, sexual orientation, and more.

**INCLUSION**
Goes beyond diversity: it’s the act of creating an environment where everyone feels welcomed, respected, supported, and valued.

spie.org/inclusion
AWARD EVENTS

Award Presentations
Monday - Wednesday 27 - 29 April 2020
8:25 AM - 8:30 AM

2020 NDE Lifetime Achievement Award
presented to
Francesco Lanza Di Scalea, Univ. of California, San Diego (USA)

Biography: Francesco Lanza di Scalea is a Professor of Structural Engineering and the Director of the Experimental Mechanics & NDE Laboratory at the University of California San Diego. His research and teaching interests are in the fields of experimental mechanics, non-destructive evaluation and structural health monitoring. Lanza di Scalea was awarded the UCSD Structural Engineering Teacher of the Year Award (2011 and 2018), the Structural Health Monitoring Person of the Year Award (2007), the ASNT Research Fellowship Award (2002, 2006 and 2010) and Faculty Grant Award (2003), the UCSD Hellman Faculty Fellowship (2000 and 2002), and the Fulbright Scholarship (1995). He currently serves on the Editorial Boards of Journal of Intelligent Materials Systems and Structures, Structural Health Monitoring International Journal, Research in Nondestructive Evaluation, ASME Journal of Nondestructive Evaluation, Diagnostics and Prognostics, and Experimental Mechanics. He is a Fellow of the American Society for Nondestructive Testing, the Acoustical Society of America, the Society for Experimental Mechanics, and a senior member of IEEE.

2020 SSM Lifetime Achievement Award
presented to
George A. Lesieutre, The Pennsylvania State Univ. (USA)

Biography: Over the last 25 years, Dr. Lesieutre pioneered several smart structures technologies for flight vehicles and garnered five society best paper awards. He earned a B.S. in AeroAstro from MIT, a Ph.D. from UCLA, and joined Penn State from industry. Having previously served as Head of Aerospace Engineering and Director of the Center for Acoustics and Vibration, he now oversees an enterprise with annual research expenditures of $150M. Dr. Lesieutre is a Fellow of AIAA, was a founding member of the AIAA Adaptive Structures TC, and served as General Chair for AIAA SciTech 2015, the world’s largest aerospace-focused conference. He once paddled a canoe from Montreal to New Orleans, ran a 50-mile ultramarathon, and is an instrument-rated private pilot.

SPIE Best Student Paper Awards
Wednesday 29 April · 8:15 AM - 8:30 AM

SPIE is sponsoring the Best Student Paper contest. Papers will be presented in a special Session on Tuesday afternoon. Entrants will be judged by a committee from SPIE. The committee will then vote to determine the top three finalists. The top three finalist student authors and/or student co-authors will receive certificates and cash awards.

Bioinspiration, Biomimetics, and Bioreplication Best Student Paper Award: In Memory of H. Don Wolpert

The Bioinspiration, Biomimetics, and Bioreplication VIII conference chairs will choose the Best Student Paper Award from their conference. This award is sponsored by the Optical Society of Southern California. A cash prize will be given to the first, second, and third place winners.

Sponsored by:

EAP-In-Action Demonstration Awards

As part of the EAPAD conference of the SPIE Smart Structures/NDE symposia, the EAP-in-Action Demonstration Session has been held over the past 20 years. In an effort to encourage excellence in developing the Electroactive Polymers (EAP) demonstrations and accelerate the transition of EAPs to practical and commercial technologies, award certificates will be issued as part of the 2020 SPIE Smart Structures/NDE symposium. A judging committee, consisting of leading EAP experts, will select the award winners among the presenters at the EAP-in-Action Demonstration Session. The judges will assess the presenters’ performance as well as the quality and content of the demos. The top ranked three will be recognized and will be awarded certificates.
This Session highlights some of the latest capabilities and applications of Electroactive Polymers (EAP) materials where the attendees are shown demonstrations of these materials in action. Also, the attendees interact directly with technology developers and given “hands-on” experience with this emerging technology. The first Human/EAP-Robot Armwrestling Contest was held during this session of the 2005 EAPAD conference.

**Tentative EAP Demonstrations**

### Diaphragm actuator can lift 4kg with a 0.96g DE

Koji Oni, Aisin AW Co., Ltd. (Japan), Mikio Waki, Wits Inc. (USA), Seiki Chiba, Chiba Science Institution (Japan)

Using only 0.96g of dielectric elastomer actuator and applying about 3kV we will be demonstrated can lift a weight of 4kg over 1mm. It is driven at relatively high speed and the time required to move 1mm can be 98 milliseconds. The DEA achieves high output using SWCNT electrodes suitable for acrylic dielectric elastomers. Currently, we are developing a new dielectric elastomer material and SWCNT. With such, we seek to make the actuator more compact and obtain higher output power. Within a year's time, we are aiming for a DEA that lifts 8kg.

### Super flexible electrode for a DE made with CNT spray

Makoto Takeshita, Mitsugu Uejima, Zeon Corp. (Japan), Mikio Waki, Wits Inc. (USA), Seiki Chiba, Chiba Science Institution (Japan)

A CNT spray can impart conductivity to various materials through simple application alone, not requiring any special equipment or techniques. The sprayed CNTs are flexible after drying and remain conductive and connected even when bent or stretched. In addition, because of its excellent adhesiveness, it does not easily peel off or scatter after drying. It is very easy to use, able to be applied with a special CNT paint spray. Expensive dispersing equipment and special coating equipment are not required, doing away with troublesome dispersion work. With a CNT sprayer and dielectric elastomer, it is possible to make a DE easily, which can further promote DE research and trial production. It is possible to change the content of CNTs according to the purpose. By simply applying CNT spray, the following can be easily achieved: DE electrodes, wiring of electronic circuits that require flexibility, mounting of electronic components on flexible PCBs, and rubber that requires flexibility. It is also possible to easily add conductivity to a sponge.
Design advances in HASEL artificial muscles
Nicholas Kellaris, Shane K. Mitchell, Philipp Rothemund, Christoph Keplinger, Univ. of Colorado, Boulder (USA)

Some recent advances in HASEL artificial muscle designs will be presented. This includes a new HASEL geometry that enables increased strains versus traditional designs. In addition, we will demonstrate a new design of HASEL that uses bioinspiration to combine rigid and soft components and create an actuator capable of bending motion to enable fast, strong, soft-actuated joints that can be independently-controlled.

Virtual Reality demo of underwater gesture recognition glove
Derek Orbaugh, Univ. of Auckland (New Zealand)

We have developed a glove capable of recognizing a range of hand gestures and translating these into commands for a virtual AUV. Dielectric elastomer strain sensors were placed on each finger to measure the angular displacement in the proximal and distal directions. An IMU is placed in the dorsal side of the palm for complex gesture recognition. A haptic motor is used for feedback when a gesture is recognized. The virtual environment simulates an AUV floating in an underwater world for the user to interact with. The aim of this environment is to train divers before using our smart dive glove for underwater communication.

Coiled polymeric fiber based actuators for environment control and soft robotics
Marcio Lima, Lintec of America, Inc. (USA)
It has been demonstrated\cite{lima2012highly, haines2014high, lima2012highly} that highly twisted polymeric fibers are also capable to generate impressive tensile actuation, providing large strokes and vastly exceeding the work and power capabilities of natural skeletal muscle. Contraction of over 50%, and lifting capacity up to 270 pounds weight have achieved using a single coiled fibers. These actuators are also can operate as torsional motors: a thin fiber can rotate heavy rotors at up to 100,000 rpm for 1,000,000 cycles. Actuation can be driven by electrical signals or by relatively small variation in environmental temperature, which can be converted into mechanical work. Bi-stable operation is also possible: energy is required only to change the shape of the actuator between two positions. Fig. 1 shows an example of automatic environmental temperature control using only coiled polymeric fibers which are capable to open and close the roof a simulated greenhouse in order to regulate its internal temperature. No electricity is required. Fig. 2 Shows torsional, electrically driven actuation to control light and air flow. Another filed of applications is on soft-robotics: since these actuators are very flexible, capable to produce large tensile strength and easily assembled into arrays they are suitable for construction of soft manipulators, as shown in Fig. 3.


High Voltage Signal Generator (HVSG)

Markus Henke, PowerOn Ltd. (New Zealand), Technische Univ. Dresden (Germany), Univ. of Auckland (New Zealand), Zak Bah, PowerOn Ltd. (New Zealand), Katie Wilson, Iain Anderson, PowerOn Ltd. (New Zealand), Univ. of Auckland (New Zealand)

We will demonstrate our latest HV Generator as a driver dielectric elastomers (DEs) that is the result of our work since 2008. This HVSG power supply is also a controller for running demonstrators and experimental setups that require high voltage, with 4 independent channels. Dielectric elastomers, piezo-electronics, electrostriction or robotics are some the applications for the HVSG. It is, multichannel unit that delivers several standard waveforms up to 1kHz and 4000V. To simplify demonstrations and extend usefulness, the HVSG comes with rechargeable, high performance lithium polymer batteries. An integrated controller, with touchscreen interface, further simplifies setup – and we also included an interface bus to stream signals or for synchronization with other instruments.

**Soft tactile detectors for soft grippers**

Markus Henke, PowerOn Ltd. (New Zealand), Technische Univ. Dresden (Germany), Univ. of Auckland (New Zealand), Dawei Zhang, PowerOn Ltd. (New Zealand), Katie Wilson, PowerOn Ltd. (New Zealand), Univ. of Auckland (New Zealand), Andreas Richter, Technische Univ. Dresden (Germany)

We will present an implementation of entirely soft and stretchable geometric dielectric elastomer switches (gDES) for soft robotic components. The switches are arranged in 2D arrays to enable space-resolved tactile sense. Soft adaptive grippers have the ability to grip randomly formed objects by adapting their geometry. To do so, they undergo large three-dimensional deformations. At the moment, there is a lack of electronics for touch detection in such grippers, because conventional electronics rely on rigid semi-conductor electronics and would hinder large deformations. Soft and stretchable gDES arrays give soft robotic grippers the ability to detect touch and do not prevent adaptive gripping. We present a soft tactile sensor attached to an adaptive gripper unit and the design of a control-loop that can adjust the gripping force to the gripped object. A FESTO fin-ray gripper with the ability to grip randomly formed objects is shown.

**Electroadhesive DEA-powered snake robot**

Joseph Ashby, Samuel Rosset, Univ. of Auckland (New Zealand), Markus Henke, Univ. of Auckland (New Zealand), Technische Univ. Dresden (Germany) and PowerOn Ltd. (New Zealand), Iain Anderson, Univ. of Auckland (New Zealand), StretchSense Ltd. (New Zealand) and PowerOn Ltd. (New Zealand)

We present here a bioinspired crawling robot based on the movement of Serpentes, using phased actuation to produce periodic deformation coupled with controllable adhesion through electroadhesive pads. This design allows the robot to traverse over smooth surfaces, a task its biological inspiration is unable to achieve as they rely on friction from their environment in order to generate forward motion. The electroadhesion would also allow the robot to operate in zero gravity environments, where traditional wheeled or walking robots cannot. The design uses hinged rigid sections which are linked by DE actuators, allowing them to bend. Changing the waveform of the periodic deformation, along with the phased actuation of the electroadhesive feet produces different motions accordingly.
## CONFERENCE SESSION SCHEDULE

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<td>Bioinspiration, Biomimetics, and Bioreplication X</td>
<td>Electroactive Polymer Actuators and Devices (EAPAD) XXII</td>
<td>Active and Passive Smart Structures and Integrated Systems IX</td>
<td>Behavior and Mechanics of Multifunctional Materials and Composites IX</td>
<td>Nano-, Bio-, Info-Tech Sensors and 3D Systems</td>
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### Monday 27 April

**Session 1**
- Mon 10:30 am to 11:50 am
- Materials I (Krenez)

**Session 2**
- Mon 1:20 pm to 3:00 pm
- Colors and Visualization (Lakhtakia)

**Session 3**
- Mon 3:30 pm to 5:50 pm
- Biointerface Solutions and Design (Martin-Palma)

**Session 4**
- Tue 10:30 am to 11:50 am
- Soft Robotics (Saito)

**Session 5**
- Tue 1:20 pm to 3:00 pm
- Flight and Navigation (Lenau)

**Session 6**
- Tue 3:30 pm to 5:50 pm
- Materials II (Zolfrank)

### Tuesday 28 April

**Session 2**
- Mon 10:30 am to 11:50 am
- Soft Robotics (Saito)

**Session 3**
- Mon 10:30 am to 11:50 am
- EAP as Emerging Actuators (Bar-Cohen, Anderson)

**Session 4**
- Mon 1:20 pm to 3:00 pm
- EAP Robotics for Earth and Space (Baughman, Sheeh)

**Session 5**
- Mon 3:30 pm to 5:50 pm
- EAP-in Action Demonstration Session (Bar-Cohen)

**Session 6**
- Tue 10:30 am to 11:50 am
- New Integrated Systems (Han)

**Session 7**
- Tue 1:20 pm to 3:00 pm
- Energy Harvesting II: Piezo-based Ions, Hydrogels, LC Elastomers, and Coiled Artificial Muscle Heat Pumping (Asaka, Ben-Tzvi)

**Session 8**
- Tue 3:30 pm to 5:50 pm
- Fluids and Electrostatics (Rosset, Rasmussen)
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<tr>
<th>Session 1</th>
<th>Mon 10:30 am to 11:50 am</th>
<th>Keynote Session (Huang, Zonta)</th>
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<tbody>
<tr>
<td>Session 1</td>
<td>Mon 10:30 am to 11:50 am</td>
<td>PZT Transducers for NDE/SHM (Jiang)</td>
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<tr>
<td>Session 2</td>
<td>Mon 1:20 pm to 3:00 pm</td>
<td>Novel Sensor and Sensing Technologies I (Tang, Loh)</td>
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<tr>
<td>Session 3</td>
<td>Mon 3:30 pm to 5:50 pm</td>
<td>Machine Learning for Smart Structures (Li, Laflamme)</td>
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<tr>
<td>Session 4</td>
<td>Tue 10:30 am to 11:50 am</td>
<td>Self-Healing and Composite Materials (Bowland)</td>
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<tr>
<td>Session 5</td>
<td>Tue 1:20 pm to 3:00 pm</td>
<td>Energy Harvesting Techniques (Liao, Lu)</td>
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**CONFERENCE 11379**
Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems

**CONFERENCE 11380**
Nondestructive Characterization and Monitoring of Advanced Materials, Aerospace, Civil Infrastructure, and Transportation IX

**CONFERENCE 11381**
Health Monitoring of Structural and Biological Systems IX

**CONFERENCE 11382**
Smart Structures and NDE for Industry 4.0, Smart Cities, and Energy Systems

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**CONFERENCE SESSION SCHEDULE**

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<tr>
<td><strong>Nondestructive Characterization and Monitoring of Advanced Materials, Aerospace, Civil Infrastructure, and Transportation IX</strong></td>
</tr>
<tr>
<td><strong>Session 1</strong> Mon 10:30 am to 11:50 am PZT Transducers for NDE/SHM (Jiang)</td>
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<tr>
<td><strong>Session 2</strong> Mon 1:20 pm to 3:00 pm Microwave/RF/Radar NDE (Huston)</td>
</tr>
<tr>
<td><strong>Session 3</strong> Mon 3:30 pm to 5:30 pm Artificial Intelligence and Machine Learning in NDE/SHM (Tang)</td>
</tr>
<tr>
<td><strong>Session 4</strong> Tue 10:30 am to 11:50 am Self-Healing and Composite Materials (Bowland)</td>
</tr>
<tr>
<td><strong>Session 5</strong> Tue 1:20 pm to 3:00 pm Autonomous and Aerospace Structures (Gyekenyesi)</td>
</tr>
<tr>
<td><strong>Session 6</strong> Tue 3:30 pm to 4:30 pm NDE/SHM for Corrosion Detection (Yu)</td>
</tr>
<tr>
<td><strong>Session 7</strong> Tue 4:30 pm to 6:10 pm Smart Materials for NDE/SHM (Loh)</td>
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<tr>
<td><strong>Health Monitoring of Structural and Biological Systems IX</strong></td>
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<tr>
<td><strong>Session 1</strong> Mon 10:30 am to 12:10 pm Guided Waves for SHM I (Fromme, Su)</td>
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<tr>
<td><strong>Session 2</strong> Mon 1:20 pm to 3:00 pm Novel and Emerging Techniques for SHM I (Bar-Cohen, Kundu)</td>
</tr>
<tr>
<td><strong>Session 3</strong> Mon 3:30 pm to 6:10 pm Monitoring of Aerospace and Composite Structures (Ricci, Ostachowicz)</td>
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<tr>
<td><strong>Session 4</strong> Tue 10:30 am to 12:10 pm Guided Waves for SHM II (Huang, Zonta)</td>
</tr>
<tr>
<td><strong>Session 5</strong> Tue 1:20 pm to 3:00 pm Guided Waves of Ultrasonic Composites (Giugliani, Ricci)</td>
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<tr>
<td><strong>Session 6</strong> Tue 3:30 pm to 6:10 pm Medical and Biomedical Applications (Jiang, Fromme)</td>
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<tr>
<td><strong>Session 7</strong> Tue 4:30 pm to 6:10 pm Smart Materials for NDE/SHM (Loh)</td>
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<tr>
<td><strong>Smart Structures and NDE for Industry 4.0, Smart Cities, and Energy Systems</strong></td>
</tr>
<tr>
<td><strong>Session 1</strong> Mon 10:30 am to 11:50 am Sensors, Adaptive Structures, and Artificial Intelligence (Gath)</td>
</tr>
<tr>
<td><strong>Session 2</strong> Mon 1:20 pm to 3:00 pm Characterization of Materials for Energy Systems (Gath)</td>
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<tr>
<td><strong>Session 3</strong> Mon 3:30 pm to 4:30 pm Development and Application of Smart Materials for Energy Systems (Gath)</td>
</tr>
<tr>
<td><strong>Session 4</strong> Mon 4:30 pm to 5:30 pm NDE and SHM of Energy Systems (Gath)</td>
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THIS PROGRAM IS CURRENT AS OF 11 DECEMBER 2019. Find complete, up-to-date information and create your personalized schedule at spie.org/ss20program.
## CONFERENCE SESSION SCHEDULE

### CONFERENCE 11375
**Electroactive Polymer Actuators and Devices (EAPAD)**
**XXII**

#### Wednesday
**29 April**
- **Session 6A**
  - Wed 10:30 am to 11:50 am
  - Ionic and Gel Actuators
  - (Dickey, Akle)

- **Session 6B**
  - Wed 10:30 am to 11:50 am
  - EAP Materials I
  - (Casucciolo, Boese)

- **Session 7A**
  - Wed 1:20 pm to 3:00 pm
  - Ionic Polymer Metal Composites
  - (Fontana, Keplinger)

- **Session 8A**
  - Wed 3:30 pm to 4:50 pm
  - Twisted Actuation
  - (Oh, Fontana)

- **Session 8B**
  - Wed 3:30 pm to 5:50 pm
  - Optimized Actuation, Compliance, Instability, and Switching
  - (Kim, Nguyen)

- **Session 9A**
  - Wed 4:50 pm to 5:50 pm
  - Applications and Optimization of EAP Actuators
  - (Seelecke, Henke)

- **Session 10**
  - Thu 8:00 am to 10:00 am
  - Dielectric Elastomer Printing
  - (Su, Otero)

- **Session 11**
  - Thu 10:30 am to 11:50 am
  - Dielectric Elastomer Self-sensing and Control
  - (Madden, Berselli)

- **Session 12**
  - Thu 1:20 pm to 3:00 pm
  - Deep Learning and Gesture Recognition, Sensing, and DE Actuation
  - (Pei, Majidi)

- **Session 13**
  - Thu 3:30 pm to 4:50 pm
  - Sensors, Sensor Arrays, and Textiles
  - (Skov, Maas)

- **Session 14**
  - Thu 4:50 pm to 6:10 pm
  - Big Actuators and Big Volts
  - (Helps, Ashby)

### CONFERENCE 11376
**Active and Passive Smart Structures and Integrated Systems IX**

#### Thursday
**30 April**
- **Session 10**
  - Thu 8:00 am to 10:00 am
  - Energy Harvesting and Transfer
  - (Youn, Shahab)

- **Session 11**
  - Thu 10:30 am to 11:50 am
  - Micro- and Nano-integrated Systems
  - (Sodano, Deü)

- **Session 12**
  - Thu 12:10 pm to 2:30 pm
  - Nonlinear Ultrasonic
  - (Chisholm, de Jong)

- **Session 13**
  - Thu 3:30 pm to 5:50 pm
  - Soft/Tunable Metamaterials
  - (Loh, Nimmagadda)

### CONFERENCE 11377
**Behavior and Mechanics of Multifunctional Materials and Composites IX**

#### Thursday
**30 April**
- **Session 7**
  - Thu 8:00 am to 10:00 am
  - Smart, Fancy, and Functional: A Session on Multifunctional Structures and Materials Systems II
  - (Hartl, Xu)

- **Session 8**
  - Thu 1:20 pm to 3:00 pm
  - Slow and Steady Wins the Race: An Additive Manufacturing Session
  - (Moghaddam, Mailen)

- **Session 9**
  - Thu 3:30 pm to 5:50 pm
  - Good Materials Stick Together: A Session for Sticky and Magnetic Materials
  - (Domann, Ciocanel)

### CONFERENCE 11378
**Nano-, Bio-, Info-Tech Sensors and 3D Systems**

#### Thursday
**30 April**
- **Session 7**
  - Thu 8:00 am to 10:00 am
  - Machine Learning for Civil Structures
  - (Ozturk, De Marqui Jr.)

- **Session 8**
  - Thu 10:30 am to 12:10 pm
  - Vibration Isolation
  - (Erturk, De Marqui Jr.)

- **Session 9**
  - Thu 10:30 am to 12:10 pm
  - Pipes and Pipelines
  - (Fromme, Reis)

- **Session 10**
  - Thu 10:30 am to 12:10 pm
  - Nonlinear Ultrasonic
  - (Chisholm, de Jong)

- **Session 11**
  - Thu 10:30 am to 12:10 pm
  - Civil Infrastructure Monitoring
  - (Schaal, Hafezi)

- **Session 12**
  - Thu 10:30 am to 12:10 pm
  - Guided Waves for SHM III
  - (Schaal, Ostachowicz)

- **Session 13**
  - Thu 10:30 am to 12:10 pm
  - Novel and Emerging Techniques for SHM II
  - (Schaal, Ostachowicz)

- **Session 14**
  - Thu 10:30 am to 12:10 pm
  - Signal and Data Processing of Sensor Data
  - (Fromme, Reis)
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Machine Learning for Civil Structures  
(Chen, Jahanshahi) | **Session 8**  
Wed 10:50 am to 11:50 am  
Pipes and Pipelines  
(Ozwin) | **Session 7A**  
Wed 10:30 am to 12:10 pm  
Guided Waves for SHM II  
(Sohn, Schaal) |
| **Session 8**  
Wed 1:20 pm to 3:00 pm  
Novel Piezoelectric Transducers  
(Kim, Jahanshahi) | **Session 9**  
Wed 1:20 pm to 3:00 pm  
Modal Analysis and Dynamic Methods for NDE/SHM  
(Sabato) | **Session 7B**  
Wed 10:30 am to 12:10 pm  
Elastic and Acoustic Metamaterials IV  
(Nouh, Yang) |
| **Session 9**  
Wed 3:30 pm to 5:50 pm  
Imaging-based SHM  
(Xu, Wang) | **Session 10**  
Wed 3:30 pm to 5:50 pm  
LDV, DIC, Camera, and Photogrammetric NDE  
(Lau) | **Session 8A**  
Wed 1:20 pm to 3:00 pm  
Nonlinear Ultrasonic Techniques  
(Su, Shen) |
| **Session 10**  
Thu 8:00 am to 10:00 am  
Optical Fiber Sensors  
(Peters, Wynne) | **Session 11**  
Thu 8:40 am to 10:00 am  
Panel Discussion: Critical Problems in NDE/SHM  
(Gilcso, Chang) | **Session 8B**  
Wed 1:20 pm to 3:00 pm  
Guided Waves for SHM III  
(Ostachowicz, Nieszreck) |
| **Session 11**  
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Passive Ultrasound Inspection Techniques  
(Giurgiutiu, di Scalea) | **Session 11**  
Thu 10:30 am to 12:10 pm  
Electrical, Thermal, and Radioactive NDE  
(Su) | **Session 9A**  
Wed 3:30 pm to 5:50 pm  
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(Reis, Banerjee) |
| **Session 12**  
Thu 1:20 pm to 3:00 pm  
Actuator Technologies for Smart Structures  
(Peraza-Hernandez, Essmele) | **Session 12**  
Thu 1:20 pm to 3:00 pm  
Acoustic/Ultrasonic NDE/SHM  
(Shull) | **Session 9B**  
Wed 3:30 pm to 5:50 pm  
Computer Vision and Optical Techniques for SHM and NDT  
(Sabato, Mao) |
| **Session 13**  
Thu 3:30 pm to 5:50 pm  
Nano-composite and Flexible Sensors  
(Tallman, Ryu) | | |

**Session 10**  
Thu 8:00 am to 10:00 am  
Novel and Emerging Techniques for SHM II  
(Schaal, Ostachowicz) | **Session 10**  
Thu 8:00 am to 10:00 am  
Novel and Emerging Techniques for SHM II  
(Schaal, Ostachowicz) | **Session 10**  
Thu 8:00 am to 10:00 am  
Novel and Emerging Techniques for SHM II  
(Schaal, Ostachowicz) |
| **Session 11**  
Thu 10:30 am to 12:10 pm  
Modeling and Neural Networks for SHM  
(Schaal, Hafezi) | | |
Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems

Conference Chair: Haiying Huang, The Univ. of Texas at Arlington (USA)

Conference Co-Chairs: Hoon Sohn, KAIST (Korea, Republic of); Daniele Zonta, Univ. of Strathclyde (United Kingdom)

Program Committee: Hiroshi Asanuma, Chiba Univ. (Japan); Chih Chen Chang, Hong Kong Univ. of Science and Technology (Hong Kong, China); Genda Chen, Missouri Univ. of Science and Technology (USA); Allison B. Flatau, Univ. of Maryland, College Park (USA); Branko Glisic, Princeton Univ. (USA); Faramarz Gordaninejad, Univ. of Nevada, Reno (USA); Benjamin W. Goss, Naval Surface Warfare Ctr. Carderock Div. (USA); Ryan L. Hame, The Ohio State Univ. (USA); Jung-Wuk Hong, KAIST (Korea, Republic of); Neil A. Hoult, Queen’s Univ. (Canada); Ying Huang, North Dakota State Univ. (USA); Mohammad Reza Jahanshahi, Purdue Univ. (USA); Wi-Joon Kim, Inha Univ. (Korea, Republic of); Jeong-Tae Kim, Pukyong National Univ. (Korea, Republic of); Simon Laflamme, Queen’s Univ. (Canada); Paul L. Greenberg, General Motors Co. (USA); Mohammad A. R. Johnson, NASA Glenn Research Ctr. (USA); Leonardo J. Bond, Iowa State Univ. of Science and Technology (USA); Diann E. Brei, Univ. of Michigan (USA); Peter C. Chen, NASA Goddard Space Flight Ctr. (USA); Michael Dallachy, Quanta Network Inc. (USA); Marcelo Dapino, The Ohio State Univ. (USA); Dimitrios E. Exarchos, Univ. of Ioannina (Greece); Beni C. Farinholt, Luna Innovations Inc. (USA); Joao Y. Baaklini, NASA Glenn Research Ctr. (USA); Christopher Niezrecki, Univ. of Massachusetts Lowell (USA); Tzu-Yang Yang, National Chiao Tung Univ. (Taiwan); John D. Watson, NASA Glenn Research Ctr. (USA); Chih-Cheng Yen, National Chiao Tung Univ. (Taiwan); Feng Yang, Virginia Polytechnic Inst. & State Univ. (USA); Shih-Kai Yang, National Taiwan Univ. (Taiwan); Jun-Ichi Yamashita, Univ. of Tokyo (Japan); Christian F. Zardini, DuPont (USA); Benjamin Zink, NASA Glenn Research Ctr. (USA); Dario Zona, Queen’s Univ. (Canada); Christian Zollner, Univ. of Innsbruck (Austria); Genda Zong, Hong Kong Univ. of Science and Technology (Hong Kong, China); Yu-Shen Zou, University of Southern California (USA)

Nondestructive Characterization and Monitoring of Advanced Materials, Aerospace, Civil Infrastructure, and Transportation IX

Conference Chair: Tzu-Yang Yang, Univ. of Massachusetts Lowell (USA)

Conference Co-Chairs: H. Felix Wu, U.S. Dept. of Energy (USA); Peter J. Shull, The Pennsylvania State Univ. (USA); Andrew L. Gyekenyesi, Ohio Aerospace Institute (USA)

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Health Monitoring of Structural and Biological Systems IX

Conference Chair: Paul Fromme, Univ. College London (United Kingdom)

Conference Co-Chair: Zhongqin Su, The Hong Kong Polytechnic Univ. (Hong Kong, China)

Program Committee: Sourav Banerjee, Univ. of South Carolina (USA); Joseph Bar-Cohen, Jet Propulsion Lab. (USA); Fu-Kuo Chang, Stanford Univ. (USA); Anthony J. Croxford, Univ. of Bristol (United Kingdom); Hadi Fekrmank, South Dakota School of Mines and Technology (USA); Victor Giurgiutiu, Univ. of South Carolina (USA); Srinivasan Gopalakrishnan, Indian Institute of Science (India); Mohammad Hadi Hafezi, The Univ. of Arizona (USA); Guoliang Huang, Univ. of Missouri (USA); Xiaoning Jiang, North Carolina State Univ. (USA); Ajay M. Koshli, NASA Johnson Space Ctr. (USA); Sridhar Krishnaswamy, Northwestern Univ. (USA); Tribikram Kundu, The Univ. of Arizona (USA); Francesco Lanza di Scalea, Univ. of California, San Diego (USA); Zhu Miao, Univ. of Massachusetts Lowell (USA); Christopher Niezrecki, Univ. of Massachusetts Lowell (USA); Mostafa A. Nouh, Univ. at Buffalo (USA); Wiesław M. Ostachowicz, The Szewalski Institute of Fluid-Flow Machinery (Poland); Xinlin Qing, Xiamen Univ. (China); Henrique L. Reis, Univ. of Illinois at Urbana-Champaign (USA); Fabrizio Ricci, Politecnico di Torino (Italy); Claudius Rizzo, Univ. of Pittsburgh (USA); Alessandro Sabato, Univ. of Massachusetts Lowell (USA); Christoph Schaal, California State Univ., Northridge (USA); Fabio Semperloti, Purdue Univ. (USA); Yanfeng Shen, Shanghai Jiao Tong University (China); Sumit Sarkar, The Ohio State Univ. (USA); Hemant Singh, University of Maryland (USA); Jeffery A. Smith, NASA Glenn Research Ctr. (USA); Joseph Sullivan, NASA Langley Res. Ctr. (USA); Chagui Taha, Tufts University (USA); Don T. Tran, University of California, Berkeley (USA); Daniel J. Van Vliet, U.S. Army CERDEC (USA); Saumyadeep Vohora, University of California, Berkeley (USA); Chris Waligora, University of Wisconsin-Madison (USA); Wladimir Wohlgemuth, University of Houston (USA)

Smart Structures and NDE for Industry 4.0, Smart Cities, and Energy Systems

Conference Chair: Kerrie Gath, Ford Motor Co. (USA)

Conference Co-Chairs: Dan J. Cinglam, Boeing Research and Technology (USA); Norbert G. Meyendorf, Univ. of Dayton (USA); Christopher Niezrecki, Univ. of Massachusetts Lowell (USA)

Program Committee: Ali Abdul-Aziz, NASA Glenn Research Ctr. (USA); Steven R. Anton, Tennessee Technological Univ. (USA); Nicolas P. Avdelidis, Univ. Laval (Canada); George Y. Baaklini, NASA Glenn Research Ctr. (USA); Leonard J. Bond, Iowa State Univ. of Science and Technology (USA); Diann E. Brei, Univ. of Michigan (USA); Peter C. Chen, NASA Goddard Space Flight Ctr. (USA); Michael Dallachy, Quanta Network Inc. (USA); Marcelo Dapino, The Ohio State Univ. (USA); Dimitrios E. Exarchos, Univ. of Ioannina (Greece); Beni C. Farinholt, Luna Innovations Inc. (USA); Joao Y. Baaklini, NASA Glenn Research Ctr. (USA); Christopher Niezrecki, Univ. of Massachusetts Lowell (USA); Tzu-Yang Yang, National Chiao Tung Univ. (Taiwan); John D. Watson, NASA Glenn Research Ctr. (USA); Chih-Cheng Yen, National Chiao Tung Univ. (Taiwan); Jun-Ichi Yamashita, Univ. of Tokyo (Japan); Christian F. Zardini, DuPont (USA); Benjamin Zink, NASA Glenn Research Ctr. (USA); Dario Zona, Queen’s Univ. (Canada); Christian Zollner, Univ. of Innsbruck (Austria); Genda Zong, Hong Kong Univ. of Science and Technology (Hong Kong, China); Yu-Shen Zou, University of Southern California (USA)

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**CONFERENCE 11374**

Islamic Republic of: Jonathan M. Rossiter, Univ. of Bristol (United Kingdom); Anuvat Sirivat, Chulalongkorn Univ. (Thailand); Anne Ladegaard Skov, Technical Univ. of Denmark (Denmark); Geoffrey M. Spinks, Univ. of Wollongong (Australia); Ji Su, NASA Langley Research Ctr. (USA); I-Hsiang Tseng, Feng Chia Univ. (Taiwan); Rocco Vertechy, Univ. degli Studi di Bologna (Italy); Frédéric Vidal, Univ. de Cergy-Pontoise (France); Thomas Wallmersperger, Technische Univ. Dresden (Germany); Jian Zhu, National Univ. of Singapore (Singapore); Pawel Zylka, Wroclaw Univ. of Technology (Poland)

**CONFERENCE 11375**

Massachusetts Lowell (USA); David L. Maccareñas, Los Alamos National Lab. (USA); Mostafa A. Nour, Univ. at Buffalo (USA); Gyuhae Park, Chonnam National Univ. (Korea, Republic of); Norbert Schweginger, Technische Univ. München (Germany); Yi-Chung Shu, National Taiwan Univ. (Taiwan); Henry A. Sodano, Univ. of Michigan (USA); Ji Su, NASA Langley Research Ctr. (USA); Norbert Schwesinger, Technische Univ. München (Germany); Yi-Chung Shu, National Taiwan Univ. (Taiwan); Henry A. Sodano, Univ. of Michigan (USA); Jianfeng Zang, Univ. of California, San Diego (USA); Kon-Well Wang, Univ. of Michigan (USA); Lihua Tang, The Univ. of Auckland (New Zealand); Serife Tol, Univ. of Michigan (USA); Yi-Chung Shu, Stanford Univ. (USA); Jian Zhu, National Univ. of Singapore (Singapore); Pawel Zylka, Wroclaw Univ. of Technology (Poland)

### PLENARY SESSION · 8:00 to 10:00 AM

Session Chairs: Zoubeida Ounaies, The Pennsylvania State Univ. (USA) and Hoon Sohn, KAIST (Korea, Republic of)

**8:25 to 8:30 AM:**
- **2020 NDE Lifetime Achievement Award** presented to Francesco Lanza DiScalea, Univ. of California, San Diego (USA)
- **2020 SSM Lifetime Achievement Award** presented to George A. Lesieutre, The Pennsylvania State Univ. (USA)

**8:30 to 9:15 AM · Plenary Presentation**

Additive-manufacturing-driven sensing technology for new era of structural health monitoring: from distributed to dispersed sensing

Zhongqing Su
The Hong Kong Polytechnic Univ. (Hong Kong, China)

**9:15 to 10:00 AM · Plenary Presentation**

Stretchable Electronics for Ubiquitous Physiological Monitoring

Michelle Khine
Univ. of California, Irvine (USA)
CONFERENCE 11379
Univ. (Japan); Yiqing Ni, The Hong Kong Polytechnic Univ. (Hong Kong, China); Hae Young Noh, Carnegie Mellon Univ. (USA); Irving J. Oppenheim, Carnegie Mellon Univ. (USA); Wieslaw M. Ostachowicz, The Szeszalski Institute of Fluid-Flow Machinery (Poland); Piervincenzo Rizzo, Univ. of Pittsburgh (USA); Donghyeon Ryu, New Mexico Institute of Mining and Technology (USA); Liming W. Salvino, Office of Naval Research Global (USA); Fabio Semperlotti, Purdue Univ. (USA); Wei Song, The Univ. of Alabama (USA); Wieslaw J. Staszewski, AGH Univ. of Science and Technology (Poland); Zhongqing Su, The Hong Kong Polytechnic University (Hong Kong, China); R. Andrew Swartz, Michigan Technological Univ. (USA); Tyler N. Tallman, Purdue Univ. (USA); Jiong Tang, Univ. of Connecticut (USA); Marco Torbol, Ulsan National Institute of Science and Technology (Korea, Republic of); Ming L. Wang, Northeastern Univ. (USA); Xingwei Wang, Univ. of Massachusetts Lowell (USA); Ya Wang, Texas A&M Univ. (USA); Yang Wang, Georgia Institute of Technology (USA); Rosalind M. Wynne, Villanova Univ. (USA); Fuh-Gwo Yuan, North Carolina State Univ. (USA)

CONFERENCE 11380
Lab. (USA); Caesar Singh, U.S. Dept. of Transportation (USA); Yu-Min Su, National Kaohsiung Univ. of Applied Sciences (Taiwan); Yan Wan, Univ. of Texas at Arlington (USA); Ming L. Wang, Northeastern Univ. (USA); Yang Wang, Georgia Institute of Technology (USA); Tian Xia, The Univ. of Vermont (USA); Lingyu Yu, Univ. of South Carolina (USA); Fuh-Gwo Yuan, North Carolina State Univ. (USA); Haifeng Zhang, Univ. of North Texas (USA); Xiaoyu R. Zheng, Virginia Polytechnic and State Univ. (USA)

CONFERENCE 11381
Univ. (China); Hoon Sohn, KAIST (Korea, Republic of); Wieslaw J. Staszewski, AGH Univ. of Science and Technology (Poland); Tadeusz Stepinski, AGH Univ. of Science and Technology (Poland); Tadeusz Uhl, AGH Univ. of Science and Technology (Poland); Wei-Chih Wang, Univ. of Washington (USA); Yue-Sheng Wang, Beijing Jiaotong Univ. (China); Jinkyu Yang, Univ. of Washington (USA); Lingyu Yu, Univ. of South Carolina (USA); Andrei N. Zagrai, New Mexico Institute of Mining and Technology (USA)

CONFERENCE 11382
HRL Labs., LLC (USA); Tobias Melz, Fraunhofer-Institut für Betriebsfestigkeit und Systemzuverlässigkeit (Germany); Michele Meo, Univ. of Bath (United Kingdom); Alexander Michaels, Fraunhofer-IKTS (Germany); Bernd Michel, Fraunhofer-Institut für Elektronische Nanosysteme (Germany); Pramita Mitra, Ford Motor Co. (USA); Christopher Niezrecki, Univ. of Massachusetts Lowell (USA); Piotr Omenzetter, Univ. of Aberdeen (United Kingdom); Gyuhae Park, Chonnam National Univ. (Korea, Republic of); Kara J. Peters, North Carolina State Univ. (USA); W. Lance Richards, Armstrong Flight ResearchCtr. (USA); Janet M. Sater, Institute for Defense Analyses (USA); Stefano Sfarra, Univ. degli Studi dell'Aquila (Italy); Tadeusz Stepinski, AGH Univ. of Science and Technology (Poland); Bernd Valeske, Fraunhofer-Institut für Zerstörungsarme Prüfverfahren IZFP (Germany); Edward V. White, The Boeing Co. (USA); Mark R. Wolke, NASA Glenn Research Ctr. (USA); H. Felix Wu, U.S. Dept. of Energy (USA); Christian Wunderlich, Fraunhofer-IKTS (Germany); Dong-Jin Yoon, Korea Research Institute of Standards and Science (Korea, Republic of); Lingyu Yu, Univ. of South Carolina (USA)
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<td><strong>Active and Passive Smart Structures and Integrated Systems IX</strong></td>
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<td><strong>Bio-inspired composites by bio-mineralization of textured interfaces</strong>, Hemant Raut, Singapore Univ. of Technology and Design (Singapore)</td>
<td><strong>Energy Harvesting I: Flow/Structure Interaction</strong></td>
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<td>EAP from 1999 to 2020: highlights from chairing the EAPAD conference for 22 years (Keynote Presentation), Yoseph Bar-Cohen, Jet Propulsion Lab. (USA)</td>
<td><strong>A bistable galloping energy harvester for enhanced concurrent wind and base vibration energy harvesting</strong>, Liya Zhao, Univ. of Technology, Sydney (Australia)</td>
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<td><strong>Novel field robots and robotic exoskeletons: design, integration, and applications</strong> (Keynote Presentation), Pinhas Ben-Tzvi, The George Washington Univ. (USA)</td>
<td><strong>Underwater flow energy harvesting using a piezoelectric swimmer platform</strong>, Yu-Cheng Wang, Young Ko, Georgia Institute of Technology (USA)</td>
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<td><strong>How EAPs can revolutionize high precision large optical-quality surface fabrication</strong>, Gil Morretto, Ctr. de Recherche Astrophysique de Lyon, CNRS (France); Kritsadi Thetpraphi, Jean-Fabien Capsal, Institut National des Sciences Appliquées de Lyon (France); Jeffrey R. Kuhn, Institute for Astronomy, Univ. of Hawai‘i (USA); David Audigier, Institut National des Sciences Appliquées de Lyon (France); Maud Langlois, Ctr. de Recherche Astrophysique de Lyon, CNRS (France)</td>
<td><strong>Self-tuning stochastic resonance energy harvester with integrated circuit for smart tire</strong>, Hongjip Kim, Hyunjung Jung, Lei Zuo, Virginia Polytechnic Institute and State Univ. (USA)</td>
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<td><strong>Spiral wrapping flexible ultra-thin pressure sensor for adapting curvature changes of miniaturized neurosurgical robots</strong> (Keynote Presentation), Tianhao Chen, Shaowei Meng, Univ. of Toronto (Canada); Jongwoo Kim, The Hospital for Sick Children (SickKids) (Canada); Thomas Looi, The Hospital for Sick Children (SickKids) (Canada) and Univ. of Toronto (Canada); Eric Diller, Univ. of Toronto (Canada); James M. Drake, The Hospital for Sick Children (SickKids) (Canada) and Univ. of Toronto (Canada); Hani E. Naghub, Univ. of Toronto (Canada)</td>
<td><strong>Spatially discretized actuators with embedded neuromorphic computing</strong>, Vijhnu Baba Sundaresan, The Ohio State Univ. (USA)</td>
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<td>Lunch Break ... Mon 11:50 am to 1:20 pm</td>
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### Keynote Session

**Session Chair:** Jaehwan Kim, Inha Univ. (Korea, Republic of)

**Spiral wrapping flexible ultra-thin pressure sensor for adapting curvature changes of miniaturized neurosurgical robots** (Keynote Presentation), Tianhao Chen, Shaowei Meng, Univ. of Toronto (Canada); Jongwoo Kim, The Hospital for Sick Children (SickKids) (Canada); Thomas Looi, The Hospital for Sick Children (SickKids) (Canada) and Univ. of Toronto (Canada); Eric Diller, Univ. of Toronto (Canada); James M. Drake, The Hospital for Sick Children (SickKids) (Canada) and Univ. of Toronto (Canada); Hani E. Naghub, Univ. of Toronto (Canada)
**CONFERENCE 11379**
Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems

**SESSION 1**
MON 10:30 AM TO 11:50 AM

**Keynote Session**
Session Chairs: Haiying Huang, The Univ. of Texas at Arlington (USA); Daniele Zonta, Univ. degli Studi di Trento (Italy)

**Strategies for the design and operation of resilient extraterrestrial habitats (Keynote Presentation)**, Shirley J. Dyke, Purdue Univ. (USA) .......... [11379-1]

**Machine learning for structural health monitoring: opportunities and challenges (Keynote Presentation)**, Fuh-Gwo Yuan, Sakib Ashraf Zargar, North Carolina State Univ. (USA) .......... [11379-2]

Lunch Break ... Mon 11:50 am to 1:20 pm

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**CONFERENCE 11380**
Nondestructive Characterization and Monitoring of Advanced Materials, Aerospace, Civil Infrastructure, and Transportation IX

**SESSION 1**
MON 10:30 AM TO 11:50 AM

**PZT Transducers for NDE/SHM**
Session Chair: Xiaoning Jiang, North Carolina State Univ. (USA)

**Magnified narrow bandwidth photoacoustic Lamb wave nondestructive testing and evaluation system using candle soot nanoparticle patches**, Taeyeang Kim, Korea Military Academy (Korea, Republic of); Ho-Wuk Kim, Xiaoning Jiang, North Carolina State Univ. (USA) ........ [11380-1]

**Noninvasive liquid level sensing technique using laser generated ultrasonic, Ho-Wuk Kim, Bharat Balagopal, Sean Kerrigan, Mo-Yuen Chow, Mohamed Bourouhi, Xiaoning Jiang, North Carolina State Univ. (USA) .......... [11380-2]

**Auxetic piezoelectric energy harvesting from train-induced railway track vibrations**, Saman Farhangdoust, Florida International Univ. (USA) [11380-3]

**Influence of the piezoelectric nonlinearities in vibration based damage detection and guided-wave based damage detection of structures**, Shivashankar P., Mahindra Ratelota, Gopalakrishnan S., S. B. Kandagal, Indian Institute of Science, Bengaluru (India) .......... [11380-4]

Lunch Break ... Mon 11:50 am to 1:20 pm

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**CONFERENCE 11381**
Health Monitoring of Structural and Biological Systems IX

**SESSION 1**
MON 10:30 AM TO 12:10 PM

**Guided Waves for SHM I**
Session Chairs: Paul Fromme, Univ. College London (United Kingdom); Zhongqing Su, The Hong Kong Polytechnic Univ. (Hong Kong, China)

**2D and 3D scanning models for quantitative guided wave inspection**, Francesco Lanza di Scalea, Margherita Capriotti, Univ. of California, San Diego (USA); Antonino Spada, Univ. degli Studi di Palermo (Italy); Ranting Cui, Univ. of California, San Diego (USA) ........ [11381-1]

**Numerical and experimental investigation of damage detection in stiffened composite panels using guided ultrasonic waves**, Steffen Tai, Fumika Kotobuki, Univ. of California, Los Angeles (USA); Christoph Schaal, California State Univ., Northridge (USA); Ailt Mai, Univ. of California, Los Angeles (USA) ........ [11381-2]

**Ultrasonic Lamb wave inspection of composite defects**, Zhaoyun Ma, Lingyu Yu, Univ. of South Carolina (USA) [11381-3]

**Modulating Lamb waves with a tunable ultrasonic lens**, Xiaowei Yin, Yanfeng Shen, Univ. of Michigan-Shanghai Jiao Tong Univ. Joint Institute (China) [11381-4]

**Baseline-free structural health monitoring based on SH wave sparse array and phased array system**, Qiang Huan, Faxin Li, Peking Univ. (China) .......... [11381-5]

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**CONFERENCE 11382**
Smart Structures and NDE for Industry 4.0, Smart Cities, and Energy Systems

**SESSION 1**
MON 10:30 AM TO 11:50 AM

**Sensors, Adaptive Structures, and Artificial Intelligence**
Session Chair: Kerrie Gath, Ford Motor Co. (USA)

**Numerical validation using finite element to assess the performance of microwave sensor in detecting blade tip displacement**, Ali Abdul-Azziz, Kent State Univ. (USA); Samir Mustapha, American Univ. of Beirut (Lebanon); Khaled Aboumerhi, Johns Hopkins Univ. (USA) ........ [11382-1]

**Deep learning-based crack detection in tunnel structure in concrete using multispectral dynamic imaging system**, Rahmat Ali, Jiangyu Zeng, Young-Jin Cha, Univ. of Manitoba (Canada) ........ [11382-2]

**High energy laser detection through thermoelectric generators**, Joseph Merkel, Deborah Mechtel, Brian Jenkins, Hatem Elbidweihy, Steven Yee, Peter Joyce, Charles Nelson, Cody Brownell, U.S. Naval Academy (USA) ........ [11382-3]

**Water pipe valve detection by using deep neural networks**, Rakiba Rayhana, Yutong Jiao, Zheng Liu, The Univ. of British Columbia Okanagan (Canada); Angie Wu, Xiangjie Kong, Pure Technologies Ltd. (Canada) ........ [11382-4]

Lunch Break ... Mon 11:50 am to 1:20 pm
Three-dimensional point cloud reconstruction of fish swimming, Mert Karakaya, Chen Feng, Maurizio Porfiri, Akira Saito, Izumi Atrouli, Kazuma Yamashita, Yuji Kuwahara, Osaka Univ. (Japan) and RIKEN SPring-8 Ctr. (Japan); Manlio Tesauro, Univ. degli Studi della Basilicata (Italy); Antonio Scaglione, Univ. degli Studi di Salerno (Italy); Paolo De Simone, Istituto Infortuni sul Lavoro (Italy). . . . . . . . . [11374-8]

Cephalopod-inspired adaptive multispectral camouflage from a stretchable polymeric conductor, Chengyi Xu, Alain Boldini, NYU Tandon School of Engineering (USA) . . . . . . . . . . . . [11374-9]

Optimization of bioinspired broadband disordered mirrors, Vincenzo Fiumara, Univ. degli Studi della Basilicata (Italy); Francesco Chiadini, Roberta De Simone, Antonio Scaglione, Univ. degli Studi di Salerno (Italy); Manlio Tesauro, Univ. degli Studi della Basilicata (Italy) . . . . . . . . . . . . [11374-8]

SESSION 2
MON 1:20 PM TO 3:00 PM
Colors and Visualization
Session Chair: Akhlesh Lakhtakia, The Pennsylvania State Univ. (USA)
A cephalopod-inspired approach to color changing devices, Atrouli Chatterjee, Alain Gorodetsky, Univ. of California, Irvine (USA) . . . . . . . . . . . . [11374-4]

Simplification of 3D nanostructure design inspired by Morpho butterfly’s randomness, Akira Saito, Osaka Univ. (Japan) and RIKEN SPring-8 Ctr. (Japan); Kazuma Yamashita, Yuji Kuwahara, Osaka Univ. (Japan) . . . . . . . . . . . . [11374-5]

Three-dimensional point cloud reconstruction of fish swimming, Mert Karakaya, Chen Feng, Maurizio Porfiri, Akira Saito, Izumi Atrouli, Kazuma Yamashita, Yuji Kuwahara, Osaka Univ. (Japan) . . . . . . . . . . . . [11374-6]

SESSION 2
MON 1:20 PM TO 3:00 PM
EAP Robotics for Earth and Space
Session Chairs: Ray H. Baughman, The Univ. of Texas at Dallas (USA); Herbert R. Shea, Ecole Polytechnique Fédérale de Lausanne (Switzerland)
The challenge of controlling a small Mars exploration plane, Seiki Chiba, Chiba Institute of Science (Japan); Mikio Waki, Wits Inc. (Japan); Kojo Fujitsu, Tohoku Univ. (Japan); Koji Ono, Yoshhiro Takikawa, Ryu Hatano, Yoshhiro Taniyama, Aisin AW Co., Ltd. (Japan). . . . . . . . . . . . [11375-5]

Sticky space snakes: hyper-redundant DEAs robots with electro-adhesive joints, Mohammad F. Towhid, The Univ. of Texas at Dallas (USA); Christoph Keplinger, Univ. of Colorado Boulder (USA) . . . . . . . . . . . . [11375-7]

Bioinspired HASSEL actuators that enable high-speed, soft actuated feet, Joseph Ashby, Samuel Rosset, The Univ. of Auckland (New Zealand); Ernst-Friedrich Markus Henke, The Univ. of Auckland (New Zealand) and TU Dresden (Germany); lain A. Anderson, The Univ. of Auckland (New Zealand) . . . . . . . . . . . . [11375-6]

SESSION 2
MON 1:20 PM TO 3:00 PM
Energy Harvesting II: Piezo-based
Session Chairs: Yi-Chung Shu, National Taiwan Univ. (Taiwan); Liya Zhao, Univ. of Technology, Sydney (Australia)
A tapered beam piezoelectric energy harvester with extended tip mass and shunted to P-SSHI interface, Guobiao Hu, Lihua Tang, The Univ. of Auckland (New Zealand); Junrui Liang, ShanghaiTech Univ. (China); Raj Das, RMIT Univ. (Australia). . . . . . . . . . . . [11376-5]

Modeling of piezoelectric energy scavenging from tapered beam with 1 to 3 internal resonances, Francesco Danzi, James M. Gibert, Purdue Univ. (USA) . . . . . . . . . . . . [11376-6]

An integrated design approach of piezoelectric vibration energy harvesters, Yabin Liao, Penn State Behrend (USA); Huanyu Cheng, The Pennsylvania State Univ. (USA). . . . . . . . . . . . [11376-7]

Self-powered SECE-based piezoelectric energy harvesting for sensor node supply under shock excitation, Y. C. Lo, P. H. Huang, Yi-Chung Shu, National Taiwan Univ. (Taiwan). . . . . . . . . . . . [11376-8]

Design and performance of a piezoelectric-footstak energy harvester, Shivashankar P., Gopalakrishnan S., Indian Institute of Science, Bengaluru (India). . . . . . . . . . . . [11376-9]

SESSION 2
MON 1:20 PM TO 3:00 PM
It Started with DogEars but Didn’t Stop Until I Waterbombed: The Origami Session
Session Chairs: Mariantonieta Gutierrez Soto, Univ. of Kentucky (USA); Suyi Li, Clemson Univ. (USA)
An efficient design approach for generating the folding sequence of active origami by 4D printing, Bingcong Jian, Frederic Domoloy, Yichi Zhang, Samuel Gomes, Univ. de Technologie de Belfort-Montbéliard (France). . . . . . . . . . . . [11377-5]

Dynamic morphing of a bi-stable water-bomb base origami using an active control strategy, Sahand Sadeghi, Suyi Li, Clemson Univ. (USA) . . . . . . . . . . . . [11377-6]

Nonlinear kirigami based oscillators, Joshua Jenkins, Hongchong Tao, Francesco Danzi, James Gibert, Purdue Univ. (USA) . . . . . . . . . . . . [11377-7]

Aerodynamic mitigation of origami-inspired building structures subjected to hurricane wind loads, Christopher Wheately, Mariantonieta Gutierrez Soto, Morgan Baumann, Univ. of Kentucky (USA). . . . . . . . . . . . [11377-8]

Active origami-inspired arrays for acoustic wave guiding, Ningxiner Zhao, Ryan L. Harne, The Ohio State Univ. (USA) . . . . . . . . . . . . [11377-9]

SESSION 2
MON 1:20 PM TO 3:00 PM
Wearable Technology
Session Chair: Il-Kwon Oh, KAIST (Korea, Republic of)

Obstacle avoidance for the visually impaired: a piezoelectric-based advanced wearable in “belt” form (Invited Paper), Alain Boldini, NYU Tandon School of Engineering (USA); JohnRoss Rizzo, NYU Langone Health (USA); Maurizio Portini, NYU Tandon School of Engineering (USA) . . . . . . . . . . . . [11378-5]

Human motion and physiological monitoring using smart kinesiology tape, Yun-An Lin, Long Wang, Kenneth J. Loh, Univ. of California, San Diego (USA) . . . . . . . . . . . . . . . . . . . . . . [11378-6]

An EI-based two-electrode multi-frequency gesture recognition system, Ma Gang, HaoFeng Chen, Xiaojie Wang, Institute of Advanced Manufacturing Technology (China); Peng Wang, Chongqing Univ. of Posts and Telecommunications (China) . . . . . . . . . . . . [11378-7]

Personal protective equipment implemented with augmented reality for workers in contaminated area and emergency situations, Sergio Malinconico, Federica Paglietti, Sergio Bellagamba, Paolo De Simone, Istituto Nazionale per l’Assicurazione contro gli Infortuni sul Lavoro (Italy) . . . . . . . . . . . . [11378-8]

Industrially knittable CNT/cotton coaxial yarn for smart textiles, Md. Milon Hossain, Mostakim M. Lutna, Philip Bradford, North Carolina State Univ. (USA) . . . . . . . . . . . . [11378-9]
**CONFERENCE 11379**

**SESSION 2**
MON 1:20 PM TO 3:00 PM

**Novel Sensor and Sensing Technologies I**

Session Chairs: Jiong Tang, Univ. of Connecticut (USA); Kenneth J. Loh, Univ. of California, San Diego (USA)

- Dynamic benchmarking of a strain based shape sensing system. Isaac Di Napoli, Casey M. Harwood, The Univ. of Iowa (USA).

**CONFERENCE 11380**

**SESSION 2**
MON 1:20 PM TO 3:00 PM

**Microwave/RF/Radar NDE**

Session Chair: Dryver R. Huston, The Univ. of Vermont (USA)

- Quantification of surface cracks in concrete panels using 1.6GHz GPR. Sanjana Vinayaka, Tzuyang Yu, Univ. of Massachusetts Lowell (USA).  
- GPR inspection of toe drainage systems in levees: a case study. Bahman Moghadamie-Jafari, U.S. Army Corps of Engineers (USA); Tzuyang Yu, Univ. of Massachusetts Lowell (USA).  
- Non-destructive testing of the effects of hot compression on microwave dielectric properties of natural rubber. Zaiqi Awang, Univ. Teknologi MARA (Malaysia).  

**CONFERENCE 11381**

**SESSION 2**
MON 1:20 PM TO 3:00 PM

**Novel and Emerging Techniques for SHM I**

Session Chairs: Joseph Bar-Cohen, Jet Propulsion Lab. (USA); Tribikram Kundu, The Univ. of Arizona (USA)

- Selective actuation and sensing of antisymmetric Lamb wave modes using d15 piezoelectric transducers. Nathan P. Salowitz, Parry Carrison, Univ. of Wisconsin-Milwaukee (USA); Hussain A. Altammar, Univ. of Jamestown (USA).  

**CONFERENCE 11382**

**SESSION 2**
MON 1:20 PM TO 3:00 PM

**Characterization of Materials for Energy Systems**

Session Chair: Kerrie Gath, Ford Motor Co. (USA)

- Design of passive acoustic hyperbolic-shaped filter for nonlinear air-coupled inspection method optimization. Marco Boccaccio, Gian Piero Mairesse Fierro, Michele Meo, Univ. of Bath (United Kingdom); Gary Bolton, National Nuclear Lab. (United Kingdom).  
- Thermographic non-destructive evaluation of impacted CFRP laminates interleaved with nanofibers. Hai Zhang, Laval Univ. (Canada); Stefano Sanna, Univ. degli Studi dell’Aquila (Italy); Fabrizio Sarasini, Sapienza Univ. di Roma (Italy); Nicolas P. Avdelidis, Laval Univ. (Canada); Clemente Ibarra-Castanedo, Xavier Maldague, Laval. Univ. Laval (Canada).  
- Initial results of post-irradiation piezoresponse force microscopy characterization of piezoelectric materials. Pradeep Ramuhalli, Oak Ridge National Lab. (USA); Shawn Reichers, Andrew Casella, Pacific Northwest National Lab. (USA); Joshua Dau, Idaho National Lab. (USA).
MONDAY 27 APRIL

CONFERENCE 11374

SESSION 3
MON 3:30 PM TO 5:50 PM
Bioinspired Solutions and Design

Session Chair: Raúl J. Martín-Palma, Univ. Autónoma de Madrid (Spain)

The ultimate bio-inspiration - how to build a self-replicating machine to colonise the Moon, Alex Ellery, Carleton Univ. (Canada).

A coupled CFD and multi-body analysis of the hydrodynamics of batoid fish locomotion, Simone Cinqueeman, Giovanni Bianchi, Ferruccio Rezzolla, Politecnico di Milano (Italy).

Biologically-inspired and interactive robotic predators to combat invasive mosquitoes, Giovanni Polverino, The Univ. of Western Australia (Australia); Mert Karakaya, Chiara Spinello, Vishrin R. Soman, Maurizio Portiri, NYU Tandon School of Engineering (USA).

Complex bioinspired solutions on the climate, Carolyn M. Dry, Natural Process Design, Inc. (USA).

Biologically inspired design for environment, Torben A. Lenau, University of Natural Resources and Life Sciences, Vienna (Austria); Akhilesh Lakhakia, The Pennsylvania State Univ. (USA) and Technical Univ. of Denmark (Denmark).

Phase-transformation of tensegric structures for bio-inspired stiffness variation and morphing, Arata Masuda, Soshi Shibutani, Yuto Hamakita, Kyoto Institute of Technology (Japan).

A flexible spiny structure featuring two anchoring points for enhancing the mobility of wall-climbing robots on rough surfaces, Chao Xie, Institute of Advanced Manufacturing Technology (China); Xuan Wu, Xiaojie Wang, Institute of Advanced Manufacturing Technology (China).

4:30 PM TO 5:45 PM
EAP-in Action Design and Demonstration Session

Moderator: Joseph Bar-Cohen, Jet Propulsion Lab. (USA)

This session highlights some of the latest capabilities and applications of Electroactive Polymers (EAP) materials where the attendees are shown demonstrations of these materials in action. Also, the attendees interact directly with technology developers and given "hands-on" experience with this emerging technology. The first Human/ EAP Robot Armwrestling Contest was held during this session of the 2005 EAPAD conference.

See the full program and descriptions of EAP presentations on page 13–14.

CONFERENCE 11375

SESSION 3
MON 3:30 PM TO 5:50 PM
Modeling, Optimization, and Design of Integrated Systems

Session Chairs: Shima Shahab, Virginia Polytechnic Institute and State Univ. (USA); JinHyeong Yoo, Naval Surface Warfare Ctr. Carderock Div. (USA)

Torsional loading analysis using cross-shaped piezoelectric sensor, Hojoon Kim, Korea Institute of Science and Technology (Korea, Republic of); Myoatseng Lim, Korea Univ. (Korea, Republic of); Youngsu Cha, Korea Institute of Science and Technology (Korea, Republic of).

Optimal shape, flexibility, and actuation pattern of a bio-inspired ray-stiffened tail fin for piezoelectric swimmer platform, Oluwafemi Ojo, Florida State Univ. (USA); Yu-Cheng Wang, Alper Erturk, Georgia Institute of Technology (USA); Kourosh Shoale, Florida State Univ. (USA).

Design and experimental verification of a planar two-dimensional piezoelectric actuator, Yung-Ting Kao, Yu-Hsiang Hsu, Chih-Kung Lee, National Taiwan Univ. (Taiwan).

Experimental study on dynamic load line for magnetostrictive actuator, JinHyeong Yoo, Nicholas J. Jones, Naval State Warfare Ctr. Carderock Div. (USA).

Modeling of an annular piezoelectric mist maker transducer for prediction of ultrasonic drying characteristics, Eric Dupuis, Shima Shahab, Virginia Polytechnic Institute and State Univ. (USA); Viral K. Patel, Ayyoub M. Momen, Oak Ridge National Lab. (USA).

Design optimization of a novel beam-shape MRE-based adaptive tuned vibration absorber, Armin Rasooli, Masoud Hemmatian, Ramin Sedaghati, Concordia Univ. (Canada).

Modeling the behavior of magnetostrictive elastomers under different loading conditions, Siddaiah Yarra, San Francisco State Univ. (USA).

CONFERENCE 11376

SESSION 3
MON 3:30 PM TO 6:10 PM
Multifunctional Material Matters

Session Chairs: Marriantonieta Gutierrez Soto, Univ. of Kentucky (USA); Ryan L. Harne, The Ohio State Univ. (USA)

Modeling, experimental characterization, and uncertainty quantification of auxetic foams: anisotropic and fractional viscoelastic mechanics, Eugenia Stanisaulis, Florida State Univ. (USA); Somayeh Mashayekhi, Kennesaw State Univ. (USA); Paul Miles, Sandia National Labs. (USA); William S. Oates, Florida State Univ. (USA).

Characterization of structural and functional properties of phase change materials and its application for thermal management in vehicle electrification, Vishnu Baba Sundaresan, Prasant Vijayaraghavan, The Ohio State Univ. (USA).

Tailoring the ferroelectric properties of ZrO2 ultrathin films by interfacial engineering, Sheng-Han Yi, Min-Jang Chen, Jay Shieh, National Taiwan Univ. (Taiwan).

Efficient numerical modeling of field-activated electro-active polymers and structures, Alexander Humer, Astrid Pechstein, Johannes Kepler Univ. Linz (Austria); Michael Krommer, Elisabeth Hansy-Staudigl, Technische Univ. Wien (Austria).

Strain amplifying mechanical metamaterials for multifunctional muon-luminescent-optoelectronic composites, George Hoover, Andrew Chua, John T. Heikenfeld, The Ohio State Univ. (USA); Ronald Harne, The Ohio State Univ. (USA).

Soft, topologically non-trivial metamaterials for non-reciprocal mechanical behavior, Maya Pishvar, Ohio State Univ. (USA); Ryan L. Harne, The Ohio State Univ. (USA).

Giant magnetocaloric effect of nanostructured Heusler alloys prepared by advanced manufacturing methods, Prina Arti-Gur, Western Michigan Univ. (USA); Ronald Nobe, NASA Glenn Research Ctr. (USA); Pranav Bhole, Western Michigan Univ. (USA).

Large-area flexible and conductive composite films through self-assembly of carbon nanofibers in thermoplastic elastomers for ice-traction and strain sensing, Navid Namdari, Hossein Sojoudi, The Univ. of Toledo (USA); Reza Rizvi, York Univ. (Canada).

CONFERENCE 11377

SESSION 3
MON 3:30 PM TO 5:30 PM
Nanomaterials and Applications I

Session Chair: Maurizio Porfiri, NYU Tandon School of Engineering (USA)

Design and test of continuous fabrication process for high-strength nanocellulose based long-fiber composites, Armin Panyam, Hyun Chan Kim, Poosja S. Panicker, Lindong Zhao, Qin Yu Zhu, Jaehwan Kim, Inha Univ. (Korea, Republic of).

Electrospinning of cellulose nanofiber and polyvinyl alcohol blend and its energy harvesting, Eun Sik Choi, Hyun Chan Kim, Jung Woong Kim, Inha Univ. (Korea, Republic of); Ramzi F. K.C. Park, Univ. of Colorado Boulder (USA); Jaehwan Kim, Inha Univ. (Korea, Republic of).

Effects of acid treatments on physical properties of carbon nanotube (CNT) wires for wiring applications, Ramazan O. Asmatulla, Pranav Bhale, Western Michigan Univ. (USA); Ahmed O. Ijala, Wichita State Univ. (USA); HEATH Misak, Spirit AeroSystems (USA).

Facile fabrication of nano-featured superhydrophobic surfaces by damage induced surface texturing of nano-composites, Navid Namdari, The Univ. of Toledo (USA); Ravi Sadanala, Univ. of Toledo (USA); Hossein Sojoudi, The Univ. of Toledo (USA); Reza Rizvi, York Univ. (Canada).

Gamma irradiation effect studies on monolayer CVD grown graphene on metallic substrates (Invited Paper), Ashok Srivastava, Chintan Chavda, Louisiana State Univ. (USA); Sangram K. Pradhan, Messaoud Bahoura, Norfolk State Univ. (USA).

Microwave characterization of graphene using improved calorimetry method and comparison with other conventional MMIC metalizations, Zaikai Awang, Univ. Teknologi MARA (Malaysia).
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PLENARY SESSION · TUE 8:00 AM TO 10:00 AM

Session Chairs: Zoubida Ounaies, The Pennsylvania State Univ. (USA) and Hoon Sohn, KAIST (Korea, Republic of)

8:20 to 8:30 AM · SPIE Fellow Recognition
8:30 to 9:15 AM · Plenary Presentation
Aerospace materials 2030: challenges and opportunities
Richard A. Vaia
Air Force Research Lab. (USA)

9:15 to 10:00 AM · Plenary Presentation
3D concrete printing: past, present, and future
Richard Buswell
Loughborough Univ. (United Kingdom)
Aimy Wissa, Univ. of Illinois (USA); Javaan S. Chahl, Univ. of South Australia (Australia) .......... [11374-22]

Yiting Tao, Titilayo Ogunwa, Univ. of South Australia, Valeria Sarco-Cortes, inspired wings requirements of deployable fin-configuration, Yiting Tao, Titilayo Ogunwa, Univ. of South Australia (Australia) .......... [11374-20]

Self calibrating polarization compass based on insect ommatidial mechanism, Jae-Hung Han, KAIST (Korea, Republic of) ................. [11374-19]

On the wings of fish: power requirements of deployable fin-inspired wings, Valeria Sarco-Cortes, Amy Wissa, Univ. of Illinois (USA) .......... [11374-20]

Bioinspired inertial empannages, Titilayo Ogunwa, Univ. of South Australia (Australia); Ermira J. Abdullah, Univ. Putra Malaysia (Malaysia); Yiting Tao, Jayaan S. Chahl, Univ. of South Australia (Australia) .......... [11374-24]

The bio-inspired design of the nano-hexagonal helical rolling actuator with its applications for the soft devices, Jungho Choi, Hyun Min Park, Kyung-Hun Lee, Inha Univ. (Korea, Republic of) .......... [11374-18]

Vladimir V. Kudin, Alexander R. Zbabov, Mikhail Yu. Kravchenko, Vologda State University (Russia) .......... [11375-20]

Determination of the dielectric constant of a 3D-printed Ni-base superalloy, Andrew Liu, Ching Wei, The Ohio State Univ. (USA) .......... [11375-22]

Hydrogel actuator for diving/surfacing device, Junggi Choi, Ho Cheol Gwac, Seo Jeong Kim, Hanyang Univ. (Korea, Republic of) .......... [11375-18]

Lambda-temperature sensor for high precision industrial applications, S. J. Yoon, H. H. Yang, W. C. Kim, Hanyang Univ. (Korea, Republic of) .......... [11375-22]

Hydrogel actuator for diving/surfacing device, Junggi Choi, Ho Cheol Gwac, Seo Jeong Kim, Hanyang Univ. (Korea, Republic of) .......... [11374-24]
CONFERENCE 11379
SESSION 5
TUE 1:20 PM TO 3:00 PM
Novel Sensors and Sensing Technologies II
Session Chairs: Austin R. J. Downey Jr., Univ. of South Carolina (USA); Ying Huang, North Dakota State Univ. (USA)
Automated drone-based vibration monitoring and assessment of structures, Nikolaos Vitzilaios, Sabrina Carroll, Joud Satme, Shadhan Alkarusii, Dimitris Rizos, Austin R. J. Downey, Univ. of South Carolina (USA) ............. [11379-19]
Evaluation of an infrared laser Doppler vibrometer placed on a moving platform for non-contact rail measurements, Korkut Kaynar, David Bridgelall, Leonard Chia, Ying Huang, Liuqing Hu, Rajendran Pasumarthi, Andrew L. Gyekenyesi, Ohio Aerospace Institute (USA) ............. [11379-20]
Moving sensors in structural dynamics, Maria Chiarietti, Jacek Krawczyszyn, Jacek Jedrzejewski, Mohammad Royvaran, National Central Univ. (Taiwan), Zhaoyun Ma, Yuling Ma, National Central Univ. (Taiwan); Steven A. Cummer, Tony Jun Huang, Duke Univ. (USA) ............. [11380-19]
Evaluating the ride quality of unpaved roads using smartphones, Xinyi Yang, Andrew L. Gyekenyesi, Ohio Aerospace Institute (USA); Michael A. Demetriou, Worcester Polytechnic Institute (USA). ............. [11379-21]
Evaluating the ride quality of unpaved roads using smartphones, Xinyi Yang, Andrew L. Gyekenyesi, Ohio Aerospace Institute (USA); Michael A. Demetriou, Worcester Polytechnic Institute (USA). ............. [11379-21]
CONFERENCE 11380
SESSION 5
TUE 1:20 PM TO 3:00 PM
Automotive and Aerospace Structures
Session Chair: Andrew L. Gyekenyesi, Ohio Aerospace Institute (USA)
Imaging multiple subwavelength defects beyond the diffraction limit through wavefield analysis, Zhenhua Tian, Mississippi State Univ. (USA); Lingyu Yu, Univ. of South Carolina (USA). ............. [11380-20]
Elastodynamic-reciprocity-based analysis of guided wave motion due to finite-length through-thickness tensile and shear cracks in plates, Brennan Dubuc, Stylianos Livadiotis, Arvin Ebrahimi Koch, Salvatore Salamone, The Univ. of Texas at Austin (USA). ............. [11380-21]
Simulating bird strikes using smoothed particle hydrodynamics for improved aircraft safety, Ian Holmes, Daniel Whaler, California State Univ., Long Beach (USA). ............. [11380-20]
Sub-surface acoustic imaging under crystalline samples using shear-force microscopy, Vishnu Baba Sundareshan, Vijay Venkatesh, The Ohio State Univ. (USA); Shailesh Joshi, Toyota Motor North America, Inc. (USA) ..................... [11380-23]
Structural damage assessment of MAV flapping wings using DIC-wavelet technique, Vivek Khare, Indian Institute of Technology Kanpur (India); David Kumar, Chih-Hung Chang, Chao Yang, Univ. of Technology (Taiwan). ............. [11380-22]
CONFERENCE 11381
SESSION 5A
TUE 1:20 PM TO 3:00 PM
Guided Waves for SHM of Composites
Session Chairs: Victor Giurgiutiu, Univ. of South Carolina (USA); Fabrizio Ricci, Univ. degli Studi di Napoli Federico II (Italy)
Elastodynamic-reciprocity-based analysis of guided wave motion due to finite-length through-thickness tensile and shear cracks in plates, Brennan Dubuc, Stylianos Livadiotis, Arvin Ebrahimi Koch, Salvatore Salamone, The Univ. of Texas at Austin (USA). ............. [11380-21]
Simulating bird strikes using smoothed particle hydrodynamics for improved aircraft safety, Ian Holmes, Daniel Whaler, California State Univ., Long Beach (USA). ............. [11380-20]
CONFERENCE 11382
SESSION 5B
TUE 1:20 PM TO 3:00 PM
Elastic and Acoustic Metamaterials II
Session Chairs: Guoliang Huang, Univ. of Missouri (USA); Jinkyu Yang, Univ. of Washington (USA)
Elastic and Acoustic Metamaterials II
Session Chairs: Guoliang Huang, Univ. of Missouri (USA); Jinkyu Yang, Univ. of Washington (USA) ..................... [11381-35]
Mitigation of impact applied to payload via origami-based mechanical metamaterials, James O’Neill, Yasuhiro Miyazawa, Jinkyu Yang, Univ. of Washington (USA) ..................... [11381-36]
Slowing down edge modes in valley phononic crystals, Zhenhua Tian, Michigan State Univ. (USA); Chen Shen, Junfei Li, Hunter Bachman, Joshua Socolar, Steven A. Cummer, Tony Jun Huang, Duke Univ. (USA) ..................... [11381-37]
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CONFERENCE 11374

TUESDAY 28 APRIL

SESSION 6
TUE 3:30 PM TO 5:50 PM
Materials II

Session Chair: Cordt Zollfrank, Technische Univ. München (Germany)

(USA) ........................................... [11374-25]

Impact characterization of spiral composites with variable pitch helicoidal layup, Mark Portus, Francesco Rizzo, Fulvio Pinto, Michele Meo, Univ. of Bath (United Kingdom) .................. [11374-26]

Making smart materials smarter, Bingcong Jian, Germain Sossou, Fredéric Domoly, Yicha Zhang, Samual Gomes, Univ. de Technologie de Belfort-Montbéliard (France) .................. [11374-27]

Supramolecular processing of proteins for hierarchical biomaterialization and advanced biomaterial design (Invited Paper), Aivalor Mata, The Univ. of Nottingham (United Kingdom) .................. [11374-28]

Mimicking chitin and chitosan type of functionality with novel thin films grown by molecular layer deposition, Karina Ashurbekova, CIC nanoGUNE (Spain) .......................... [11374-29]


Efficient fog harvesting through electrospun superhydrophobic polyacrylonitrile nanocomposite fiber mats, Md. Nizam Uddin, Ramazan Asmatulu, Wichita State Univ. (USA) ........................................... [11374-31]

Conference End.
Seismic energy dissipation of periodic assembly tensegrity system, Hongyu Li, Yue Wu, Gullin Univ. of Technology (China); Lu Zhang, Gullin Univ. of Technology (China) and Univ. of Illinois at Chicago (USA); Didem Ozevin, Univ. of Illinois at Chicago (USA) ........................ [11379-24]

Magnetostrictive vibration power generator from vehicle-induced highway vibrations for battery free LPWA module with titanium wire sensor, Shota Kita, Toshiyuki Ueno, Saiki Fukuda, Kanazawa Univ. (Japan)[11379-25]

Towards high efficiency PVDF nanofiber based energy harvester: the influence of the contact and the coating, Guangshuai Han, Yan-Fang Su, Luna Lu, Purdue Univ. (USA) . . . [11379-26]

Maximum power point tracking of multi-layered piezoelectric heel charger with levered mechanism: towards load-independent efficiency improvement, Ru He, Hui Texas A&M Univ. (USA); Sebastian Marin-Quiros, Stanford Univ. (USA); Harsha Mohan, Ya S. Wang, Texas A&M Univ. (USA). . . . [11379-27]

Micro magnetostrictive vibrational power generator for battery-free wireless for machine tool, Toshiyuki Ueno, Kanazawa Univ. (Japan). [11379-28]

Seismic energy dissipation of periodic assembly tensegrity system, Hongyu Li, Yue Wu, Gullin Univ. of Technology (China); Lu Zhang, Gullin Univ. of Technology (China) and Univ. of Illinois at Chicago (USA); Didem Ozevin, Univ. of Illinois at Chicago (USA) ........................ [11379-24]

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Micro magnetostrictive vibrational power generator for battery-free wireless for machine tool, Toshiyuki Ueno, Kanazawa Univ. (Japan). [11379-28]

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Energy Harvesting Techniques

A concept for energy autonomous impact monitoring of mechanical structures, Lukas Grasböck, Manfred Nader, Gerhard Kaineder, Linz Ctr. of Mechatronics (Austria); Alexander Humer, Martin Schagerl, Johannes Kepler Univ, Linz (Austria); Malte Misoi, Hans Monner, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany); Sven Herold, Fraunhofer-Institut für Betriebsfestigkeit und Systemzuverlässigkeit LBF (Germany); Dirk Mayer, Fraunhofer-Institut für Integrierte Schaltungen IIS (Germany).

Extra-large magnetostriective vibrational power generator for bridge health monitoring, Renya Ariiso, Toshiyuki Ueno, Kanazawa Univ. (Japan).

A self-powered three-axis piezoelectric MEMS accelerometer for condition monitoring, Kuewen Gong, Wei-Hain Liao, The Chinese Univ. of Hong Kong (Hong Kong, China); Wen-Jong Wu, National Taiwan Univ. (Taiwan).

Smart Materials for NDE/SHM

Nanocomposite sensing skins for monitoring the integrity of a full-scale reinforced concrete wall, Long Wang, Gloria Faraone, Tara Hutchinson, Kenneth J. Loh, Univ. of California, San Diego (USA).


Electromechanical analysis of self-sensing CFRP and its application to real-time non-destructive evaluation, Hyung Doh Roh, Young-Bin Park, Ulsan National Institute of Science and Technology (Korea, Republic of).

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**Ionic Polymer Metal Composites**

Session Chairs: Tran-Minh Giao Nguyen, Univ. de Cergy-Pontoise (France); Kentaro Takagi, Nagoya Univ. (Japan)

- **Dielectric elastomer using CNT as an electrode**, Seiki Chiba, Chiba Institute of Science (Japan); Mikio Waki, Wits Inc. (Japan); Makoto Takeshita, Mitsuugu Uejima, Kohei Arakawa, Zeon Corp. (Japan).
- **Influence of the electrode on the actuation of thin-film DE stack-transducers**, Tim Krueger, Ozan Cabuk, Jürgen Maas, Technische Univ. Berlin (Germany).
- **Effect of humidity, temperature, and elastomer material on the lifetime of silicone-based dielectric elastomer actuators under a constant DC electric field**, Fabio Beco Albuquerque, Herbert R. Shea, Ecole Polytechnique Fédérale de Lausanne (Switzerland).
- **Bringing static surfaces into motion with electroactive polymer coatings**, Fabian Visschers, Technical Univ. Eindhoven (Netherlands); Hubert Gowezwski, G. Julius Vancio, Univ. of Twente (Netherlands); Dirk J. Broer, Danqing Liu, Technische Univ. Eindhoven (Netherlands).
- **Insight into the dielectric breakdown of elastomers**, Justina Vaicekauskaite, Liyuan Yu, Anne Ladegaard Skov, Technical Univ. of Denmark (Denmark).
- **Aerodynamic characteristics of a continuously twisting spanwise morphing trailing edge**, Pyae Su, Jose Mendoza, Duygu Thy My Nguyen, Eun Jung Chae, California State Univ., Long Beach (USA); Bernardino Galasso, Ctr. Italiano Ricerche Aerospaziali (Italy).

**Passive and Active Vibration Isolation Systems I**

Session Chairs: Dimitris A. Saravanos, Univ. of Patras (Greece); Gang Wang, The Univ. of Alabama in Huntsville (USA)

- **Characterization of blisk mistuning induced by bonded piezoelectric elements**, Andres M. Rodriguez, Jeffrey L. Kaufmann, Univ. of Central Florida (USA).
- **Nonlinear electro-thermo-mechanical vibrations of piezoelectric layered cylindrical shell conveying fluid**, Dan Wang, Chaojun Bai, Xian Jiaotong Univ. (China).
- **Hybrid passive-active modal networks for structural acoustic control**, Alan Luo, Kenneth A. Cunefare, Georgia Institute of Technology (USA); Boris Lossoouarn, Conservatoire National des Arts et Métiers (France).
- **An adaptive acoustic black hole for perfect flexural waves absorption**, Morvan Ouisse, David Renaud, Gaët Matten, Pauline Butaud, Emeline Seddaoulet-St, FEMTO-ST, Univ. Bourgogne Franche-Comté (France); Guillaume Raybaud, Adrien Pelat, François Gautier, Lab. d’Acoustique de l’Univ. Du Maine (France).
- **Semi-active nonlinear composite-piezoelectric beam-mass damper for enhanced energy dissipation**, Dimitris Saravanos, Konstantinos Georgopoulos-Bosinas, Nikolaos Chrysochooids, Univ. of Patras (Greece); Dimitris Varelis, Hellenic Air Force Academy (Greece); Grigorio-Christos Kardarakos, Univ. of Patras (Greece).
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Novel Piezoelectric Transducers
Session Chairs: Daewon Kim, Embry-Riddle Aeronautical Univ. (USA); Mohammad R. Jahanshahi, Purdue Univ. (USA)

Auxetic MEMS piezoelectric sensor, Saman Farhangdoust, Florida International Univ. (USA) .................................................. [11379-36]

Deep learning-based ultrasonic array imaging for small defect characterization, Homin Song, Argonne National Lab. (USA); Yongchao Yang, Michigan Technological Univ. (USA) ......... [11379-37]

Investigations on the behaviour of axially compressed advanced composite cylindrical shells with surface bonded PZT patches, Priyadarshini R. S., College of Engineering Trivandrum (India); S. M. Sivakumar, Indian Institute of Technology Madras (India). .................................................. [11379-38]

Strain sensing using flexible surface acoustic wave sensor, Rishikesh Srivasaraghavan Govindarajan, Daewon Kim, Eduardo A. Rojas-Nastrucci, Embry-Riddle Aeronautical Univ. (USA) .......................................................... [11379-39]

Self-powered oscillation of piezoelectric ultrasonic active sensors, Arata Masuda, Masaaki Inoue, Yosuke Fujiwara, Kyoto Institute of Technology (Japan). .................................................. [11379-40]

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Modal Analysis and Dynamic Methods for NDE/SHM
Session Chair: Alessandro Sabato, Univ. of Massachusetts Lowell (USA)

Real-time model updating algorithm for structures experiencing high-rate dynamic events, Seong Hyeon Hong, Austin R. J. Downey, Yi Wang, Univ. of South Carolina (USA); Jacob Dodson, Air Force Research Lab. (USA); Jonathan Hong, Applied Research Associates, Inc. (USA). .................................................. [11380-36]

In-situ damage monitoring of composites using nylon/Ag fiber sensor during low velocity dynamic impact, Yumna Qureshi, Ecole Nationale Supérieure de Techniques Avancées Bretagne (France); Mostapha Tarfaoui, Ecole Nationale Supérieure de Techniques Avancées Bretagne (France) and Univ. of Dayton (USA); Hamza Benyahia, Ecole Nationale Supérieure de Techniques Avancées Bretagne (France); Khalil K. Lafdi, Univ. of Dayton (USA); Khalid Lafdi, Univ. of Dayton (USA) and Northumbria Univ. (United Kingdom) .................................................. [11380-37]

Development of a diagnostic technique for civil structures based on the model updating of dynamic parameters, Francesco Ripamonti, Ferruccio Resta, Politecnico di Milano (Italy); Alberto Bussini, Matías Cortes-Camus, ISAC S.r.l. (Italy) .................................................. [11380-38]

Torsional vibration of a hollow shaft for fluid viscosity measurement, Haifeng Zhang, Chen Zhang, Ju Shuai, Parham Zahedinejad, Univ. of North Texas (USA) .................................................. [11380-39]

Alternate strain based modal analysis using piezo-sensors, Dattar Singh Aulakh, Suresh Bhalla, Indian Institute of Technology Delhi (India).................................................. [11380-40]

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Nonlinear Ultrasonic Techniques
Session Chairs: Zhongqing Su, The Hong Kong Polytechnic Univ. (Hong Kong, China); Yanfeng Shen, Shanghai Jiao Tong Univ. (China)

A nonlinear ultrasonic resonance technique based on spectral correlation for fatigue crack detection, Junzhen Wang, Yanfeng Shen, Shanghai Jiao Tong Univ. (China) .................................................. [11381-64]

Modally selective nonlinear ultrasonic waves for characterizing pitting damage in whipple shields of spacecraft, Wuxiong Cao, Kai Wang, Pengyu Zhou, Xiongbing Yang, The Hong Kong Polytechnic Univ. (Hong Kong, China); Baojun Pang, Harbin Institute of Technology (China); Paul Fromme, Univer College London (United Kingdom); Zhongqing Su, The Hong Kong Polytechnic Univ. (Hong Kong, China) .................................................. [11381-65]

Damage imaging and quantification in composite structures utilizing linear and nonlinear ultrasonics via scanning laser doppler vibrometry, Mingling Cen, Yanfeng Shen, Shanghai Jiao Tong Univ. (China) .................................................. [11381-66]

Evaluation of the intrinsic nonlinearity of rail steel using Rayleigh waves emitted and sensed by a fully non-contact experimental setup, Faez Masurkar, Peter Tse, City Univ. of Hong Kong (Hong Kong, China) .................................................. [11381-67]

Linear and non-linear ultrasonic techniques for the evaluation of stress-induced damage in concrete, Anna Castellano, Aguinaldo Fraddosio, Politecnico di Bari (Italy); Tribikram Kundu, The Univ. of Arizona (USA); Mario Daniele Piccioni, Politecnico di Bari (Italy) .................................................. [11381-68]

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Guided Waves for SHM III
Session Chairs: Wiesław M. Ostachowicz, The Szeszowski Institute of Fluid-Flow Machinery (Poland); Christopher Nieszrecki, Univ. of Massachusetts Lowell (USA)

The band structures of guided waves in periodically piezoelectric composite plate with a mirror plane, Rongyu Xia, Zheng Li, Peking Univ. (China) .................................................. [11381-69]

Non-local boundary control for plane wave steering in an acoustic waveguide, Emanuele De Bono, Manuel Collet, Ecole Centrale de Lyon (France); Gaël Mattein, Morvan Guisse, Univ. Bourgogne Franche-Comté (France); Sami Karkar, Ecole Centrale de Lyon (France) ......... [11381-70]

Complete conversion of Lamb modes into shear horizontal modes enabled by an elastic metamaterial surface, Yiran Tian, Yanfeng Shen, Shanghai Jiao Tong Univ. (China) .................................................. [11381-71]

Quantitative damage estimation method based on Lamb waves for transverse damage in composite laminates, Muhammad Saqib Hameed, Zheng Li, Peking Univ. (China) .................................................. [11381-72]

Full wavefield and point-wise methods for damage detection in stiffened CFRP panel, Tomasz Wadowski, Paweł H. Malinowski, Rohan N. Soman, The Szeszowski Institute of Fluid-Flow Machinery (Poland) .................................................. [11381-73]
Twisted Actuation  
Session Chairs: II-Kwon Oh, KAIST (Korea, Republic of); Marco Fontana, Univ. degli Studi di Trento (Italy)

On the fluctuation phenomenon of axial thermal stress of a torsional fishing-line artificial muscle (twisted polymer fiber) actuator, Hiroki Iwai, Kentaro Takagi, Chihaya Oiwa, Toshitomo Irisawa, Nagoya Univ. (Japan); Masatoshi Shiroya, Ken Masuya, Tokyo Institute of Technology (Japan); Kenji Tahara, Kyushu Univ. (Japan); Haruhiko Watanabe, Daichi Sakurai, DENTCO Corp. (Japan); Kinji Asaka, National Institute of Advanced Industrial Science and Technology (Japan). ...........................................[11375-45]

Experimental investigation and modeling of the lonely stroke behavior in supercoiled polymer artificial muscles, Revanth Konda, Jun Zhang, Univ. of Nevada Reno (USA) ...........................................[11375-46]

A smart window: reversibly driven by shear-run artificial muscle and twisted and coiled polymer artificial muscle, Jianjun Wu, Yue Zhang, Xuemin Wang, Georgia Southern Univ. (USA). ...........................................[11375-47]

Variable-stiffness artificial muscles using twisted rubber, Tim Helps, Majid Taghavi, Sihan Wang, Jonathan M. Rossiter, Univ. of Bristol (United Kingdom). ...........................................[11375-48]

Optimized Actuation, Compliance, Instability, and Switching  
Session Chairs: Kwang Jin Kim, Univ. of Nevada, Las Vegas (USA); Tran-Minh Giao Nguyen, Univ. de Cergy-Pontoise (France)

Design and experimental evaluation of a large stroke LC and c-based, dielectric elastomer actuator, Giacomo Moretti, Lorenzo Agostini, Scuola Superiore Sant’Anna (Italy); Rocco Vertechy, Univ. degli Studi di Bologna (Italy); Giovanni Berselli, Univ. degli Studi di Genova (Italy); Marco Fontana, Univ. degli Studi di Trento (Italy) ...........................................[11375-49]

Optimization of prestretch and strain of DEA-based cell stretcher, Sahar Jayatissa, Iain A. Anderson, Vickie Shim, Samuel Rosset, The Univ. of Auckland (New Zealand) ...........................................[11375-50]

An analytical model and its validation for the design of multistable dielectric elastomer actuators with high-blocking forces, Bekir Aksoy, Herbert R. Shea, Ecole Polytechnique Fédérale de Lausanne (Switzerland) ...........................................[11375-51]

Switching of amorphous silicon thin-film actuators for optically functional robotic devices, Calum Gillespie, Univ. of Bristol (United Kingdom); Asier Marzo, Univ. Pública de Navarra (Spain); Fabrizio Scarpa, Jonathan M. Rossiter, Andrew T. Conn, Univ. of Bristol (United Kingdom) ...........................................[11375-52]

The firm touch: towards dielectric elastomer switches enabling tactile senses for soft robotic grippers, Dawen Zhang, Mathias Bueck, Philipp-Jann Meinzer, TU Dresden (Germany); Katherine E. Wilson, The Univ. of Auckland (New Zealand); Delwin Tanto, PowerOn Ltd. (New Zealand); Iain A. Anderson, The Univ. of Auckland (New Zealand) and PowerOn Ltd. (New Zealand); Samuel Rosset, The Univ. of Auckland (New Zealand); Andreas Richter, Ernst-Friedrich Markus Henke, TU Dresden (Germany) ...........................................[11375-53]

Artificial proprioception: actuators driven by reactions involving molecular machines transducing thermal, chemical, and electrical working conditions, Toribio F. Otero, Univ. Politecnica de Cartagena (Spain) ...........................................[11375-58]

Dynamic output performance characterization of conical dielectric elastomer actuators, Chongjing Cao, Zhe Gu, Xing Gang Xu, Institute of Advanced Technology (China) ...........................................[11375-55]
**Good Materials Stick Together: A Session for Sticky and Magnetic Materials**

**Session Chairs:** John P. Domann, Virginia Polytechnic Institute and State Univ. (USA); Constantin Cioceanu, Northern Arizona Univ. (USA).

A new test device for valve-mode electrorheological fluids, An-Ding Zhu, Guan-Nan He, Guo-Dong Bai, Xian-Xu Bai, Hefei Univ. of Technology (China). [11377-48]

Effect of composite design parameters on the inverse magnetostrictive characteristics of hybrid carbon fiber reinforced plastic embedded with Fe-Co fibers, Kenichi Katabira, Hiroki Kurita, Fumio Narita, Tohoku Univ. (Japan). [11377-42]

An empirical model of magnetostrictive material performance informed by magnetoelastic coupling, Jinjie Liu, Delaware State Univ. (USA); Jin-Yeong Yoo, Nicholas J. Jones, Naval Surface Warfare Ctr. Carderock Div. (USA). [11377-44]

Effects of additional elements (Cr, Mo) and heat treatment on the magnetostrictive, magnetic, and mechanical properties of Co-rich Fe-Co alloys, Kenya Nakajima, Fumio Narita, Tohoku Univ. (Japan). [11377-45]

Rigorous analysis of magnetostrictive constitutive models, Alexander N. Imhof, John P. Domann, Virginia Polytechnic Institute and State Univ. (USA). [11377-46]

Magnetico-friction induced damping for vibration mitigation, Gaël Chevallier, Svenja Herrmann, Pauline Butaud, Institut Franche-Comté Electromagnétique et Optique (France). [11377-47]

The effect of the evolution of magnetic domains on twin boundary motion in Ni2MnGa magnetic shape memory alloys with coarse and fine twin structure, Glen J. D’Silva, Heidi P. Felgenhauer, Constantin Cioceanu, Northern Arizona Univ. (USA). [11377-48]
**Conference attendees are invited to attend the joint poster session to network, enjoy light refreshments, and view the poster papers. Attendees are required to wear their conference registration badge. Authors of poster papers will be present to answer questions concerning their papers. Poster authors must set up their posters between 10:00 am and 4:00 pm on Wednesday, 29 April. View poster presentation guidelines.**

**POSTER SESSION**

Wednesday 29 April | 6:00 PM - 8:00 PM

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**CONFERENCE 11374**

Bioinspiration, Biomimetics, and Bioreplication X

Experimental verification of motion pattern generation for peristaltic mobile robot using numerical optimization method. Tsubasa Sugiyama, Norihiro Kamamichi, Tokyo Denki Univ. (Japan) ........................ [11374-32]

A bionic adhesive disc for underwater application inspired by the Guizhou Gastromyzontidae. Yosayao Zhang, Univ. of Science and Technology of China (China); Xuan Wu, Ling Gong, Guisong Chen, Xiaojie Wang, Institute of Advanced Manufacturing Technology (China) .......................... [11374-33]

Design of a biomimetic robot inspired by the manta ray. Simone Cinquemani, Giovanni Bianchi, Ferruccio Resta, Politecnico di Milano (Italy) ................ [11374-35]

Bio-inspired vibration isolator with quasi-zero-stiffness over large stroke. Gagan, Wen-Ling Zhang, Shanghai Jiao Tong Univ. (China) .......................... [11374-34]

Design of a soft pneumatic robot inspired by plant roots’ movement. Simone Cinquemani, Giovanni Bianchi, Ferruccio Resta, Politecnico di Milano (Italy) ................ [11374-36]

Infiltration of the wing scales of Morpho butterflies with metals. Rehab Ramadan, Univ. Autónoma de Madrid (Spain) and Minia Univ. (Egypt); Sébastien R. Mouchet, Univ. of Exeter (United Kingdom) and Univ. de Namur (Belgium); Vicente Torres-Costa, Raúl J. Martín-Palma, Univ. Autónoma de Madrid (Spain) ...................... [11374-37]

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**CONFERENCE 11375**

Electroactive Polymer Actuators and Devices (EAPAD) XXII

PVD-based electroactive polymers for flexible electronics. Damien Thuau, Isabelle Dufour, Cédric Aylea, Lab. d’Intégration du Matériau au Système (Fresnes, France, London 357-82)

Enhanced electromechanical properties of the electro-responsive poly (lactic acid) by adding multi-walled carbon nanotubes. Natittia Thanumaranun, Anuvat Sirivat, The Petroleum and Petrochemical College, Chulaongkorn Univ. (Thailand) [11375-83]

Enhanced performance of an integrated, flexible pyroelectric infrared detector system: modeling and simulation. Alakananda Bandyopadhyay, Ashok K. Barat, Mohan D. Aggarwal, George Taylor, Alabama A&M Univ. (USA) ................ [11375-84]

The study of shape memory ionic polymer-metal composite actuator. Lijun Zhao, Hongjun Kim, Univ. of Nevada, Las Vegas (USA) ........... [11375-85]

Electroactive polymer fabric stretch sensors embedded suit for tracking human motion completely (360 degree rotation). Nitin Kumar Singh, SQUATS Fitness Private Ltd. (India); Jatin Patel, SQUATS Fitness Private Limited (India) .................. [11375-86]

Modeling of electrostatic bellow transducers based on soft composite dielectric structures. Giacomo Moretti, Simone Cinquemani, Ferruccio Resta, Politecnico di Milano (Italy) ................ [11375-88]

Non-invasive, image-guided flexible electroactive polymer actuators for diagnosing Otitis Media. Saoni Banerji, Iman Dadras, Univ. of Tartu (Estonia); Jaan Raik, Tallinn Univ. of Technology (Estonia); Albo Aabloo, Univ. of Tartu (Estonia) .................. [11375-88]

Instability and thermodynamics of dielectric elastomers. Liwu Liu, Jiaying Leng, Harbin Institute of Technology (China) ................ [11375-89]

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Active and Passive Smart Structures and Integrated Systems IX

Theoretical and experimental study on a piezoelectric linear motor driven by multi-integer-frequency multi-mode method. Wen-Chun Sun, Yu-Hsiang Hsu, Chih-Kung Lee, National Taiwan Univ. (Taiwan) .......................... [11376-86]

Modelling of electret-base vibration energy harvester with DC circuit and the reverse current effect of diode. Lihsu Tang, The Univ. of Auckland (New Zealand) ................ [11376-87]

Experiment and analysis of magnetorelophological adaptive shock mitigation system. Long Yuan, Xiang Li, Ping Jiang, An-Ding Zhu, Xian-Xu Bai, Hefei Univ. of Technology (China) .......................... [11376-88]

The influence of origami geometry on its deployment dynamics. Yutong Xia, Narayanay Kidambi, Kon-Well Wang, Univ. of Michigan (USA) ................ [11376-89]

Artificial intelligence-designed smart mechanical micro-actuators. Pengcheng Jiao, Zhejiang Univ. (China); Amir H. Alavi, Univ. of Pittsburgh (USA) ................ [11376-90]

Ocean thermal energy harvesting using triboelectric effect. Dong-Hyun Lim, Dong-Gun Lee, Korea Polytechnic Univ. (Korea, Republic of) ................ [11376-91]

Metamaterial inspired tensaury beam for frequency band attenuation. Ansharat Singh, Indian Institute of Technology Kanpur (India); Arnab Banerjee, Indian Institute of Technology Delhi (India); Bishakh Bhattacharya, Indian Institute of Technology Kanpur (India) ................ [11376-95]

A parametric approach towards the band structure of piezo-embedded negative stiffness metamaterial for maximizing of attenuation band. Ankur Dwivedi, Indian Institute of Technology Kanpur (India); Arnab Banerjee, Indian Institute of Technology Delhi (India); Bishakh Bhattacharya, Indian Institute of Technology Kanpur (India) ................ [11376-95]

A new design of variable stiffness mechanism based on magneto-relophological elastomer. Xuan Phu Do, Vietnamese-German Univ. (Viet Nam) and Inha Univ. (Korea, Republic of); Byung-Hyuk Kang, Seung-Bok Choi, Inha Univ. (Korea, Republic of) ................ [11376-96]

A study on ferroelectric film-type speaker. Yu-Sheng Liao, Yu-Hsiang Hsu, Chih-Kung Lee, National Taiwan Univ. (Taiwan) ........................ [11376-97]

Solution of inverse kinematic problem for serial robot based on screw theory. Liangchuan Liao, Southeast Univ. (China) and Jiangsu Automation Research Institute (China); Weibin Chen, Jiangsu Automation Research Institute (China) and Southeast Univ. (China) .................. [11376-98]

Machine learning in design of optimization of MR actuators: a new view of solution. Bo-Gyu Kim, Inha Univ. (Korea, Republic of); Do Xuan Phu, Vietnamese-German Univ. (Viet Nam); Seung-Bok Choi, Inha Univ. (Korea, Republic of) ................ [11376-99]

Design and conception of a trailing edge morphing wing concept with bistable composite skin. Agnha Mukherjee, Shaikh F. Ali, Arunachalakasi Arockiarajan, Indian Institute of Technology Madras (India) ................ [11376-100]

Active vibration suppression in a flexible structure by using a nonlinear rotational actuator. Diego Armando Flores-Sanchez, Luis Gerardo Trujillo-Franco, Instituto Tecnologico de Pachuca, Tecnologico Nacional de Mexico (Mexico); Francisco Beltran-Carballo, Univ. Autónoma de Sinaloa (Mexico); Rafael Campos-Amezua, Hugo Francisco Abundis-Fong, Instituto Tecnologico de Pachuca, Tecnologico Nacional de Mexico (Mexico) ........ [11376-101]

A selective negative derivative feedback algorithm to improve stability for inertial actuators. Simone Cinquemani, Norihiro Kamamichi, Tokyo Denki Univ. (Japan); Laura Bacci, Politecnico di Milano (Italy) .................. [11376-102]

Self-powered implantable drug delivery system using human body heat energy and smart materials. Jung-Ho Jeon, Dong-Gun Lee, Korea Polytechnic Univ. (Korea, Republic of) .................. [11376-103]

Development of an active mass damper using non-linear oscillator network: case of oscillator network with 2-hub. Junichi Hongu, Tottori Univ. (Japan); Daisuke Iba, Kyoto Institute of Technology (Japan) .................. [11376-104]

New insight for the metastable state of adaptive bi-stable composite laminated panels in the high-temperature environments. Yan Zheng, Wei Zhang, Tuo Liu, Beijing Univ. of Technology (China) .................. [11376-105]

Double-parameters nonlinear dynamic behaviors of adaptive bi-stable composite laminate panels under combined external force and temperature. Tao Liu, Wei Zhang, Yan Zheng, Beijing Univ. of Technology (China) .................. [11376-106]

Dynamics of quasi-periodically stiffened elastic beams. Mohit Gupta, Massimo Ruzzene, Univ. of Colorado Boulder (USA) .................. [11376-107]

Design and manufacture of a variable-camber and variable-chord morphing flap using a wire-winding mechanism. Jae-Sung Bae, Hyun Chul Lee, Korea Aerospace Univ. (Korea, Republic of) .................. [11376-108]
A method to overcome wireless communication limits in decentralized active control applications. Simone Cinquemani, Nicola Debbattisti, Maria Laura Bacci, Politecnico di Milano (Italy) .............................................................. [11378–88]

Application of a virtual inerter in active vibration control using inertial actuators, Simone Cinquemani, Nicola Debbattisti, Maria Laura Bacci, Politecnico di Milano (Italy) .......................................................... [11378–89]

Effect of microchannel dimensions on sensing performance of EGAln-silicone strain sensors, Byungseok Yoo, Univ. of Maryland, College Park (USA); Darryll J. Pines, Univ. of Maryland, College Park (USA) ............................................................... [11378–90]

Improvement of sensing performance of EGAln-silicone sensors via a predeformation-mold method, Byungseok Yoo, David Bowen, Darryl J. Pines, Univ. of Maryland, College Park (USA) ............................................................... [11378–91]

Development of a P(VDF-TrFE) piezoelectric thread for small strain sensing, Lin Tain-Tz, Yu-Hsiang Hsu, National Taiwan Univ. (Taiwan). [11378–92]

Fabrication of a microstructured PDMs interferometric optical sensor on glass substrate for industrial applications, Victor Argueta-Diaz, Nathaniel D. Wilburn, Alma College (USA) ............................................................... [11378–93]

Static structural health monitoring and automated data analysis procedures applied to the diagnosis of a complex medieval masonry monastery, Nirvan Makoon, Luca Pela, Clément Molins, Pere Roca, Univ. Politécnica de Catalunya (Spain) ................................................................. [11378–94]

Corrosion-induced damage detection and conditional assessment for metallic civil structures using machine learning approaches, Zhibin Lin, Hong Pan, Zi Zhang, North Dakota State Univ. (USA); Fujian Tang, Dalian Univ. of Technology (China); Xingyu Wang, North Dakota State Univ. (USA) ................................................................. [11378–95]

**CONFERENCE 11380**

Nondestructive Characterization and Monitoring of Advanced Materials, Aerospace, Civil Infrastructure, and Transportation IX

Nondestructive evaluation and monitoring of vibration characteristics of equipment by MEMS sensors, Volodymyr V. Sklarov, National Scientific Ctr., Institute of Metrology (Ukraine) ................................................................. [11380–58]

Meteorological data prediction for service environments of bridge using interpolation method, Linren Zhou, Lan Chen, Yi Yue, South China Univ. of Technology (China) ................................................................. [11380–59]

**CONFERENCE 11381** Health Monitoring of Structural and Biological Systems IX

Research on construction site monitoring based on machine vision, Jiayuan Yin, Univ. of Technology (China); Guangyi Zhou, China Construction Eighth Engineering Division Corp., Ltd.; Chenfeng Zhao, Dalian Univ. of Technology (China) ................................................................. [11380–61]

Structural health monitoring of CFRP using piezoresistivity effect based novel structure monitoring method, Inyong Lee, Ulsan National Institute of Science and Technology (Korea, Republic of) ................................................................. [11380–62]

Composite bond quality nondestructive evaluation with fully non-contact air-coupled transducer-scanning laser Doppler vibrometer Lamb wave system, Wenfeng Xiao, Lingyu Yu, Univ. of South Carolina (USA) ................................................................. [11380–63]

Experiment research on smart metamaterial structures for heath monitoring, Xudong Guo, Jianguo Automation Research Institute (China); Liangchuan Liao, Jianguo Automation Research Institute (China) and Southeast Univ. (China) ................................................................. [11380–64]

Wave propagation analysis of ultrasonic probe for railway monitoring, Yixin Yao, Jiong Tang, Univ. of Connecticut (USA) ................................................................. [11380–65]

Acoustic emission evaluation of rolling element bearing fault diagnosis and prognosis, Brenna Feiring, Univ. of South Carolina (USA) ................................................................. [11380–66]

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Active cavitation imaging of phase-change nanodroplets versus microbubbles in a fixed jet, Jinwook Kim, Ryan M. Deruiiter, Paul A. Dayton, The Univ. of North Carolina at Chapel Hill (USA) ................................................................. [11381–116]

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Deep learning-based tunnel lining damage detection using convolutional neural networks, Xu Yan, Shengyuan Li, Chengcheng Liu, Xueleng Zhao, Dalian Univ. of Technology (China) ................................................................. [11381–117]

Damage detection and seismic performance evaluation of a multi-story structure, Sakat Bagchi, Timir Baran Roy, Avinrup Sarkar, Ashutosh Bagchi, Concordia Univ. (Canada); Saroj Kumar Panigrahi, Ajay Chourasia, Central Building Research Institute (India) ................................................................. [11381–118]

Optimal quantum valley Hall insulators by Berry curvature and band structure engineering, Zongliang Du, Hui Chen, Guoliang Huang, Univ. of Missouri (USA) ................................................................. [11381–119]

Development of a P(VDF-TrFE) piezoelectric thread for small strain sensing, Lin Tain-Tz, Yu-Hsiang Hsu, National Taiwan Univ. (Taiwan) ................................................................. [11381–120]

Study on anomalous elastic wave propagation in pentamode metamaterial with anisotropic mass density, Yi Jia, Bing Cai, Beijing Institute of Technology (China) ................................................................. [11381–121]

Machine-learning optimized method for regional control of sound field, Tianyu Zhao, Kai Zhang, Beijing Institute of Technology (China) ................................................................. [11381–122]

Improvement of mechanical properties and biocompatibility of hip implants through topology optimization utilizing finite element analysis, Behzad Farhang, Bharath B. Ravichander, Narges Shayesteh Moghaddam, The Univ. of Texas at Arlington (USA) ................................................................. [11381–123]

Conference attendees are invited to attend the joint poster session to network, enjoy light refreshments, and view the poster papers. Attendees are required to wear their conference registration badge. Authors of poster papers will be present to answer questions concerning their papers. Poster authors must set up their poster between 10:00 am and 4:00 pm on Wednesday, 29 April. View poster presentation guidelines.

POSTER SESSION

Wednesday 29 April | 6:00 PM - 8:00 PM
Research on smart clock synchronization method based on GPS for seismic data acquisition and recording system, Liangchuan Liao, Southeast Univ. (China); Jinshi Xu, Lianyungang Jari Automation Co., Ltd. (China). .......................... [11382-38]

Calculation of structural surface damage volume based on multi-view stereo reconstruction, Chengcheng Liu, Xuefeng Zhao, Dalian Univ. of Technology (China). .......................... [11382-39]

Evaluation and protection technology of steel strand corrosion in transmission line, Jun Ma, State Grid Tonghua Power Supply Co. (China); Bo Lu, Dalian Univ. of Technology (China); Yonggang Shi, Gang Dong, State Grid Tonghua Power Supply Co. (China); Xuefeng Zhao, Dalian Univ. of Technology (China). .......................... [11382-40]

Cutting-tools degradation assessment for structural-steel machining center, Min-Chun Pan, National Central Univ. (Taiwan). .......................... [11382-41]

Acoustic emission monitoring of the fracture behavior of mortar specimens fabricated using recycled concrete aggregates, Anastasios C. Mpalaskas, Theodore E. Matikas, Univ. of Ioannina (Greece). .......................... [11382-42]

Correlation between acoustic emission parameters and fracture behavior of repaired marble specimens, Anastasios C. Mpalaskas, Univ. of Ioannina (Greece); Dimitrios G. Aggelis, Vrije Univ. Brussel (Belgium); Theodore E. Matikas, Univ. of Ioannina (Greece). .......................... [11382-43]

Monitoring a model cable-stay bridge structure by acoustic emission and laser Doppler vibrometry, Theodoti Z. Kordatou, Anastasios Balaskas, Ilias Tragzikis, Theodore E. Matikas, Univ. of Ioannina (Greece). .......................... [11382-44]

Ultrasonic monitoring of modified recycled fine concrete aggregates for mortar production, Theodoti Z. Kordatou, Anastasios Balaskas, Theodore E. Matikas, Univ. of Ioannina (Greece). .......................... [11382-45]
CONFERENCES

**CONFERENCES**

**CONFERENCE 11379**  
Sensors and Smart Structures  
Technologies for Civil, Mechanical, and Aerospace Systems

**SESSION 10**  
THU 8:00 AM TO 10:00 AM

**Optical Fiber Sensors**

**Session Chairs:**  
Kara J. Peters, North Carolina State Univ. (USA); Rosalind M. Wynne, Villanova Univ. (USA)

- Preparation and localization accuracy of shape sensor with fine diameter for puncture operation, Xiangyan Chen, Jinwu Qian, Yanan Zhang, Linyong Shen, Shanghai Univ. (China)  
- Imaging 3T3 cells in photonic crystal fibers, Rosalind M. Wynne, Villanova Univ. (USA)
- Modeling of ultrasound generation by a polymer composite based fiber-optic photoacoustic transducer, Oleg Shiriyaye, Univ. of Alaska Anchorage (USA); Nader Vahdati, Khalifa Univ. of Science, Technology and Research (United Arab Emirates)
- Optimization of sensor placement for guided waves based SHM using fiber Bragg grating sensors, Rohan N. Soman, The Szewalski Institute of Fluid-Flow Machinery (Poland); Junghyun Lee, Cara Peters, North Carolina State Univ. (USA); Wieslaw Ostachowicz, The Szewalski Institute of Fluid-Flow Machinery (Poland)
- Self-referencing ultrasound detection of fiber Bragg grating sensor remotely bonded at two locations, Junghyun Lee, Kevin Alexander, Cara Peters, North Carolina State Univ. (USA)
- Applications of distributed fiber optic sensing for monitoring civil infrastructure, Nicholas de Battista, Cedric Kechavarzi, Univ. of Cambridge (United Kingdom) and Epsimon Ltd. (United Kingdom)

**CONFERENCE 11380**  
Nondestructive Characterization and Monitoring of Advanced Materials, Aerospace, Civil Infrastructure, and Transportation IX

**SESSION 10**  
THU 8:00 AM TO 10:00 AM

**Panel Discussion**

8:40 AM TO 10:00 AM

**Panel Discussion: Critical Problems in NDE/SHM**

Confirmed panelists: Branko Gilsco, Princeton Univ. (USA); Chih-Hung Chiang, Chaoyang Univ. of Technology (Taiwan)

**CONFERENCE 11381**  
Health Monitoring of Structural and Biological Systems IX

**SESSION 10**  
THU 8:00 AM TO 10:00 AM

**Novel and Emerging Techniques for SHM II**

**Session Chairs:** Christoph Schaal, California State Univ., Northridge (USA); Wieslaw M. Ostachowicz, The Szewalski Institute of Fluid-Flow Machinery (Poland)

- Deflection sensing for structural health monitoring, Alex Tongue, Sensuron, LLC (USA)
- Fiber Bragg grating sensor application for composite fast patrol boat, Magdalena Mieloszyk, Katarzyna Majewska, The Szewalski Institute of Fluid-Flow Machinery (Poland); Bartose Puchowski, CreeYacht (Poland)
- FBG sensors application for fibre reinforced polymer structures under influence of simultaneous temperature and humidity action, Katarzyna Majewska, Magdalena Mieloszyk, Wieslaw Ostachowicz, The Szewalski Institute of Fluid-Flow Machinery (Poland)
- Roll threader manufacturing process control for miniature fasteners, Henrique L. Reis, Univ. of Illinois (USA)
- Piezoelectric energy harvesting induced by radial direction of rotating magnetic plucking with random noise effect, Y. W. Liao, S. W. Chen, Yi-Chung Shu, National Taiwan Univ. (Taiwan)
- From an undergraduate course project to nondestructive testing research, Christoph Schaal, Heriberto Aguilera, Alberto Aguilera, Francisco Pacheco, Carmen Garcia, James Lozano, Artur Balyan, Cesar Gonzales, California State Univ., Northridge (USA)
THURSDAY 30 APRIL

CONFERENCES 11375

SESSION 11
THU 10:30 AM TO 11:50 AM

Dielectric Elastomer Self-sensing and Control

Session Chairs: John D. W. Madden, The Univ. of British Columbia (Canada); Giovanni Berselli, Univ. degli Studi di Genova (Italy)

DE membrane actuator systems: design and applications (Invited Paper), Stefan S. Seelecke, Univ. des Saarlandes (Germany) [11375-65]

Self-sensing position control of dielectric elastomer transducer, Thorben Hoffstadt, Jürgen Maas, Technische Univ. Berlin (Germany) [11375-66]

Active deformation of dielectric elastomer for detection of biofouling, Sara Krpovic, Kim Dam-Johansen, Anne Ladegaard Skov, Technical Univ. of Denmark (Denmark); Samuel Rosset, Iain A. Anderson, The Univ. of Auckland (New Zealand) [11375-67]

Scaled tremor suppression with folded dielectric elastomer stack actuators, Christopher R. Kelley, Jeffrey L. Kauffman, Univ. of Central Florida (USA) [11375-68]

Lunch Break ............... Thu 11:50 am to 1:20 pm

CONFERENCES 11376

SESSION 11
THU 10:30 AM TO 11:50 AM

Micro- and Nano-integrated Systems

Session Chairs: Henry A. Sodano, Univ. of Michigan (USA); Jean-François Deü, Conservatoire National des Arts et Métiers (France)

Solute precipitation 3D printing technique for polymers and functional devices applications, Ruowen Tu, Ethan Sprague, Henry A. Sodano, Univ. of Michigan (USA) [11376-70]

Laser induced graphene on aramid fiber-reinforced composites for embedded sensing, LoriAnne Groo, Jalal Nasser, Daniel J. Inman, Henry A. Sodano, Univ. of Michigan (USA) [11376-71]

Investigations on ultrasonic vibration-induced microchannel flow in thin plate perforations, Eric Dupuis, Shima Shahab, Virginia Polytechnic Institute and State Univ. (USA); Viral K. Patel, Ayyoub M. Momen, Oak Ridge National Lab. (USA) [11376-72]

Reduced-order models for nonlinear vibrations of piezoelectric micro-electro-mechanical systems, Jean-François Deü, Conservatoire National des Arts et Métiers (France) [11376-73]

Lunch Break ............... Thu 11:50 am to 1:20 pm
### Thursday 30 April

#### SESSION 11: Passive Ultrasound Inspection Techniques
**CONFERENCE 11379**

**THU 10:30 AM TO 11:50 AM**

**Passive Ultrasound Inspection Techniques**

- **Session Chairs:** Victor Giurgiutiu, Univ. of South Carolina (USA); Francesco Lanza di Scalea, Univ. of California, San Diego (USA)
- **Defect detection performance of high-speed rail inspection system from passive acoustic identification**, Diplojit Datta, Albert Liang, Ranting Cui, Francesco Lanza di Scalea, Univ. of California, San Diego (USA). [11379-54]
- **Introducing an internet-of-thing approach to acoustic emission monitoring**, Arvin Ebrahimkhaniou, Salvatore Salamone, The Univ. of Texas at Austin (USA). [11379-55]
- **Automatic boiler tube leak detection with deep bidirectional LSTM neural networks on acoustic emission signals**, Majid G. Ramezani, Behrouz Golchinfar, Mostafa Hasanian, Hossain Saboonchi, MISTRAS Group, Inc. (USA). [11379-56]
- **Acoustic emission (AE) fatigue-crack source modeling and simulation using moment tensor concept**, Roshan Joseph, Victor Giurgiutiu, Univ. of South Carolina (USA). [11379-57]

**THURSDAY 30 APRIL**

**Lunch Break**

- **Thu 11:50 am to 1:20 pm**

#### SESSION 11: Electrical, Thermal, and Radioactive NDE
**CONFERENCE 11380**

**THU 10:30 AM TO 12:10 PM**

**Electrical, Thermal, and Radioactive NDE**

- **Session Chair:** Yu-Min Su, National Kaohsiung Univ. of Science and Technology (Taiwan)
- **Real-time inorganic-organic hybrid x-ray detectors for non-destructive evaluation of large area, conformable structures**, Hashini Thirimanne, Imalka Jayawarden, Prabodhi Nanayakkara, Univ. of Surrey (United Kingdom); Andrew Nisbet, Univ. College London (United Kingdom); Richard Parmee, Cheyney Design & Development Ltd. (United Kingdom); Ravi Silva, Univ. of Surrey (United Kingdom). [11380-47]
- **The temperature gradient modeling of hot mix asphalt pavement in conjunction with a multilayered temperature monitoring station**, Yu-Min Su, Jui-An Wu, National Kaohsiung Univ. of Science and Technology (Taiwan); Tsung-Chih Hou, National Cheng Kung Univ. (Taiwan); Huang-Hei Pan, National Kaohsiung Univ. of Science and Technology (Taiwan); Min-Gin Lee, Chao-yang Univ. of Technology (Taiwan). [11380-48]
- **An electrical impedance-based technique for estimation of moisture saturation condition of concrete**, Abhijit Ganguli, Indian Institute of Technology Tirupati (India); Gopinandan Dey, National Institute of Technology, Agartala (India); Bishwajit Bhattacharjee, Indian Institute of Technology Delhi (India). [11380-49]
- **The influence of shear conductivity on anisotropic electrical impedance tomography used for spatial strain sensing**, Yening Shu, Univ. of California, San Diego (USA) and Christian Doppler Lab. for Structural Strength Control, Johannes Kepler Univ. Linz (Austria) and Institute of Structural Lightweight Design, Johannes Kepler Univ. Linz (Austria); Martin J. Schagerl, Christian Doppler Lab. for Structural Strength Control, Johannes Kepler Univ. Linz (Austria) and Institute of Structural Lightweight Design, Johannes Kepler Univ. Linz (Austria); Kenneth J. Loh, Univ. of California, San Diego (USA). [11380-50]
- **Quantitative IR-thermography for in-line testing of fiber reinforced composites: limitations and opportunities**, Vitalij Popow, Martin Gurka, Institut fuer Verbundwerkstoff (Germany). [11380-51]

**THURSDAY 30 APRIL**

**Lunch Break**

- **Thu 12:10 pm to 1:20 pm**

#### SESSION 11: Modeling and Neural Networks for SHM
**CONFERENCE 11381**

**THU 10:30 AM TO 12:10 PM**

**Modeling and Neural Networks for SHM**

- **Session Chairs:** Christoph Schaal, California State Univ., Northridge (USA); Mohammad Hadi Hafezi, The Univ. of Arizona (USA)
- **Coupling of peridynamics and finite element method for crack propagation analysis**, Suyeong Jin, Jung-Wuk Hong, KAIST (Korea, Republic of). [11381-94]
- **Thermo-mechanical fatigue of welded power plant components**, Mohammad Hadi Hafezi, The Univ. of Arizona (USA). [11381-95]
- **Prognosis of cracks using mechano-luminescent sensing skins and artificial neural network**, George Hoover, Jeremy Trujillo, Setayesh Fakhimi, Donghyeon Ryu, New Mexico Institute of Mining and Technology (USA). [11381-96]
- **Deep learning and guided-wave based structural health monitoring for detection and localization of rivet holes**, Mahendra Rautela, Shivshankar P., Gopalakrishnan Srinivasan, Indian Institute of Science, Bengaluru (India). [11381-97]
- **Theoretical periuistrasound formulation for substantia nigra neurodegeneration**, Mohammad Hadi Hafezi, The Univ. of Arizona (USA). [11381-98]

**THURSDAY 30 APRIL**

**Lunch Break**

- **Thu 12:10 pm to 1:20 pm**

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THURSDAY 30 APRIL

CONFERENCE 11375

SESSION 12
THU 1:20 PM TO 3:00 PM
Deep Learning and Gesture Recognition, Sensing, and DE Actuation

Session Chairs: Qi Bing Pei, Univ. of California, Los Angeles (USA); Carmel Majidi, Carnegie Mellon Univ. (USA)

Deep reinforcement learning control of dielectric elastomer actuator using EMG signals for biorobotic applications, Abdullah El Atrache, Daewon Kim, Eduardo Divo, Embry-Riddle Aeronautical Univ. (USA) ............................................. [11375-69]

The challenges of hand gesture recognition using dielectric elastomer sensors, Derek Orbaugh, Christopher R. Walker, Samuel Rosset, Iain A. Anderson, The Univ. of Auckland (New Zealand) ............................................. [11375-70]

Pressure measurement based on dielectric elastomers for an intelligent glove providing worker assessment in the digital production, Sebastian Gratz-Kelly, Univ. des Saarlandes (Germany); Paul Motzki, Andreas Meyer, Zentrum für Mechatronik und Automatisierungstechnik gGmbH (Germany); Gianluca Rizzello, Univ. des Saarlandes (Germany); Stefan S. Seelecke, Univ. des Saarlandes (Germany) ................................................................. [11375-71]

A soft pneumatic gripper with embedded soft dielectric elastomer actuator pump, Chongjing Cao, Zhe Lin, Lei Wang, Xing Gao, Shenzhen Institutes of Advanced Technology (China) ................................................................. [11375-72]

Measuring pressure and multi-location with dielectric elastomer capacitive sensors, Yuting Zhu, Iain A. Anderson, Samuel Rosset, The Univ. of Auckland (New Zealand) ............................................. [11375-73]

CONFERENCE 11376

SESSION 12
THU 1:20 PM TO 3:00 PM
Passive and Active Vibration Isolation Systems II

Session Chairs: Carlos De Marqui Jr., Univ. de São Paulo (Brazil); Laura Micheli, The Catholic Univ. of America (USA)

Effect of negative capacitance circuits on the performance of a piezoelectric nonlinear energy sink, Jaime Alberto Mosquera-Sánchez, Carlos De Marqui Jr., Univ. de São Paulo (Brazil) ............................................. [11376-74]

Shock reduction on thin plate with elastic patch, Dae-Hyun Hwang, Hyun-Su Park, Jae-Hung Han, KAIST (Korea, Republic of) ............................................. [11376-75]

Surrogate-based performance evaluation strategy for high performance control systems under uncertainties, Laura Micheli, The Catholic Univ. of America (USA); Simon Laflamme, Iowa State Univ. of Science and Technology (USA); Liang Cao, Lehigh Univ. (USA) ................................................................. [11376-76]

Vibration and noise attenuation of composite panels with shunted piezoceramics, Siddanagouda Kandagal, Indian Institute of Science, Bengaluru (India) ................................................................. [11376-77]

Numerical investigation towards the control of flexural waves using structural intensity for an active barrier of structure-borne sound, Alexander Kokott, Thomas Haase, Hans Peter Monner, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany) ................................................................. [11376-78]
SESSION 12
THU 1:20 PM TO 3:00 PM
Actuator Technologies for Smart Structures

Session Chairs: Edwin A. Peraza-Hernandez, Univ. of California, Irvine (USA); Sevki Cesmeci, Georgia Southern Univ. (USA)

A brake-by-wire featuring magnetorheological fluid clutch, Yang Liu, Shun-Chang Duan, Jun Sun, Xian-Xu Bai, Hefei Univ. of Technology (China) ............................................ [11379-58]

Experimental investigation of an active mass damper with acceleration feedback sliding mode control, Shieh-Kung Huang, National Ctr. for Research on Earthquake Engineering (Taiwan); Yong-An Lai, National Central Univ. (Taiwan); Chia-Ming Chang, National Taiwan Univ. (Taiwan); Cho-Yen Yang, National Cheng Kung Univ. (Taiwan); Chin-Hsiung Loh, Univ. of California, San Diego (USA) ................................................................. [11379-59]

Design of compressible magnetorheological damping systems using computational fluid dynamics, Sevki Cesmeci, Georgia Southern Univ. (USA); Faramarz Gordaninejad, Advanced Materials and Devices, Inc. (USA) .................................................... [11379-60]

Development of intelligent tension adjustment mechanism, Shui-Dong Jiang, Houfei Fang, Shanghai YS information and Technology Co. (China) ....................................................... [11379-61]

Design of continuum/compliant multi-scale mechanisms with smart material actuation, Yudong Fang, Univ. of California, Irvine (USA) and Chongqing Univ. (China); Woo Rib Suh, Edwin A. Peraza-Hernandez, Univ. of California, Irvine (USA) ....................... [11379-62]

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SESSION 12
THU 1:20 PM TO 3:20 PM
Acoustic/Ultrasonic NDE/SHM

Session Chair: Peter J. Shull, The Pennsylvania State Univ. (USA)

Acoustic emission monitoring of high mast illumination poles: a data mining approach to assess crack growth, Arvin Ebrahimi-Khanlou, Brennan Dubuc, Korkut Kaynardag, Mohammed Ali Morovat, Salvatore Salamone, Michael Engelhardt, The Univ. of Texas at Austin (USA) ...................................................... [11380-52]

Modal acoustic emission testing of composite overwrapped pressure vessels in accordance to US DOT specifications, Behnoush Golchinfar, Majid G. Ramezani, Miguel A. Gonzalez-Nunez, Hossain Saboonchi, Obdulia Ley, MISTRAS Group, Inc. (USA) ................................................................. [11380-53]

Laser-based ultrasound interrogation of sub-surface voids in advanced manufacturing materials, Kathryn Harke, David Stobbe, Lawrence Livermore National Lab. (USA); Todd Murray, Rosa Morales, Univ. of Colorado Boulder (USA); Jefferson Cuadra, Joseph W. Tringe, Lawrence Livermore National Lab. (USA) .......................... [11380-54]

Ultrasonic sensor concepts and performance characterization for in situ monitoring during transient irradiation tests, Pradeep RamuBahl, Oak Ridge National Lab. (USA); Joshua Dow, Idaho National Lab. (USA); Andrew M. Casella, Matthew Provant, Chris Hutchinson, Morris Good, Robert Montgomery, Pacific Northwest National Lab. (USA) ................................................................. [11380-55]

Structural health monitoring using a sparse array with a nonlinear ultrasound subtraction technique, Gian Piero Malpensi Fierro, Christos Andreades, Michele Meo, Univ. of Bath (United Kingdom) ................................................................. [11380-56]

Design of sparse array transducers for synthetic imaging of plate-like structures, Tadeusz Stepiński, Michał Malarz, Łukasz Ambrozinski, AGH Univ. of Science and Technology (Poland) [11380-57]

Conference End.

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SESSION 12
THU 1:20 PM TO 3:00 PM
Signal and Data Processing

Session Chairs: Paul Fromme, Univ. College London (United Kingdom); Henrique L. Reis, Univ. of Illinois (USA)

Merging machine learning and ultrasound for damage detection and quantification in concrete structures, Ninel Alver, Ege Univ. (Turkey); Ulas Baçı, F. Necati Catbas, Univ. of Central Florida (USA) ................................................................. [11381-99]

Effect of image size and resolution on performance of vibration-based plastic-gear crack detection system using a convolutional neural network, Huy Kien Bui, Daisuke Iba, Yusuke Tsutsui, Aoto Kajihata, Nanako Miura, Takashi Iizuka, Arata Masuda, Akira Sone, Ichiro Moriwaki, Kyoto Institute of Technology (Japan) .... [11381-100]

Full-field steady state ultrasonic imaging using compressed laser scanning for structural damage detection, Seong Jin Im, GyuHae Park, JunYoung Jeon, Chonnam National Univ. (Korea, Republic of) ................................................................. [11381-101]

Concentrated mass localization in beam-like structures using natural frequency and guided wave measurements, Ganggang Sha, Hohai Univ. (China); Maciej Radzienski, The Szewalski Institute of Fluid-Flow Machinery (Poland); Maosen Cao, Hohai Univ. (China); Wieslaw Ostachowicz, The Szewalski Institute of Fluid-Flow Machinery (Poland) ................................................................. [11381-102]

Structural damage identification using transmissibility function and wavelet packet transform, Lijun Liu, Ying Le, Xiamei Univ. (China) ................................................................. [11381-103]
THURSDAY 30 APRIL

CONFERENCE 11375

SESSION 13
THU 3:30 PM TO 4:50 PM

**Sensors, Sensor Arrays, and Textiles**
Session Chairs: Anne Ladegaard Skov, Technical Univ. of Denmark (Denmark); Jürgen Maas, Technische Univ. Berlin (Germany)

- Compressible dielectric elastomer sensor for robotic application, Masoumeh Mahmoudinezhad, Samuel Rosset, Iain A. Anderson, The Univ. of Auckland (New Zealand).
- Experimental characterization of a smart dielectric elastomer multi-sensor grid, Andreas Meyer, ZEM GmbH (Germany) and Saarland Univ. (Germany); Stephan Lenz, Sebastian Gratz-Kelly, Paul Motzki, Stefan S. Seelecke, Gianluca Rizzello, Univ. des Saarlandes (Germany).
- Sheath-run artificial muscles and their use for robotics and comfort adjusting textiles, Jiuke Mu, Ray H. Baughman, The Univ. of Texas at Dallas (USA).
- 3D-printed and wireless piezoelectric tactile sensors, Linda Choi, Zhangxian Deng, Boise State Univ. (USA).

SESSION 14
THU 4:50 PM TO 6:10 PM

**Big Actuators and Big Volts**
Session Chairs: Tim Helps, Univ. of Bristol (United Kingdom); Joseph Ashby, The Univ. of Auckland (New Zealand)

- High-voltage class-D amplifier for dielectric elastomer transducers in audio and haptic applications, Florian Klug, Susana Solano-Arana, Helmut F. Schlaak, Technische Univ. Darmstadt (Germany).
- Modeling and simulation of a soft robotic structure actuated by rolled dielectric elastomer membranes, Johannes Prechtl, Rukmini Manoz Banda, Univ. des Saarlandes (Germany); Sophie Naibach, ZEM GmbH (Germany); Paul Motzki, Zentrum für Mechatronik und Automatisierungstechnik gGmbH (Germany); Gianluca Rizzello, Stefan S. Seelecke, Univ. des Saarlandes (Germany).
- Design and fabrication of silicone-based dielectric elastomer rolled actuators for soft robotic applications, Rukmini Manoz Banda, Johannes Prechtl, Univ. des Saarlandes (Germany); Sophie Naibach, Paul Motzki, Zentrum für Mechatronik und Automatisierungstechnik gGmbH (Germany); Gianluca Rizzello, Univ. des Saarlandes (Germany); Stefan S. Seelecke, Univ. des Saarlandes (Germany) and Zentrum für Mechatronik und Automatisierungstechnik gGmbH (Germany).
- A method to fabricate monolithic dielectric elastomer actuators, Daiki Ichige, The Univ. of Electro-Communications (Japan); Koya Matsuno, Kazumasa Baba, Genki Sago, Hiromitsu Takeuchi, Toyoda Gosei Co., Ltd. (Japan); Jun Shintake, The Univ. of Electro-Communications (Japan).

Conference End.

CONFERENCE 11376

SESSION 13
THU 3:30 PM TO 5:50 PM

**Soft/Tunable Metamaterials**
Session Chairs: Kenneth J. Loh, Univ. of California, San Diego (USA); Chaitanya Nimmagadda, Ford Motor Co. (USA)

- Preliminary exploration of auxetic superelastic knitted structures, Henry Koon, Julianna Abel, Univ. of Minnesota, Twin Cities (USA).
- In-situ tunable auxeticity in pressurized soft mechanical metamaterials, Tyler N. Tallman, Purdue Univ. (USA); Narayan Kidambi, Vinip Agarwal, Kon-Well Wang, Univ. of Michigan (USA).
- Self-foldable single-layer photopolymer and carbon structures, Derosh George, Edwin A. Peraza-Hernandez, Marc Madou, Univ. of California, Irvine (USA).
- Exploring the potential of 3D printed soft material metastructures for low frequency vibration attenuation in automobiles, Chaitanya Nimmagadda, Janice L. Tardiff, Ford Motor Co. (USA).
- Controlling 3D deformations of bio-inspired active skins through designed geometrical imperfections, Yujin Park, Kenneth J. Loh, Univ. of California, San Diego (USA).
- Locally resonant mechanical dome metastructures for bandgap estimation, Vivek Gupta, Indian Institute of Technology Kanpur (India); Sondipon Adhikari, Swansea Univ. (United Kingdom); Bishak Bhattacharya, Indian Institute of Technology Kanpur (India).
- Origami-based lattice constructions and lattice transformations in mechanical metamaterials, Hongbin Fang, Fudan Univ. (China); Suyi Li, Clemson Univ. (USA); Kon-Well Wang, Univ. of Michigan (USA).

Conference End.
THURSDAY 30 APRIL

CONFERENCE 11379

SESSION 13
THU 3:30 PM TO 5:50 PM

Nano-composite and Flexible Sensors

Session Chairs: Tyler N. Tallman, Purdue Univ. (USA); Donghyeon Ryu, New Mexico Institute of Mining and Technology (USA)

3D impact self-sensing composites for aerospace structures, Setayesh Fakhimi, Jeremy Trujillo, Donghyeon Ryu, New Mexico Institute of Mining and Technology (USA) . . . . . . . . . . . [11379-63]

Self-powered delamination detection in fiber-reinforced polymer using multifunctional mechano-luminescence-optoelectronic composites, Alfred Mongare, Donghyeon Ryu, New Mexico Institute of Mining and Technology (USA) . . . . . . . . . . . . . . . [11379-64]

The effect of extrusion temperature and cycles on electrical resistivity in carbon nanofiber-modified PLA filament for multi-functional additive manufacturing, Cole Maynard, Julio Hernandez, David Gonzalez, Tyler N. Tallman, Jose Garcia, Brittany Newell, Purdue Univ. (USA) . . . . . . . . . . . [11379-65]

Sensing of dispersion and adhesion by 2D Electrical Resistance (ER) mapping of CNT in polyurethane nanocomposites for aircraft topcot, Jong Man Park, Gyeongsang National Univ. College of Engineering (Korea, Republic of); Jong Hyun Kim, Pyung Su Shin, Gyeongsang National Univ. (Korea, Republic of); Lawrence K. DeVries, The Univ. of Utah (USA) . . . . . . . . . . [11379-66]

Additive manufacturing of magnetostrictive thin film sensors, Shane Palmer, Takoda Bingham, Zhangxian Deng, Boise State Univ. (USA). [11379-67]

SpaceSkin: characterization of aerospace-grade piezoelectric textile for simultaneous protection and hypervelocity impact characterizations, Juliana Cherston, MIT Media Lab. (USA); David Veyaset, Yuchen Sun, Keith A. Nelson, Massachusetts Institute of Technology (USA); Joseph A. Paradiso, MIT Media Lab. (USA) . . . . [11379-68]

Development of manufacturing and characterization methods for carbon black-based conductive polymer composite sensors, Tyler B. Albright, Jared D. Hobeck, Kansas State Univ. (USA) . . . . . . . . . . . [11379-69]

Conference End.

CONFERENCE 11381

SESSION 13
THU 3:30 PM TO 4:50 PM

Signal and Data Processing of Sensor Data

Session Chairs: Paul Fromme, Univ. College London (United Kingdom); Henrique L. Reis, Univ. of Illinois (USA)

Additive manufacturing method application for manufacturing polymeric structure with embedded fiber Bragg grating sensor, Magdalena Mieloszyk, Artur Andreczyk, Katarzyna Majewska, The Szewalski Institute of Fluid-Flow Machinery (Poland) . . . . . . . . . . . . . . . . . . . . [11381-104]

Structural health monitoring of transmission tower based on tilt angle sensor system, Jun Ma, State Grid Tonghua Power Supply Co. (China); Bo Lu, Dalian Univ. of Technology (China); Yonggang Shi, Gang Dong, State Grid Tonghua Power Supply Co. (China); Xuefeng Zhao, Dalian Univ. of Technology (China) . . . . . . . . . . . . . . . . . . . . [11381-105]

Integration of inspection and health monitoring for better bridge management, Zhen Sun, Jiangsu Transportation Institute (China) . . . . . . . . . . . . . . . . . . . . [11381-106]

An impact-based experimental setup for evaluation of electromechanical impedance based structural health monitoring, Eric Nolan, Tennessee Technological Univ. (USA); Mohsen Safaei, Georgia Institute of Technology (USA); Steven R. Anton, Tennessee Technological Univ. (USA) . . . . . . . . [11381-108]

Conference End.
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**Sunday 26 April**
8:30 AM - 12:30 PM
SC1265: **Industry 4.0: Advanced Materials and NDE in Smart Factory Systems** (Meyendorf)
SC1293: **Piezoelectric Energy Harvesting** (Erturk)

1:30 PM - 5:30 PM
SC1294: **Engineered Biomimicry** (Lakhtakia, Martín-Palma, Knez)
SC634: **Electroactive Polymer Actuators and Devices** (Madden, Pei, Spinks)
Industry 4.0: Advanced Materials and NDE in Smart Factory Systems

**SC1265**

**Course Level:** Introductory

**CEU:** 0.4 $330 Members | $186 Student Members | $390 Non-Members USD

**Sunday 8:30 am to 12:30 pm**

The fourth industrial revolution will change the way we create, apply, and inspect Smart Materials and Systems. Modern manufacturing techniques are characterized by networking of systems in all industrial areas (Industry 4.0) and producing individual components tailored to the needs of individual customers.

This course explains how the Internet of Things and the next generation of industrial production encompasses the complete networking of all industrial areas. New production techniques, such as 3D printing, will allow efficient in-time production for low numbers of unique parts. A significant aspect is also quality and maintainability of these sometimes unique structures and components. NDE has to follow these trends, by not only adapting NDE techniques to the new technologies, but also by introducing the capability of cyber systems into the inspection and maintenance processes.

This course will introduce present trends in industry such as production of individual parts by 3D printing, product design and testing by digital twins, 3D volume data creation, component live data files, management of big data, real time monitoring of structural integrity, reliable inspection of individual components, and remote NDE to include competencies not available onsite.

**LEARNING OUTCOMES**

This course will enable you to:

- develop lumped-parameter electromechanical models and analyze those models for piezoelectric energy harvesting from mechanical vibrations
- express more advanced (e.g. distributed-parameter) electromechanical models that relate AC mechanical (vibration) input to DC electrical output
- identify various forms of nonlinearities (e.g. designed, inherent, etc.) and their implications in piezoelectric energy harvesting
- leverage intentionally introduced (designed) nonlinearities in frequency bandwidth enhancement for broadband energy harvesting
- interpret other nonlinearities including those associated with electrical circuit domain and material behavior
- identify methods of energy harvesting from fluid flow (aeroelastic and hydroelastic energy harvesting), spanning from vortex-induced vibrations to classical flutter
- integrate recent developments in metamaterials/phononic crystals domain for enhanced energy harvesting from elastic and acoustic waves

**INTENDED AUDIENCE**

- Scientists, engineers, technicians, managers or students who wish to get an overview of different aspects of Industry 4.0. Undergraduate training in engineering or science is assumed.

**INSTRUCTOR**

Norbert Meyendorf is adjunct faculty at the Iowa State University, the University of Dayton, and the University of Technology in Dresden (Germany). He is recently retired from Fraunhofer Institute for Ceramic Technologies and Systems (IKTS). His expertise ranges from materials science, imaging and data processing, to NDE and SHM. He is Editor-in-Chief of the Journal of Nondestructive Evaluation and a Fellow of SPIE.

**Piezoelectric Energy Harvesting**

**SC1293**

**Course Level:** Intermediate

**CEU:** 0.4 $330 Members | $186 Student Members | $390 Non-Members USD

**Sunday 8:30 am to 12:30 pm**

Energy harvesting from dynamical systems offers the possibility of enabling self-powered wireless electronic components, such as low-power sensors in a plethora of current and future applications of the Internet of Things, from wearable electronics to civil structures. Piezoelectric energy harvesting is arguably the most popular method in this context. This course will cover methods of piezoelectric energy harvesting with examples from two decades of literature. Following a brief review of the basic concepts and lumped-parameter electromechanical representation, the standard problem of vibration-based energy harvesting using piezoelectric transduction will be discussed for AC and DC power generation scenarios. The extension of such lumped-parameter approaches to distributed-parameter systems will also be summarized. Performance and bandwidth enhancement in piezoelectric energy harvesting by leveraging intentionally introduced nonlinearities will be covered next. Specifically, monostable and bistable Duffing oscillator configurations will be reviewed with various examples from the literature, along with select modeling techniques, such as the use of the method of harmonic balance. Inherent material and dissipative nonlinearities, as well as circuit nonlinearities, will also be summarized. Aeroelastic and hydroelastic energy harvesting techniques will be reviewed for converting fluid flow into electricity. Examples will be detailed on leveraging the classical flutter and axial flow-induced nonlinear limit cycle oscillations. Finally, recent developments in the domain of exploiting metamaterial and phononic crystal concepts in energy harvesting will be addressed with select examples of energy harvesting combined with structure-borne elastic wave focusing and bulk acoustic wave focusing, as well as with locally resonant metamaterials.

**LEARNING OUTCOMES**

This course will enable you to:

- express more advanced (e.g. distributed-parameter) electromechanical models that relate AC mechanical (vibration) input to DC electrical output
- identify various forms of nonlinearities (e.g. designed, inherent, etc.) and their implications in piezoelectric energy harvesting
- leverage intentionally introduced (designed) nonlinearities in frequency bandwidth enhancement for broadband energy harvesting
- interpret other nonlinearities including those associated with electrical circuit domain and material behavior
- identify methods of energy harvesting from fluid flow (aeroelastic and hydroelastic energy harvesting), spanning from vortex-induced vibrations to classical flutter
- integrate recent developments in metamaterials/phononic crystals domain for enhanced energy harvesting from elastic and acoustic waves

**INTENDED AUDIENCE**

- Engineers, scientists, graduate students, postdoctoral researchers interested in learning about piezoelectric energy harvesting, from fundamentals to recent developments. Undergraduate training in engineering or science is assumed (elementary training in dynamics, vibration, and/or circuits is a plus).

**INSTRUCTOR**

Alper Erturk is the Woodruff Professor of Mechanical Engineering at Georgia Tech, where he leads the Smart Structures and Dynamic Systems Laboratory. He has published more than 200 articles in archival journals and conference proceedings, 4 book chapters, and 2 books (total citations around 12,000 and h-index: 48). He received various awards including the NSF CAREER Award, ASME Gary Anderson Early Achievement Award for early career impact in the field of adaptive structures and material systems, ASME C.D. Motte Jr. Early Career Award for demonstrated research excellence in the field of vibration and acoustics, SEM James W. Dally Young Investigator Award for demonstrated research excellence in experimental mechanics, and two ASME Energy Harvesting Best Paper Awards, among others.
Engineered Biomimicry

SC1294

Course Level: Introductory
CEU: 0.4 $330 Members | $186 Student Members | $390 Non-Members USD
Sunday 1:30 pm to 5:30 pm

This course covers a variety of aspects of engineered biomimicry ranging from the lessons learned from the bioworld and the understanding of underlying principles to the adaptation of those principles to create novel devices, methods or materials. The course will give insight into natural principles with relevance for engineering, the strategies of abstraction and the techniques for adaptation to engineering. Examples of devices and systems which are already in use or currently under development will be discussed.

LEARNING OUTCOMES

This course will enable you to:

- Explain naturally occurring systems in various fields of relevance for engineering
- Describe multifunctionality, multicontrollability, sustainability, and circular economy inherent in the bioworld
- Identify correlations between problems in engineering and existing solution strategies available in the bioworld
- Identify pathways for adaptation of systematics
- Describe microfabrication and nanofabrication techniques used in the field of engineered biomimicry
- Recognize main characterization techniques

INTENDED AUDIENCE

Scientists, engineers, technicians, or managers who wish to learn more about how to understand principles of functionalities in nature and adapt them to solving problems in engineering.

INSTRUCTOR

Mato Knez is an associate professor at the University of Wollongong, Australia. His research interests focus on soft robotics and wearable robotics. http://globalchallenges.uow.edu.au/the-team/UOW156626.html

Electroactive Polymer Actuators and Devices

SC634

Course Level: Introductory
CEU: 0.4 $330 Members | $186 Student Members | $390 Non-Members USD
Sunday 1:30 pm to 5:30 pm

This course will provide an overview of the field of EAP covering the state of the art, challenges and potential. Three general classes of polymer materials are described, namely those that involve ionic mechanisms (Ionic EAP including gels), field activated materials (Electronic EAP) and torsional actuators (typically thermally or electrothermally driven). The basic mechanisms responsible for the active behavior of EAP materials will be covered and compared with natural muscles. Analytical models, fabrication processes and methods of characterizing these materials will be described. Moreover, the currently considered applications will be reviewed including actuators, robotics, animatronics, energy harvesting, medical, and biologically inspired mechanisms, so called biomimetics.

The course begins with an overview of the field, current capabilities, potential and challenges. The course follows with a description of the currently available EAP materials and principles of operating them as actuators and artificial muscles. The course ends with a review of the future prospect of EAP as actuators and sensors in systems, mechanisms and smart structures for industrial and medical applications.

LEARNING OUTCOMES

This course will enable you to:

- Identify EAP based available and emerging actuators/sensors
- Assess the applicability of current EAP actuators while accounting for their limitations
- Review mechanical analysis and design principles associated with EAP
- Review mechanical analysis and design principles associated with EAP
- Identify pathways for adaptation of systematics
- Describe microfabrication and nanofabrication techniques used in the field of engineered biomimicry
- Recognize main characterization techniques

INTENDED AUDIENCE

Engineers, scientists and managers who need to understand the basic concepts of EAP, or are interested in learning, applying or engineering mechanisms or devices using EAP materials. Also those who wish to discover the excitement of research and development in EAP materials and their applications - present and future.

INSTRUCTOR

John Madden is a Professor of Electrical & Computer Engineering at the University of British Columbia, Vancouver, Canada. His research areas include the application of EAP materials in active catheters, as well as the development and characterization of molecular, carbon nanotube and anisotropically thermally expanding polymer actuators. http://www.mina.ubc.ca/jmadden

Qiling Pei is professor of materials science and engineering at the University of California, Los Angeles. His research interests cover a wide range of soft materials and span from polymer synthesis, processing, to fabrication of functional devices which include flexible polymer electronics, dielectric elastomer artificial muscles, and Braille electronic readers. http://www.mse.ucla.edu/faculty/pei/

Geoffrey Spinks is a Professor of Materials Engineering at the University of Wollongong, Australia. His research interests focus on new materials and manufacturing methods for artificial muscles, soft robotics and wearable robotics. http://globalchallenges.uow.edu.au/the-team/UOW156626.html
Registration

Onsite Registration Hours/ Badge Pick-Up
Marriott Anaheim, Grand Ballroom Foyer
Sunday 26 April ....................... 7:30 AM - 5:00 PM
Monday 27 April ...................... 7:00 AM - 5:00 PM
Tuesday 28 April ..................... 7:30 AM - 5:00 PM
Wednesday 29 April ................ 7:45 AM - 5:00 PM
Thursday 30 April ................... 7:45 AM - 11:00 AM

Early Registration Pricing and Dates
Conference registration prices increase by $150 USD ($75 for students), and course prices increase $75 after 10 April 2020. The online form will automatically display the increased prices. All online charges are made in US dollars at the current exchange rate.

Course and Workshop Registration
• Courses and workshops are priced separately.
• Course-only registration includes your selected course(s), course notes, and coffee breaks.
• Onsite, please go to SPIE Registration after you pick up your badge.

SPIE Member, SPIE Student Member and Student Pricing
• SPIE Members receive conference and course registration discounts. Discounts are applied at the time of registration.
• SPIE Student Members receive receive significant discounts on courses.
• Student registration rates are available only to undergraduate and graduate students who are enrolled full time and have not yet received their Ph.D. Post-docs may not register as students. A student ID number or proof of student status is required with your registration.

Onsite Services

SPIE Cashier
Located in the SPIE Registration Area. Open during registration hours.
• Registration Payments
If you are paying by cash or check as part of your onsite registration, wish to add a course, workshop, or special event requiring payment, or have questions regarding your registration, visit the SPIE Cashier.

Receipts and Certificate of Attendance
Preregistered attendees who did not receive a receipt or attendees who need a Certificate of Attendance may obtain those from the SPIE Cashier at Registration.

Badge Corrections
Badge corrections can be made by the SPIE Cashier. Please have your badge removed from the badge holder and marked with your changes before approaching the counter.

Refund Information
There is a $50 USD service charge for processing refunds. Requests for refunds must be received by 16 April 2020; all registration fees will be forfeited after this date. Membership dues, SPIE Digital Library subscriptions or Special Events purchased are not refundable.

U.S. Government Credit Cards
U.S. Government credit card users: have your purchasing officer contact the credit card company and get prior authorization before attempting to register. Advise your purchasing agent that SPIE is considered a 5968 company for authorization purposes.

SPIE Conference and Exhibition App
Search and browse the program, special events, participants, exhibitors, courses, and more. Free Conference App available for iPhone and Android phones. Download the free SPIE Conference App

SPIE Bookstore
Anaheim Convention Center, Main Entrance Lobby, Level 1
Stop by the SPIE Bookstore to browse the latest SPIE Press Books, proceedings, and educational materials. While there, get a t-shirt or educational toy to bring home to the family.

Speaker Check-In and Presentation Upload
Anaheim Marriott, Gold Key I/II
Monday through Thursday, 7:30 AM - 5:00 PM
• All presenters are requested to come to Speaker Check-In with their memory devices or laptops to confirm their presentation display settings. View Oral Presentation Guidelines
• All conference rooms have a computer workstation, projector, screen, lapel microphone, and laser pointer.

Poster Setup Instructions
Anaheim Convention Center, Ballroom E, Level 3
• Poster presenters may set up between 7:00 AM and 4:00 PM on Wednesday, 29 April
• Presenters who have not set up by 4:00 PM will be considered a “no show” and their manuscript will not be published.
• Poster Session is Wednesday, 29 April from 6:00 PM - 8:00 PM
• Presenters must remove their posters by 8:00 PM that same night. Posters not removed will be considered unwanted and will be discarded. SPIE assumes no responsibility for posters left up after the poster sessions.

Register today and receive:
• a complimentary t-shirt
• entries in drawings for prizes and a grand prize of an all-expense paid trip to SPIE’s next conference

Poster Session is on Wednesday, 29 April from 6:00 PM - 8:00 PM where presenters will have the opportunity to present their posters. Each poster will be displayed on a two-foot by four-foot stand for 2.5 hours. There will be an opportunity for questions and discussion after each presentation.

Poster Setup Instructions
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General Information
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U.S. Government credit card users: have your purchasing officer contact the credit card company and get prior authorization before attempting to register. Advise your purchasing agent that SPIE is considered a 5968 company for authorization purposes.

www.spie.org
GENERAL INFORMATION

Food and Beverage Services

Coffee Breaks
Conference Room Lobbies
Complimentary coffee will be served daily, from the opening of registration until 4:00 PM.

Food & Refreshments for Purchase
Anaheim Marriott
nFuse Restaurant, Bar & Lounge - Fresh California cuisine infused with a global culinary twist.
The Market - Coffee, pastries, and freshly-made sandwiches and snacks at a grab-and-go restaurant.
Slice Pizzeria - Restaurant caliber pizza with a large selection of fresh toppings.
More details and nearby restaurant options on the Marriott website.

Restaurant and City Information
Anaheim Marriott, Concierge, Hotel Lobby
Services include amusement park ticket packages, reservations and local area maps. More information about local attractions on the Marriott Hotel and Visit Anaheim websites.

Education Services
Anaheim Convention Center, Main Entrance Lobby, Level 1
Browse course offerings or learn more about SPIE courses available in portable formats such as Online and customized, in-company courses.

Lost and Found
Anaheim Marriott, Grand Ballroom. SPIE Cashier - Registration hours
Found items will be kept at Cashier all week and at the end of the meeting then turned over to Marriott Anaheim Security. 714.750.1000

Urgent Message Line
An urgent message line is available during registration hours: 360.927.6411

Press
For credentialed press and media representatives only. Please email contact information, title, and organization to media@spie.org.

Travel to Anaheim
Popularly recognized as the “The OC,” Orange County is a world-famous visitor destination in the center of all the Southern California fun. Anaheim, the second largest city in “The OC,” is ideally located halfway between Los Angeles and San Diego. You’ll find plenty of things to see and do: inviting beaches, unparalleled shopping and entertainment, trendy restaurants, nightlife, championship golf, lively art districts, beautiful historic landmarks and legendary, yet always new and changing, internationally famed family attractions.
Warm sunshine, swaying palm trees and breathtaking ocean views create a relaxed lifestyle where shorts, sandals and sunglasses are always in season. Experience nearly 300 days of sunshine, just 13 inches of rain -- no snow - and an average temperature of 67 degrees.
Covering 50 square miles, the City of Anaheim is one of the nation’s premier municipalities and is home to more than 341,000 residents (one of California’s most populous cities). This vibrant metropolis attracts approximately 20 million visitors (40 million in all of Orange County) each year. Read more at the Visit Anaheim website.

Dining and Nightlife
Anaheim has become a foodie city with an expansive culinary footprint and an award-winning craft beer scene. Enjoy hundreds of critically acclaimed restaurants in and around Anaheim for fine dining and new artisanal hotspots with chef-driven concepts and farm-to-fork menus. The revitalized downtown has become a popular hotspot for its wealth of innovative eateries and drinkeries, live music and thriving nightlife. View a list of popular restaurants here.

Four Major Airports
Orange County Airport/John Wayne Airport (SNA)
Distance from Anaheim Convention Center (ACC) and the Disneyland Resort: 13 miles
Services about 120 arrivals and departures per day to over 20 destinations
Services international flights to Canada and Mexico
Los Angeles International Airport (LAX)
Distance from ACC and the Disneyland Resort: 34 miles
Over 1,500 arrivals and departures per day to over 90 destinations
Services about 125 international arrivals per day
Long Beach Airport (LGB)
Distance from ACC and the Disneyland Resort: 18 miles
So services about 45 - 90 arrivals and departures daily to 12 destinations
Domestic flights only
LA/Ontario International Airport (ONT)
Distance from ACC and the Disneyland Resort: 35 miles
About 60 flights flights per day to over 14 destinations
Book with Alaska Airlines to receive a conference attended discount.
SPIE SS+NDE20 Alaska Group Discount

Ground Transportation
Traveling to Anaheim and around Orange County is a breeze for visitors. Four major airports, AmtrakSM, Metrolink, public transportation, shuttle services and taxi, limousine and rideshare companies can get you here and to everywhere you want to be.

For more information visit Travel to Anaheim at spie.org/ss.

Airport Shuttle
Super Shuttle offers a 10% discount on one way or roundtrip shared rides to/from SNA or LAX, booked at least 24 hours in advance and prepaid with a valid credit card. Regular cost is $11 or $17, respectively, each way less 10% discount reflected at reservation checkout. Book Online or call 1-800-258-3826 and refer to group code SPIE.
Karmel Shuttle offers a discount for SPIE attendees - $8 off per adult on roundtrip airport transfers.* Reservations required. Book online or call for reservations within 12 hours of pick-up: 1-888-995-7433. Use Promo Code SPIE20 at the time of reservations. *Discount is applied to “shared van” service. $10 discount offered for private van options.
**General Information**

**Parking**
Anaheim Convention Center Parking - maps, rates and parking information
$15/day - Map of Parking Lot 4 & 6 (near Hall D)
ParkMe - Prepay for the closest, cheapest parking spot
Parkopedia - maps and rates of nearby parking options

**Car Rental**
Hertz Car Rental is the selected as the official car rental agency for this Event. To reserve a car, identify yourself as a Defense + Commercial Sensing conference attendee using the Hertz Meeting Code CV# 029B0025. Discount rates apply for rentals up to one week prior through one week after the conference dates. Note: When booking from International Hertz locations, the CV # must be quoted with the letters CV before the number, i.e. CV029B0025. Click here to book online

- In the United States call 1-800-654-2240.
- In Canada call 1-800-263-0600, or 1-416-620-9620 in Toronto.
- In Europe and Asia call the nearest Hertz Reservation Center or travel agent.
- Outside of these areas call 1-405-749-4434.

**Visa Information**
If you need a travel visa, begin the visa application process now. Strict security requirements may cause delays in visa processing. It is strongly encouraged travelers to apply for their visas as early as possible (at least 3 to 4 months before the visa is needed).

Individuals requiring letters of invitation to obtain travel visas to present their papers may access information and the form on the Visa Information and Invitation Requests page.

**Book Early - Get Rewarded**
SPIE Smart Structures/NDE 2020 will be held at Anaheim Marriott, 700 West Convention Way, Anaheim, CA 92802
The Anaheim Marriott hotel is a 4-Star hotel and is a perfect choice for your conference stay in California. This hotel offers a fantastic location within walking distance to Anaheim Convention Center, the House of Blues and DISNEYLAND® Resort. After a full day of business, refresh and recharge in the resort-style hotel with an outdoor pool, fully-equipped fitness center, and several fresh-food, eat-in options. Rates starting at $212 single/double.

If you book your Anaheim Marriott room as part of the SPIE room block by Wednesday, March 25, 2020 you will be entered to win: Grand Prize - one of (5) $100 Marriott Gift Cards, or Second Prize - one night stay for two with breakfast (for future stay at the Anaheim Marriott®) *Some restrictions apply. Here are a few ideas on how to spend that gift card:
- Use it toward the cost of your room
- Spend it on a great meal at any of the three restaurants onsite
- Go ahead, get room service
- Buy a souvenir at the gift shop
- Save it for another trip

Winning registrants must attend either SPIE Smart Structures/NDE or SPIE Defense + Commercial Sensing 2020 meetings and book their hotel room through the hotel link provided above. Winners will be notified during the conference and can claim their prize onsite.

View the other hotel options and their pricing online. See why booking within the SPIE conference hotel block has definite advantages. The SPIE Hotel block pricing ends 1 April 2020.

**The fine print.**
A block of rooms at special conference rates has been reserved for event attendees. The conference rates cannot be guaranteed after the room block has been filled. Please do not contact SPIE to book your hotel room. Booking within the official housing reservation system for Smart Structures/NDE 2020 is what enables SPIE to secure better rates for our attendees, as well as to contract desirable space and dates for the conference.

All reservations must be accompanied by a first night room deposit or guaranteed with a major credit card. The hotel will not hold any reservations unless secured by one of these methods.

**Cancellation Policy**
Generally, to cancel a reservation without penalty, the hotel must be notified at least 72 hours prior to arrival. Otherwise a penalty fee of one night’s room plus tax will be applied to credit card on file with the hotel. Be sure to check with your hotel for their specific cancellation policy.

**Warning: Unofficial Housing Solicitations**
SPIE Official Contractor

Use the SPIE Official Housing Vendor to book your room
SPIE has arranged special discounted hotel rates for SPIE conference attendees. To receive special hotel rates for this meeting, you must use the SPIE Official Housing Vendor (Hotels) listed above.

SPIE strongly recommends you DO NOT book housing from any company or hotel that contacts you via phone or email.

The reservation system that SPIE uses for this event is available only via the Hotel page on the event website.

Our housing vendors DO NOT reach out to you with solicitations.

Our housing vendors may follow up with you about housing once you have begun booking via our website, but NOT as an initial solicitation.

SPIE cannot be liable for any claims made by unofficial entities or for any damages suffered by you if you use any vendor or service that is not an SPIE Official Housing Vendor.
Acceptance of Policies and Registration Conditions

The following Policies and Conditions apply to all SPIE Events. As a condition of registration, you will be required to acknowledge and accept the SPIE Registration Policies and Conditions contained herein.

Agreement to Hold Harmless

Attendee agrees to release and hold harmless SPIE from any and all claims, demands, and causes of action arising out of or relating to your participation in the event you are registering to participate in and use of any associated facilities or hotels.

Anti-Harassment Policy

It is SPIE policy that all employees, volunteers, and participants are entitled to respectful treatment. Any form of bullying, discrimination, harassment, sexual or otherwise, is unacceptable and will not be tolerated. This policy applies to all locations and situations where SPIE business is conducted and to all SPIE-sponsored activities and events.

Read complete policy http://spie.org/harassment

Attendee Registration and Admission Policies

SPIE, or their officially designated event management, in their sole discretion, reserves the right to accept or decline an individual’s registration for an event. Further, SPIE, or event management, reserves the right to prohibit entry of or to remove any individual whether registered or not, be they attendees, exhibitors, representatives, or vendors, whose conduct is not in keeping with the character and purpose of the event. Without limiting the foregoing, SPIE and event management reserve the right to remove or refuse entry to anyone who has registered or gained access under false pretenses, provided false information, or for any other reason whatsoever that they deem is cause under the circumstances.

Capture and Use of a Person’s Image

By registering for an SPIE event, you grant full permission to SPIE to capture, store, use, and/or reproduce your image or likeness by any audio and/or visual recording technique and create derivative works of these images and recordings in any SPIE media now known or later developed, for any legitimate SPIE marketing or promotional purpose. By registering for an SPIE event, you waive any right to inspect or approve the use of the images or recordings or of any written copy. You also waive any right to royalties or other compensation arising from or related to the use of the images, recordings, or materials. By registering, you release, defend, indemnify and hold harmless SPIE from and against any claims, damages or liability arising from or related to the use of the images, recordings, or materials, including but not limited to claims of defamation, invasion of privacy, or rights of publicity or copyright infringement, or any misuse, distortion, blurring, alteration, optical illusion or use in composite form that may occur or be produced in taking, processing, reduction or production of the finished product, its publication or distribution.

Code of Conduct

SPIE is committed to providing a harassment- and discrimination-free experience for everyone at our events, an experience that embraces the richness of diversity where participants may exchange ideas, learn, network, and socialize in the company of colleagues in an environment of mutual respect.

Read complete Code: http://spie.org/conduct

Event Cancellation Policy

If for some unforeseen reason SPIE should have to cancel an event, processed registration fees will be refunded to registrants. Registrants will be responsible for cancellation of travel arrangements or housing reservations and the applicable fees.

Family-Friendly Policy

Conference Events: All conference technical and networking events require a badge for admission. Registered attendees may bring children with them if they have been issued a badge. Registration badges for children under 18 are free and available at the SPIE registration desk onsite. Children under 14 years of age must be accompanied by an adult at all times, and guardians are asked to help maintain a professional, disturbance-free conference environment.

Exhibition Hall: Everyone who attends the exhibition must be registered and have a badge. Badges for children are free and available onsite at the registration desk. Children under 14 years of age must be accompanied by an adult at all times. Guardians are asked to help maintain a professional, disturbance-free exhibition environment. Children under 18 are not allowed in the exhibition area during exhibition move-in and move-out.

Identification Requirement

To verify registered participants and provide a measure of security, SPIE will ask attendees to present a government-issued photo identification at registration to collect registration materials. Individuals are not allowed to pick up badges for other attendees. Further, attendees may not have some other person participate in their place at any conference-related activity. Such other individuals will be required to register on their own behalf to participate.

Laser Pointer Safety Policy

SPIE supplies tested and safety-approved laser pointers for all conference meeting rooms. For safety reasons, SPIE requests that presenters use provided laser pointers. Use of a personal laser pointer represents the user’s acceptance of liability for use of a non-SPIE-supplied laser pointer.
No-Smoking Policy
Attendees will observe all non-smoking regulations that are publicly posted by the facilities used by the event.

Payment Policy
Registrations must be fully paid before access to the conference is allowed. SPIE accepts VISA, MasterCard, American Express, Discover, Diner’s Club, checks and wire transfers. Onsite registrations can also be paid with cash.

Recording Policy
Conferences, courses, and poster sessions: For copyright reasons, recordings of any kind are prohibited without prior written consent of the presenter or instructor. Attendees may not capture or use materials presented in any meeting/course room or in course notes on display without written permission. Consent forms are available at Speaker Check-In or SPIE Registration. Individuals not complying with this policy will be asked to leave a given session and/or asked to surrender their recording media. Refusal to comply with such requests is grounds for expulsion from the event. Exhibition Hall: Recordings of any kind are prohibited without explicit permission from on-site company representatives. Individuals not complying with this policy will be asked to surrender their recording media and to leave the exhibition hall. Refusal to comply with such requests is grounds for expulsion from the event.

Unauthorized Solicitation
Unauthorized solicitation in the Exhibition Hall is prohibited. Any nonexhibiting manufacturer or supplier observed to be distributing information or soliciting business in the aisles, or in another company’s booth, will be asked to leave immediately.

Unsecured Items
Personal belongings should not be left unattended in meeting rooms or public areas. Unattended items are subject to removal by security. SPIE is not responsible for items left unattended.

Wireless Internet Service
At most events, SPIE provides wireless access for attendees. Properly secure your computer before accessing the public wireless network. SPIE is not responsible for computer viruses or other kinds of computer damage.
The leading source of photonics news, market trends and product applications. Sign up free to the weekly newsletter and we’ll send the news to you. optics.org/newsletter

Get the latest industry news.
Paid registration includes online Proceedings
Available on the SPIE Digital Library as papers are published, usually by 3 weeks after the meeting. In the tables below, find product order numbers for use on the registration form.

- **Online Proceedings Volume**—access to a single conference proceedings volume.
- **Online Proceedings Collection**—access to multiple related proceedings volumes.

Accessing your Proceedings
Visit [http://spiedigitallibrary.org](http://spiedigitallibrary.org), sign in or create an account using the same email address you used to register. Access is also available through an organization’s SPIE Digital Library account. Contact SPIE if you need assistance.

Online Proceedings Volumes
Conference Attendees: The price for additional online proceedings volumes is noted above. Order during registration.

<table>
<thead>
<tr>
<th>Product Order Number</th>
<th>Volume Title/Volume Editors</th>
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<tbody>
<tr>
<td>DL 11374</td>
<td>Bioinspiration, Biomimetics, and Bioreplication X Mato Knez</td>
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<tr>
<td>DL 11375</td>
<td>Electroactive Polymer Actuators and Devices (EAPAD) XXII Yoseph Bar-Cohen</td>
</tr>
<tr>
<td>DL 11376</td>
<td>Active and Passive Smart Structures and Integrated Systems IX Jae-Hung Han</td>
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