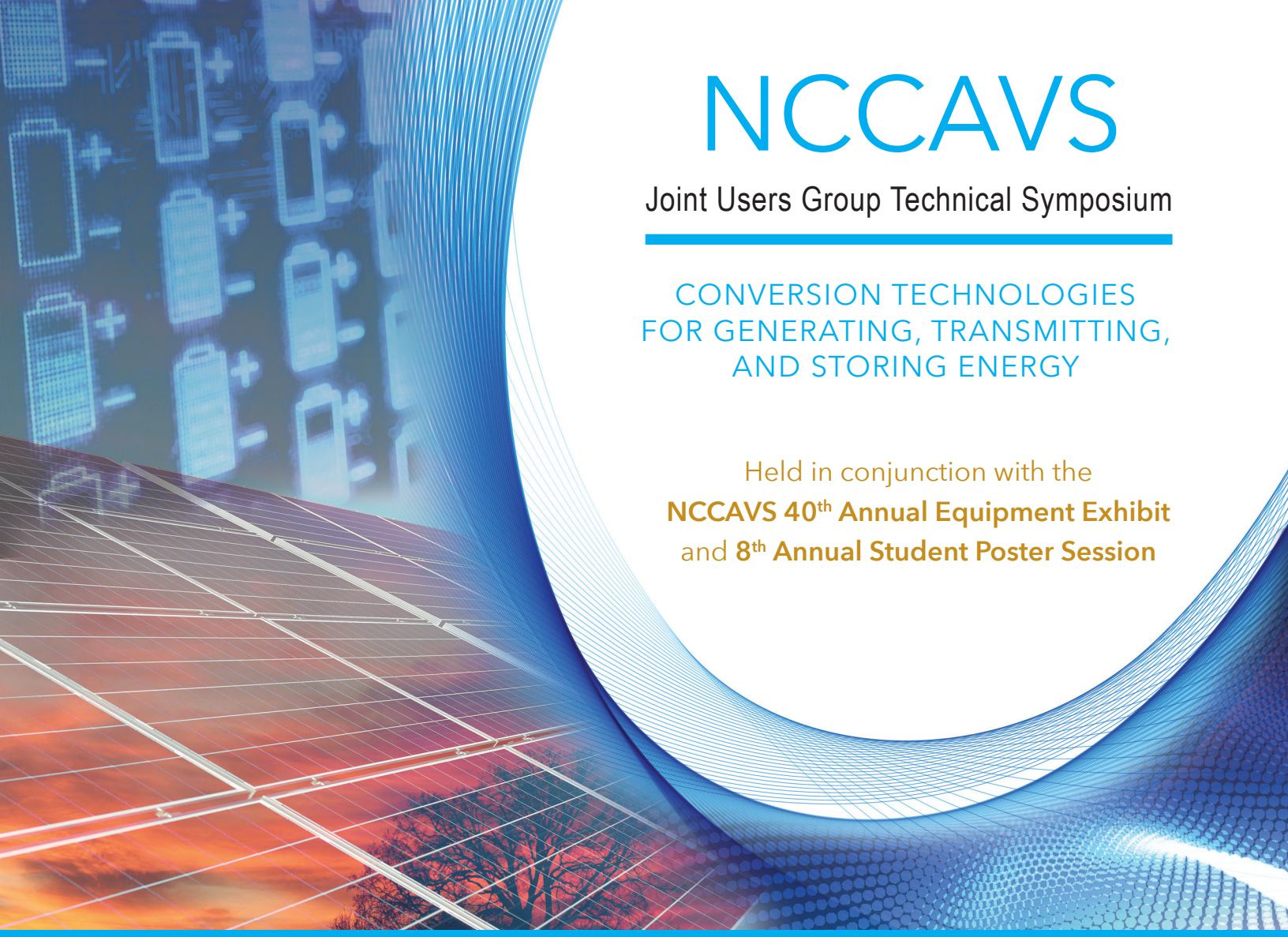

NCCAVS

Joint Users Group Technical Symposium

CONVERSION TECHNOLOGIES FOR GENERATING, TRANSMITTING, AND STORING ENERGY

Held in conjunction with the
NCCAVS 40th Annual Equipment Exhibit
and **8th Annual Student Poster Session**

Hosted by CMPUG, JTG, PAG, and TFUG | www.nccavs-usergroups.avs.org

HOLIDAY INN SAN JOSE - SILICON VALLEY | February 21, 2019 | 10 AM - 7 PM

EVENT SPONSORS

Agilent Technologies

UC COMPONENTS

JOINT USER GROUP TECH SYMPOSIUM SPONSORS

AMT

APPLIED MATERIALS

VERSUM MATERIALS

Morgan Advanced Materials

COMMITTEE

Chair: Paul Werbaneth, paulwerbaneth@n-c.com
Past-Chair: Susan Felch, sfelch@sbcgobal.net
Exhibit Chair: Chris Malocsay, chris_malocsay@avs.org
Poster Session Chair: Michael Oye, moye@ucsc.edu
Students: Heather Renee Sully, Cynthia Melendrez
JTG: Michael Current
PAG: Lucia Feng
TFUG: Ya-His Hwang, Mayu Yamamura
CMPUG: David Hansen

EXHIBITORS

Advanced Energy
Agilent Technologies
AGS Plasma Systems, Inc
ANCORP
Anderson Dahlen - Applied Vacuum Division
Applied Engineering
Applied Surface Technologies
Atlas Technologies
Brooks Automation
Centrotherm
Cosmotec
CS Clean Solutions, Inc
Denton Vacuum
DHF Technical Products
Duniway Stockroom Corporation
Dynavac
EAG
Ebara Technologies Inc
Edwards Vacuum
EP Laboratories, Inc
Flodynamix
Gamma Vacuum
GNB
Hiden Analytical Inc
HIS Innovations Group
INFICON
Intellivation
Intlvac Thin Film
Kashiyama-USA
Kaufman & Robinson, Inc
Key High Vacuum Products Inc.
KLA-Tencor Corp.
Kratos Analytical
Kurt J. Lesker Company
LACO
Leybold USA Inc.
Materials Science Inc.
Mbartech Inc.
MDC Vacuum Products LLC
MegaCold LLC
MeiVac Inc.
Mewasa USA
Milestone Technology
Molecular Vista, Inc
MPF Products, Inc.
NCCAVS Education Committee.
Nor-Cal Products, Inc
NSI
Omley Industries Inc.
Osaka Vacuum USA, Inc
Pfeiffer Vacuum
Physical Electronics
PI Scientific
Plasmaterials
Power Connection
Precision Plus Vacuum Parts
Process Materials Inc.
Protech Materials
Provac Sales Inc.
R.D. Mathis Company
Reliable Corporation
Rigaku Vacuum Products
SAES Group
SciAps, Inc.
Science from Scientists
Semicore Equipment Inc.
SemiTorr Group, Inc.
Solid Sealing Technology
SynSysCo
TDK-LAMDA Americas Neptune Division
Technetics Group
Telemark
TGM Inc.
Thermionics Laboratory Inc.
UC Components Inc.
UHV Transfer Systems Inc.
VACGEN
Vacuum Research Corp
Valqua America Inc.
VAT
Von Ardenne North America
XEI Scientific

AGENDA

10:00 – 10:05am

Introduction and Welcome, Paul Werbaneth

NOVEL BATTERIES SESSION

Chairs: Mayu Yamamura, Zoran Misetic

10:05 – 10:45am

Next Generation Energy Storage Technologies PLENARY SESSION

Speaker: Subramanya (Subra) Herle, Applied Materials

ABSTRACT

With renewable energies forecasted to make up over 50% of electricity generation by 2035 [1] energy storage is playing an increasingly bigger role in energy markets, from niches such as powering mobile devices and electric vehicles to broader roles such as replacing conventional coal-power generators and supporting renewable power integration.

From portable power to grid storage applications the demand for improvements in energy storage performance (Wh/l and Wh/kg), cycling efficiency and price ($/kWh) has continued to outpace technological innovation and what the market is able to provide. Among all energy storage technologies, lithium ion batteries (LIB) now play the central role in addressing some of the energy storage needs. However, LIB energy densities will soon reach their practical limit. This talk will review the current technologies of the state of the art Li-ion batteries, followed by a survey of potential next-generation battery technologies.

[1] “Global Energy Perspective 2019: Reference Case”, p. 5, McKinsey Energy Insights.

SPEAKER BIO

Dr. Subramanya Herle has over 16 years of experience with Li-ion battery research and ultra-thin film processing. Subra worked for the Panasonic Corporation battery division before joining Applied Materials in 2010. He currently is a Distinguished Member of the Technical Staff at Applied Materials and technology director in the Corporate CTO office. He has over 20 academic publications, 16 patents and presented work at conferences/workshops and invited talks.

10:45 – 11:15am

Solid-state Thin Film Batteries Take a Page Out of the 3D Transistor Play Books

Speaker: J.R. Gaines, Kurt J. Lesker Company

Abstract and Speaker Bio continues on the next page ▸

ABSTRACT

Solid-state thin film batteries, featuring a non-combustible high performance ceramic electrolyte, were demonstrated by Bates, et al. in the mid '90's. The cyclical performance of these early examples were extraordinary, despite their size-limited capacity. Their quick charging times and advanced safety features made these energy storage devices the hope of the portable electronics markets.

Turn your watches forward 25 years and these batteries are still not commonplace in the market. Several deposition techniques have been used but none beat the performance of sputtering. Issues with cost and the investment required to build capacity so that economies of scale can be leveraged have yet to materialize. One approach to reducing costs, given that cheaper deposition processes may not be effective, is to increase energy density. One approach to increase energy density is to steal an approach from the transistor industry and graduate from 2D to 3D architectures.

Atomic layer deposition (ALD) is one route which may succeed in making the dense, pin-hole free and conformal coatings that make up a solid state thin film battery. This process is very adept, with some limitations, at coating deeply trenched substrates with trenchesl exceeding 30 to 1 depth to width profiles.

In this talk recent advancements on the application of ALD to energy storage in thin solid films will be discussed. Performance comparisons and limitations for the 2D and 3D approaches will be aluminated and future work in the area of high density thin film micro-batteries will be discussed.

SPEAKER BIO

J.R. Gaines is Technical Director of Education for the Kurt J. Lesker Company and has the honor of developing and curating a suite of courses in vacuum technology designed to make his clients better vacuum technologists. He has had the pleasure to teach at many of the great universities, national laboratories and technology companies in the world including Harvard, Stanford, The Ohio State University, The National Institute of Standards, The National Renewable Energy Laboratory, the U.K. Atomic Energy Authority, the Max Plank Institute for MicroPhysics, The Chinese Institute of Physics, Intel, Texas Instruments, Seagate, Blue Origin, SpaceX and others. Through teaching, publishing and a passionately collaborative approach that spans many technologies, J.R. helps others better practice advanced vacuum.

11:15 – 11:45am

Advances and Challenges with Rechargeable Lithium-Air Batteries

Speaker: Dave Sopchak, Coulombic, Inc.

ABSTRACT

Rechargeable lithium-air (Li-air) batteries offer tantalizingly high energy densities. However, the practical challenges of combining a lithium metal negative electrode with an air electrode have kept Li-air batteries from getting out of the laboratory. This talk will present the basic science behind Li-air batteries, historical challenges, recent research, and successes in bringing this technology closer to market.

SPEAKER BIO

Dr. Dave Sopchak is the founder and CTO of Coulombic, Inc., a rechargeable Li-air startup in Oakland. Dr. Sopchak has worked in fuel cell and battery R&D for over 15 years and was Chief Scientist at Ultracell Corporation, which shipped the world's first reformed methanol portable fuel cell system. He earned his Ph.D. in electrochemistry from Case Western Reserve University in Cleveland in 2000 and was a postdoctoral researcher at Lawrence Livermore National Laboratory from 2002-2005, focusing on MEMS fuel cells. He holds 10 patents in fuel cells and batteries.

11:45 – 12:15pm

Peak Power Impact on Battery Cycle Life

Speaker: Naoki Matsumura, Intel

ABSTRACT

Mobile/IOT devices expect batteries to have long battery life and cycle life . This session talks about the importance of impedance for longer battery life and methods to extend battery cycle life through battery charging algorithm. These are expected to reduce the cost of ownership as it enables less battery replacement.

SPEAKER BIO

Naoki Matsumura is a senior battery technologist at Intel Corporation, responsible for technical assessment of new battery technologies, algorithms and sourcing for mobile/IOT devices. Prior to that, Naoki held battery research/ development roles at Panasonic. Naoki earned his MS in Energy Science from Kyoto University and holds many patents. Naoki is also a Lecturer of Battery Control Systems in the graduate school of engineering at San Jose State University.

12:15 – 1:30pm

FREE LUNCH in Exhibit Hall – Visit Equipment Exhibition FREE

ENERGY HARVESTING SESSION

Chairs: Lucia Feng, Sing-Pin Tay

1:30 – 2:00pm

Directly Converting Heat to Electricity using Compact, Microfabricated Thermionic Devices

Speaker: Jared Schwede, Spark Thermionics

ABSTRACT

Spark Thermionics is developing a “powerplant on a chip,” a thermionic energy conversion device that can turn any fuel into electricity very efficiently and with no moving parts. Spark was founded by world leaders in thermionic technology, and Spark has received wide recognition, including being featured in Physics Today, Fortune, the Official White House blog, and elsewhere. As part of the Cyclotron Road program, Spark is fully supported at Lawrence Berkeley National Lab to translate thermionic technology from academic proof-of-principle to prototype development and commercialization.

SPEAKER BIO

Jared Schwede completed his Ph.D. in the department of physics at Stanford University. At Stanford, he was part of a world-leading research group on thermionic energy converters, focusing on a breakthrough solar conversion process based on photon-enhanced thermionic energy conversion, which harvests both photon and heat energy from the sun’s spectrum. Schwede’s work on thermionics, developed together with his technology and business partner Daniel Riley, has been recognized with the Ross N. Tucker Award, which acknowledges excellence in semiconductor and materials research, at the Berkeley Energy and Resources Collaborative Innovation Expo, and by the Global Climate and Energy Project, among others.

2:00 – 2:30pm

AlN-based Piezoelectric Energy Harvesting

Speaker: Mary Ann Maher, SoftMEMS

SPEAKER BIO

Dr. Mary Ann Maher received her PhD from Caltech in 1989 in the area of semiconductor device modeling developing a new charge-based transistor model. At Caltech, she conducted research in the area of neuromorphic systems, analog circuits and transistor modeling. She pursued post doctoral studies at the CSEM in Neuchatel, Switzerland, where she studied analog memories and low power analog ICs with on-chip sensors for artificial vision applications. At Tanner Research she began the simulation and modeling group and launched Tanner's T-Spice analog circuit simulator product. She then became the Software Architect responsible for specifications for layout, routing, simulation, analysis, schematic and viewing design tools. As Director of Advanced Products, she brought to market Tanner's MEMS Pro microsystem and MCM Pro multi-chip module and packaging design tool suites. Moving to MEMSCAP, she became the company's CTO and the General Manager and Executive Vice President of the Design Automation Business Unit. In 2004, she started SoftMEMS, LLC, the maker of the popular microsystems design tools – MEMS Pro and MEMS Xplorer, where she serves as CEO.

2:30 – 3:00pm

Tribute to John W. Coburn

Speaker: David Graves, U.C. Berkeley

ABSTRACT

Dr. John W. Coburn was one of the most influential low temperature plasma and surface scientists of the 20th century. He passed away in San Jose, California on November 28, 2018. In this talk, I will summarize some of John's many contributions and his enormous impact on both fundamental understanding and applications associated with plasma-surface interactions, thin film deposition and etching. John was born in Vancouver, British Columbia and received his BS degree in Engineering Physics and his PhD in Electrical Engineering from the University of Minnesota. After his postdoctoral work at Simon Fraser University, John joined IBM Research (Almaden, California) in 1978. He worked at IBM for 25 years, and retired in 1993. John joined the AVS while still in graduate school and he served as the National AVS Treasurer for many years and in addition served as President in 1988. In 1994, John began to collaborate with me at UC Berkeley as a Senior Research Associate in the department of Chemical Engineering. He had a tremendous impact on me and my group over a period of over 20 years. This impact was both scientific and personal. In this talk, I describe some of John's most important work in non-equilibrium plasma science and plasma-surface interactions, with a special emphasis on the work he did at UC Berkeley with me and my co-workers.

SPEAKER BIO

David B. Graves joined the University of California at Berkeley in 1986 after receiving his PhD in Chemical Engineering from the University of Minnesota. He is currently Full Professor. His group studies the physics and chemistry of chemically active low temperature plasmas, including modeling and simulation, experimental studies of plasma using various gas phase and surface spectroscopies, dusty plasmas, plasma stability, plasma-electromagnetic interactions, plasma-organic and biological materials interactions, and plasma-liquid interactions. David Graves is a fellow of the American Vacuum Society and the Institute of Physics and was the recipient of the Electrochemical Society Young Author Award, the NSF Presidential Young Investigator Award, the Tegal Plasma Thinker Award, and the 3rd annual Plasma Prize of the Plasma Science and Technology Division of the AVS. He was named the Lam Research Distinguished Chair in Semiconductor Processing at UC Berkeley for 2011-16. He received the Allis Prize for the Study of Ionized Gases from the American Physical Society in 2014 and the 2017 International Symposium of Dry Processes Nishizawa Award.

3:00 – 3:20pm

BREAK

GaN IS GREEN SESSION

Chairs: Daphne Pappas, Jacques Matteau

3:20 – 3:50pm

How to Make Manufacturing of LEDs Truly Green

Speaker: Prasad N. Gadgil, Atomic Precision Systems

ABSTRACT

This paper analyzes Gallium Nitride (GaN) based High-brightness LED manufacturing process chemistry closely to evaluate total energy consumption and suggests novel pathways including the reactor design, new reactor sub-systems to accommodate new process chemistry that can help make HBLED manufacturing significantly less energy intensive. Prevalent HBLED manufacturing process employs tri-methyl Gallium (TMG), a liquid gallium precursor, in combination with ammonia gas to deposit MOCVD GaN layer at ~1,000 °C and in a 5 h process run. A single MOCVD consumes 18 million liters of Ultra High Purity ammonia (called white ammonia) per year at barely 10% efficiency. Ammonia is manufactured on large scale by combining methane and water at 700 – 1,100 °C, to generate H2 and CO2. Hydrogen is then combined with N2 obtained from air by separating O2 and other gases which is another energy intensive process. N2 and H2 are combined in a pressure vessel at 2,000 – 3,500 psi at 500 °C to manufacture ammonia (NH3) gas. This “technical grade” ammonia must be purified to ppb level and then supplied to an MOCVD system to obtain light from an LED device. In the end ~ 90% ammonia becomes effluent that must be scrubbed. Atomic Precision has developed an alternative GaN process pathway that employs GaCl3, a stable and inexpensive gallium precursor, in combination with N2 + H2 plasma to deposit GaN thin films at 500 °C. It is relatively simple and much less cumbersome to purify both N2 and H2 gases as compared to highly reactive gaseous ammonia. Real-time Computational Fluid Dynamics (CFD) simulation of the ALD-CVD reactor operation, linear microwave plasma source along with preliminary results of ALD-CVD reactor operation, system fabrication and also novel GaN process development are presented.

SPEAKER BIO

Prasad N. Gadgil is founder of Atomic Precision Systems Inc. He has more than two decades of experience in process chemistry, ALD, CVD reactor design, thin film processes and photovoltaics. He holds six US patents and has published 10 journal papers and an edited monograph. He has been an invited speaker in Germany, France, India and Canada. Prasad earned MSc degree in Chemistry from Indian Institute of Technology, Mumbai, India and PhD in chemical physics from Simon Fraser University, Vancouver, Canada.

3:50 – 4:20pm

GaN HEMT Electronics for Extreme Environments

Speaker: Saleh Kargarrazi, Stanford XLab

Abstract and Speaker Bio continues on the next page ▸

ABSTRACT

Gallium Nitride (GaN) HEMT has been shown as a viable semiconductor device for operation at extreme temperatures. In this talk, we discuss the GaN HEMTs we develope at EXtreme Environment Microsystems Lab (XLab) at Stanford, for sensor electronics module at extreme environments, and discuss aspects such as compact modeling and integrated circuit development for harsh atmospheres in automotive, geothermal exploration, aviation and space exploration.

SPEAKER BIO

Saleh Kargarrazi is currently a postdoctoral scholar in Aeronautics and Astronautics department at Stanford University. His research has been focused on wide-bandgap devices and circuits (including Silicon Carbide and Gallium Nitride) for extreme environments. He is a recipient of the prestigious Knut and Alice Wallenberg postdoctoral award at Stanford in 2017, as well as the winner of the KTH innovation competition “Digital Future” in 2016.

4:20 – 4:25pm

Closing Remarks, Paul Werbaneth

STUDENT POSTER SESSION

Chair: Michael Oye

4:30 – 6:00pm

Student Poster Session

Co-Chairs: Heather Renee Sully, Cynthia Melendrez

Judges: Susan Felch, Michael Current, Wenonah Vercoutere

STUDENTS

Dong-Il Moon, NASA Ames Research Center (USRA)
Myeonglok Seol, NASA Ames Research Center (USRA)
Heather Renee Sully, University of California Santa Cruz
Zeal Panchal, University of California Santa Cruz
Cynthia Melendrez, San Jose State University
David Fryauf, University of California Santa Cruz
Bin Yao, University of California Santa Cruz
Brian Giraldo, University of California Santa Cruz
Mina Tavakolzadeh, San Jose State University

4:30 – 6:30pm

Networking and Good Cheer in the Exhibition Hall

NOTES