47th Annual Electronic Materials Symposium

Allen 101x auditorium, Stanford University - May 10, 2019

The Electronic Materials Symposium is an inter-disciplinary conference that presents a broad spectrum of expert views on problems at the intersection of electronic materials and devices. This one-day symposium seeks to inform participants about challenges that excite today's materials scientists through a series of invited talks by experts in their respective fields.

8:50 – Opening Remarks – Prof. Jonathan Fan, Symposium Chair

9:00 - Emerging Material Platforms, Design and Optimization Approaches for Nanophotonic Devices
Prof. Alexandra Boltesseva - Purdue University

9:45 - Spin Orbit Coupling in Doped Mott Insulators
Prof. Alessandra Lanzara - UC Berkeley

10:30 – Break – Poster Session

11:00 - Connecting Quantum Systems Through Optimized Photonics
Prof. Jelena Vuckovic - Stanford University

11:45 - Hardware for AI and Quantum Computing
Dr. Jeff Welser - IBM

12:30 – Lunch – Poster Session

1:30 - Aspects of Nanophotonics: Topology and Machine Learning
Prof. Shanhui Fan - Stanford University

2:15 - Optical Challenges Paving the Road to the Ultimate Mixed Reality Experience
Dr. Bernard Kress - Microsoft

3:00 – Break – Poster Session

3:30 - Reliable, Feedback Insensitive, Quantum Dot Lasers Epitaxially Grown on CMOS Compatible Silicon Substrates
Prof. John Bowers - UC Santa Barbara

4:15 - Materials and Device Challenges for Next Generation LIDARs
Prof. Jim Harris - Stanford University

5:00 – Reception – Awards

For additional information about EMS and previous symposia, please visit *www.electronicmaterialssymposium.org*

Emerging Material Platforms, Design and Optimization Approaches for Nanophotonic Devices

Prof. Alexandra Boltesseva

Purdue University

Abstract: The fields of nanophotonics and plasmonics have taught us unprecedented ways to control the flow light at the nanometer scale, unfolding new optical phenomena and redefining centuries-old optical elements. As we continue to transfer the recent advances into applications, the development of new material platforms has become one of the centerpieces in the field of nanophotonics. In this presentation, I will discuss emerging material platforms including transparent conducting oxides, transition metal nitrides, oxides and carbides as well as two- and quasi-two-dimensional materials for future practical optical components across the fields of on-chip optics and optoelectronics, sensing, spectroscopy and energy conversion.

Biography: Alexandra Boltasseva is a Professor at the School of Electrical & Computer Engineering and Birck Nanotechnology Center, Purdue University. She received her PhD in electrical engineering at Technical University of Denmark, DTU in 2004. Boltasseva specializes in nanophotonics, nanofabrication, and optical materials. She is 2018 Blavatnik National Award for Young Scientist Finalist, and received the 2013 IEEE Photonics Society Young Investigator Award, 2013 Materials Research Society (MRS) Outstanding Young Investigator Award, the MIT Technology Review Top Young Innovator (TR35) award that "honors 35 innovators under 35 each year whose work promises to change the world", the Purdue College of Engineering Early Career Research Award, the Young Researcher Award in Advanced Optical Technologies from the University of Erlangen-Nuremberg, Germany, and the Young Elite-Researcher Award from the Danish Council for Independent Research. She is a Fellow of the Optical Society of America (OSA) and SPIE. Alexandra authored more than 130 journal articles with a total number of citations above 14000. She served on MRS Board of Directors and is Editor-in-Chief for OSA's Optical Materials Express.

Hardware for AI and Quantum Computing

Dr. Jeff Welser

IBM

Abstract: While traditional scaling is becoming increasing challenging, the rise of new workloads such as deep learning are opening up opportunities for new hardware innovations that can continue to advance a chip and system level performance roadmap. Moreover, entirely new paradigms for computation, such as the emerging field of Quantum Computing, offer entirely new challenges for semiconductor and system development. Combined, these trends are accelerating the need for expanded research in materials, devices and architectures, and several exciting examples of this work and the roadmap ahead will be discussed.

Biography: Dr. Jeffrey Welser, Vice President, IBM Research –Almaden, oversees exploratory and applied research. Home of the relational database and the world's first hard disk drive, Almaden today continues its legacy of advancing data technology and analytics for Cloud and AI systems and software, and is increasingly focused on advanced computing technologies for AI, neuromorphic devices and quantum computing. After joining IBM Research in 1995, Dr. Welser has worked on a broad range of technologies, including novel silicon devices, high-performance CMOS and SOI device design, and next generation system components. He has directed teams in both development and research as well as running industrial, academic and government consortiums, including the SRI Nanoelectronics Research Initiative. Just prior to his current role, Dr. Welser was the Director of Almaden Services Research, managing a portfolio of research into improved business processes, software and technology to enable IBM's Services organizations. Dr. Welser received his Ph.D. in Electrical Engineering from Stanford University. He holds 21 US Patents and has published over 75 technical papers and presentations. He is a member of the IBM Academy of Technology, an IEEE Fellow, a member of the American Physical Society, Chairman of the Bay Area Science and Innovation Consortium and has served on numerous Federal agency and Congressional panels on advanced semiconductor technology.

Connecting Quantum Systems Through Optimized Photonics

Prof. Jelena Vuckovic

Stanford University

Abstract: At the core of most quantum technologies, including quantum networks and quantum simulators, is the development of homogeneous, long lived qubits with excellent optical interfaces, and the development of high efficiency and robust optical interconnects for such qubits. To achieve this goal, we have been studying color centers in diamond (SiV, SnV) and silicon carbide (VSi in 4H SiC), in combination with novel fabrication techniques, and relying on the powerful and fast photonics inverse design approach that we have developed. Our inverse design approach offers a powerful tool to implement classical and quantum photonic circuits with superior properties, including robustness to errors in fabrication and temperature, compact footprints, novel functionalities, and high efficiencies. We illustrate this with a number of demonstrated devices in silicon, diamond, and silicon carbide.

Biography: Jelena Vuckovic (PhD Caltech 2002) is a Professor of Electrical Engineering and by courtesy of Applied Physics at Stanford, where she leads the Nanoscale and Quantum Photonics Lab. She is also the director of the Q-FARM: the Stanford-SLAC Quantum Initiative. Vuckovic has won numerous prizes including the Humboldt Prize, the Hans Fischer Senior Fellowship, the DARPA Young Faculty Award, the Presidential Early Career Award for Scientists and Engineers, and the Office of Naval Research Young Investigator Award. She is a Fellow of the American Physical Society (APS), of the Optical Society of America (OSA), and of the Institute of Electronics and Electrical Engineers (IEEE).

Anomalous Spin Texture in High Temperature Superconductors

Prof. Alessandra Lanzara

UC Berkeley

Abstract: Two types of interactions commonly drive new emergent phenomena beyond textbook band theory in solids: electron correlaion and spin orbit coupling. The first, born from Mott's observation that strong electron correlation can drive a system on the verge of being an insulator, has excited the condensed matter community over the past several decades and lies at the core of many unsolved phenomena, such as unconventional superconductivity. The second has been vastly explored in the previous decades in the context of Rashba effect and recently in the context of topological phases of matter. The real frontier today is to understand whether strongly interacting systems can exhibit any type of intrinsic topological order, distinct from band topology in insulators and what consequences this might have. In this talk I will present experimental results for a variety of materials spanning a large range of interaction, from strong correlation (Mott insulators), to strong spin orbit coupling (topological insulators). I will present intriguing results on the interplay between these two interactions and how, even in the most extreme case, they can give rise to unexpected topological like features. The future of the field is discussed.

Biography: Alessandra Lanzara is a Professor of Physics at University of California, Berkeley and a Faculty Scientist at the Lawrence Berkeley National Laboratory. She received her B.S and PhD in physics from Universita' di Roma La Sapienza, Italy in 1999. She was a post-doctoral Researcher at Stanford University from 1999-2002. In 2002 she joined the physics Department faculty at UC Berkeley as Assistant Professor and since 2011 she is a Full Professor. She is also a Faculty Scientist at the Materials Sciences Division of the Lawrence Berkeley National Laboratory since 2002. Prof. Lanzara is one of the board members of the Far West Section of the American Physical Society; serves as a Panel member of the Linar Coherent Light Source at Stanford; as an Advisory Member of the "Scientific Council of the Rome International Center for Material Science"; and as a board member of the Photon Science Advisory Committee of the Paul Scherer Institute in Switzerland. She is also serving on the board of a few prestigious scientific journals.

Aspects of Nanophotonics: topology and machine learning

Prof. Shanhui Fan

Stanford University

Abstract: In this talk we discuss some of our recent efforts in advancing both the theory and the applications of nanophotonics. In particular, we show that simple nanophotonic structures can in fact exhibit rich topological features in their scattering properties. These topological features may be fruitfully used to provide arbitrary control of polarization of light. We will discuss the use of photonic and wave structures for analog implementations of artificial neural networks, including recurrent neural networks.

Biography: Shanhui's research involves the theory and simulations of photonic and solid-state materials and devices, photonic crystals, nano-scale photonic devices and plasmonics, quantum optics, computational electromagnetics, and parallel scientific computing. He has published over 400 articles and has over 60 patents. He is the recipient of numerous honors and awards, including the Adolph Lomb Metal from the OSA and the Vannevar Bush Faculty Fellowship from the US Department of Defense, and he is a Fellow of the OSA, APS, SPIE, and IEEE. Shanhui was a Thomson Reuters Highly Cited Researcher in Physics in 2015 and 2016.

Optical Challenges Paving the Road to the Ultimate Mixed Reality Experience

Dr. Bernard Kress

Microsoft

Abstract: It is a challenging task to engineer the best possible Mixed Reality headset. The optical engineer has to work around a narrow design window dictated by both the Industrial Design (ID) and User Experience (UX) teams. He has to take into account wearable comfort (size, weight, center of gravity and thermal management), visual comfort by providing the best 3D cues without introducing visual conflicts in any viewing zones, and producing at the same time the best sensory immersion experience for the user. Most of all, the optical designer has to make sure that the immersive display system is matching the human visual perception system rather than matching traditional optical performance criterii as in camera systems. And all this has to come at a consumer price point for mass production. However, it seems that there is still today no consumer market for either smart glasses, AR or MR headsets. This allows then for wider design windows (especially in size, weigh and costs), before addressing a potential future consumer market.

Biography: Bernard has made over the past two decades significant scientific contributions as an engineer, researcher, associate professor, consultant, instructor, and author. He has been instrumental in developing numerous optical sub-systems for consumer electronics and industrial products, generating IP, teaching and transferring technological solutions to industry. Application sectors include laser materials processing, optical anti-counterfeiting, biotech sensors, optical telecom devices, optical data storage, optical computing, optical motion sensors, digital image projection, displays, depth map sensors, and more recently head-up and head mounted displays (smart glasses, AR and VR). His is specifically involved in the field of micro-optics, wafer scale optics, holography and nanophotonics. Bernard has published numerous books and book chapters on micro-optics and has more than 30 patents granted worldwide. He is a short course instructor for the SPIE and was involved in numerous SPIE conferences as technical committee member and conference co-chair. He is an SPIE fellow since 2013 as has been recently elected to the board of Directors of SPIE. Bernard has joined Google [X] Labs. in 2011 as the Principal Optical Architect, and is now Partner Optical Architect at Microsoft Corp, on the Hololens project.

Reliable, Feedback Insensitive, Quantum Dot Lasers Epitaxially Grown on CMOS Compatible Silicon Substrates

Prof. John Bowers

UC Santa Barbara

Abstract: The integration of optical functions on a microelectronic chip is progressing rapidly. The delta-function-like density of states of quantum dots (QD) has a number of advantages for lasers, including higher temperature operation, isolator free operation, lower threshold, and superior mode locking capability. QD lasers directly grown on silicon are very promising for achieving low cost transmitters with high thermal stability and insensitivity to optical reflections. A summary of progress, problems and potential solutions is provided. A recent example includes a 4.1 Tbps, 60 wavelength, 32 Gbaud PAM-4 transmitter using a single mode locked quantum dot laser. The interplay between QD growth and device performance will be described along with prospect for improving performance.

Biography: John Bowers is Director of the Institute for Energy Efficiency and a professor in the Departments of Electrical and Computer Engineering and Materials at the University of California, Santa Barbara. His research interests are primarily concerned with silicon photonics, optoelectronic devices, optical switching and transparent optical networks and quantum dot lasers. Bowers received the M.S. and Ph.D. degrees from Stanford University and then worked for AT&T Bell Laboratories before joining UCSB. Bowers is a fellow of the IEEE, OSA and the American Physical Society, and a recipient of the IEEE Photonics Award, OSA/IEEE Tyndall Award, the IEEE LEOS William Streifer Award and the South Coast Business and Technology Entrepreneur of the Year Award. He is a member of the National Academy of Engineering and the National Academy of Inventors.

Materials and Device Challenges for Next Generation LIDARs

Prof. Jim Harris

Stanford University

Abstract: The past decade has seen considerable experimental development of LIDAR (Light Detection and Ranging) systems for autonomous vehicles, but these have all been based upon conventional, readily available components that are far too costly and obtrusive for anything but experimental development, demonstration and verification. The new wave of dramatically different technology for related facial recognition and need to produce similar integrated, far lower cost and volume systems has created an exciting research and development effort to meet this challenge. My group has worked on a broad range of applicable materials and device technologies to address these challenges and I will describe work on new materials to produce eye-safe VCSEL arrays, photon management in photodiodes and metamaterials that could provide the needed foundation for these exciting new areas.

Biography: James Harris is the James and Ellenor Chesebrough Professor of Electrical Engineering, Applied Physics and Materials Science at Stanford University. He received B.S., M.S. and Ph.D. degrees in Electrical Engineering from Stanford University, Stanford, CA in 1964, 1965 and 1969, respectively. In 1969, he joined the Rockwell International Science Center where he was a key contributor to MBE and heterojunction devices. In 1982, he joined the Solid-State Electronics Laboratory, Stanford University as Professor of Electrical Engineering. His current research interests are in the physics and application of ultra-small structures and novel materials to new photonic devices. He has supervised over 130 PhD students and has over 1100 publications in these areas. Dr. Harris is a Member of the National Academy of Engineering, a Fellow of IEEE, the American Physical Society, Optical Society of America and Materials Research Society. He received the 2000 IEEE Morris N. Liebmann Award, the 2000 International Compound Semiconductor Conference Welker Medal, an IEEE Third Millennium Medal an Alexander von Humboldt Senior Research Prize in 1998, the International MBE Conference MBE Innovator Award in 2008, the 2013 SRC Aristotle Award for graduate student training and mentoring and International MBE Conference Al Cho Award in 2014.

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