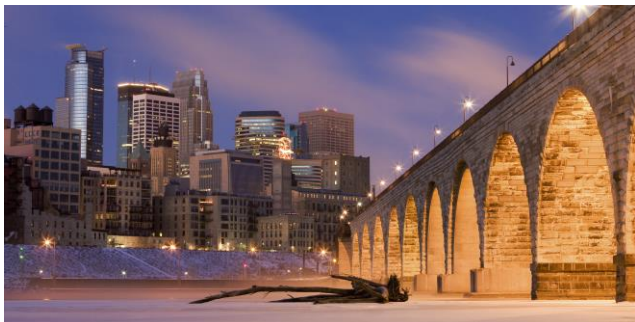




**International Conference on
Compound Semiconductor
Manufacturing Technology**

April 29th – May 2nd, 2019

www.csmantech.org



**Hyatt Regency
Minneapolis, Minnesota, USA**

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MESSAGE FROM THE CONFERENCE CHAIR

On behalf of the Executive and Technical Program Committees, it is my pleasure to welcome you to Minneapolis, MN for the 34th annual International Conference on Compound Semiconductor Manufacturing Technology (CS-MANTECH). From its inception in 1986, the CS-MANTECH conference has been the only conference dedicated to featuring manufacturing-focused presentations alongside state of the art compound materials challenges and industry-leading device performance demonstrations, all within a single venue. This year the conference continues this tradition, offering a diverse technical program in compound semiconductor manufacturing, advances in materials growth and characterization, and device performance improvements. This year's program includes traditional elements attendees have come to expect, including RF devices, process control, reliability, manufacturing, and fabrication processes. In addition, the conference features strong talks in emerging areas, including GaN and other wide bandgap devices, heterogeneous integration, power devices, and optoelectronic devices. As chair of this year's conference, I am gratified by the opportunity to help bring together compound semiconductor professionals from around the world to share information, exchange ideas, and establish professional ties within the community.

As with all previous CS-MANTECH conferences, this year's conference would not be possible without a tremendous amount of work from many individuals who have volunteered their time to ensure its success. I would like to thank *all* of the volunteers on the Technical Program Committee and the Executive Committee, along with their supporting organizations. It is the work of these individuals that enables CS-MANTECH to provide its important service to the compound semiconductor industry.

I look forward to welcoming you in person to Minneapolis, and to a successful 2019 CS-MANTECH!

Patrick Fay
University of Notre Dame
Conference Chair

CONFERENCE AT A GLANCE

SUNDAY, April 28th

6:00 PM – 8:00 PM

REGISTRATION
Nicollet Alcove D

7:00 PM – 9:00 PM

JEDEC JC-14.7 MEETING
St. Croix (2nd floor)

MONDAY, April 29th

7:00 AM – 7:00 PM

**CS MANTECH
REGISTRATION**
Nicollet Alcove D

7:00 AM – 8:30 AM

ROCS REGISTRATION
Nicollet Alcove A

7:00 AM – 8:30 AM

**CS MANTECH & ROCS
WORKSHOP BREAKFAST**
Nicollet D

8:15 AM – 5:15 PM

CS MANTECH WORKSHOP
Nicollet B-C

8:30 AM – 5:00 PM

ROCS WORKSHOP
Nicollet A

11:30 AM – 1:00 PM

**CS MANTECH & ROCS
WORKSHOP LUNCHEON**
Nicollet D

2:00 PM – 7:00 PM

**SPEAKER PREPARATION/
READY ROOM**
Grant Room

6:00 PM – 9:00 PM

EXHIBITS RECEPTION
Exhibit hall

6:15 PM – 8:55 PM

EXHIBITOR FORUM
Exhibit hall

TUESDAY, April 30th

7:00 AM – 5:00 PM

REGISTRATION
Nicollet Alcove D

7:00 AM – 7:00 PM

**SPEAKER PREPARATION/
READY ROOM**
Grant Room

7:00 AM – 8:00 AM

BREAKFAST
Exhibit hall

8:00 AM – 8:30 AM

OPENING CEREMONIES
Nicollet A-C

TUESDAY, April 30th continued

8:00 AM – 5:30 PM	EXHIBIT HOURS <i>Exhibit hall</i>
8:30 AM – 9:30 AM	SESSION 1: PLENARY <i>Nicollet A-C</i>
9:30 AM – 10:00 AM	BREAK <i>Exhibit hall</i>
10:00 AM – 12:00 PM	SESSION 1: PLENARY <i>Nicollet A-C</i>
12:00 PM – 1:30 PM	EXHIBITS LUNCH <i>Exhibit hall</i>
1:00 PM – 5:10 PM	EXHIBITOR FORUM <i>Exhibit hall</i>
1:30 PM – 3:10 PM	SESSION 2: 5G <i>Nicollet A</i>
1:30 PM – 3:10 PM	SESSION 3: MANUFACTURING CULTURE <i>Nicollet B-C</i>
3:10 PM – 3:40 PM	BREAK <i>Exhibit hall</i>
3:40 PM – 5:40 PM	SESSION 4: RF DEVICES AND FILTERS <i>Nicollet A</i>
3:40 PM – 5:40 PM	SESSION 5: GaAs PROCESS CONTROL & YIELD <i>Nicollet B-C</i>
5:45 PM – 6:45 PM	STUDENT FORUM <i>Lakeshore C</i>
7:00 PM – 10:00 PM	INTERNATIONAL RECEPTION <i>Minneapolis Institute of Art</i>

WEDNESDAY, May 1st

6:00 AM – 7:00 AM	CS MANTECH RUN/WALK <i>Hyatt Regency Minneapolis Loring Greenway Exit</i>
7:00 AM – 5:00 PM	REGISTRATION <i>Nicollet Alcove D</i>
7:00 AM – 7:00 PM	SPEAKER PREPARATION/ READY ROOM <i>Grant Room</i>

WEDNESDAY, May 1st continued

7:00 AM – 8:00 AM	BREAKFAST <i>Exhibit hall</i>
8:00 AM – 11:00 AM	EXHIBIT HOURS <i>Exhibit hall</i>
8:00 AM – 10:00 AM	SESSION 6: POWER ELECTRONICS PLENARY <i>Nicollet B-C</i>
10:00 AM – 10:30 AM	BREAK <i>Exhibit hall</i>
10:30 AM – 12:00 PM	SESSION 7: WIDE BANDGAP POWER DEVICES <i>Nicollet B-C</i>
10:30 AM – 12:10 PM	SESSION 8: HETEROGENEOUS INTEGRATION & PROCESSING <i>Nicollet A</i>
12:15 PM – 1:30 PM	OPEN <i>Lunch on your own with a little time to explore Minneapolis</i>
1:30 PM – 3:20 PM	SESSION 9: GaN LATERAL POWER DEVICES <i>Nicollet B-C</i>
1:30 PM – 3:30 PM	SESSION 10: DEVICE PROCESSING I <i>Nicollet A</i>
3:30 PM – 4:00 PM	BREAK <i>Nicollet Promenade</i>
4:00 PM – 5:40 PM	SESSION 11: TEST & CHARACTERIZATION – CS DEVICES <i>Nicollet B-C</i>
4:00 PM – 5:40 PM	SESSION 12: DEVICE PROCESSING II <i>Nicollet A</i>
6:00 PM – 8:00 PM	RUMP SESSIONS <i>Nicollet D & Lakeshore A-C</i>
8:00 PM – 9:00 PM	SEMI STANDARDS MEETING <i>St. Croix (2nd floor)</i>

THURSDAY, May 2nd

- 7:00 AM – 9:30 AM **REGISTRATION**
Nicollet Alcove D
- 7:00 AM – 12:00 PM **SPEAKER PREPARATION/
READY ROOM**
Minnehaha Room (2nd Floor)
- 7:00 AM – 8:00 AM **BREAKFAST**
Nicollet D
- 8:00 AM – 10:00 AM **SESSION 13:
OPTOELECTRONICS
PLENARY**
Nicollet B-C
- 10:00 AM – 10:30 AM **BREAK**
Nicollet Promenade
- 10:30 AM – 12:20 PM **SESSION 14: VCSEL**
Nicollet B-C
- 10:30 AM – 12:10 PM **SESSION 15: TEST &
CHARACTERIZATION OF
WIDE BANDGAP
HETEROSTRUCTURES**
Nicollet A
- 12:20 PM – 1:30 PM **CS MANTECH LUNCH**
Nicollet D
- 1:30 PM – 3:30 PM **SESSION 16: PROCESS
AND YIELD**
Nicollet B-C
- 1:30 PM – 3:30 PM **SESSION 17: MATERIALS
AND GROWTH
FUNDAMENTALS**
Nicollet A
- 3:40 PM – 4:30 PM **SESSION 18: POSTER
SESSION**
Lakeshore ballroom
- 4:30 PM – 5:30 PM **CLOSING RECEPTION**
Lakeshore ballroom
- 6:00 PM – 8:00 PM **CoInnovateCS Networking
Reception**
<https://www.coinnovatecs.com>

FRIDAY, May 3rd

- 8:00 AM – 8:30 AM **CoInnovateCS Registration**
- 8:30 AM – 1:15 PM **CoInnovateCS**
<https://www.coinnovatecs.com>

2019 CONFERENCE HIGHLIGHTS

On behalf of the Technical Program Committee for the 2019 CS MANTECH Conference, I thank you for participating in this year's program. We have an excellent conference planned and I am sure you will find many enlightening and informative talks and sessions for your enjoyment and edification.

CS MANTECH has its roots in the application of compound semiconductors for RF devices. This year we broaden the scope beyond RF into other compound semiconductor markets and are introducing a plenary session for each day. On Tuesday we will have a classic CS MANTECH plenary session. On Wednesday we will have our first dedicated CS MANTECH Power electronics plenary session followed by our CS Optoelectronic plenary session on Thursday. Both dedicated plenary sessions are comprised of a keynote and invited talks.

Another new feature this year is that we are co-located with CoInnovateCS (<https://coinnovatecs.com>) which is being held in the US for the first time. CoInnovateCS promises to offer an interactive one day event fostering innovation across the compound semiconductor supply chain, by exploring industry-led next generation challenges and opportunities.

Here are the highlights for the program:

Sunday, April 28th

- This year we are introducing our first CS MANTECH golf outing (weather permitting). More details can be found on our website and mobile app. Please check in frequently.

Monday, April 29th

- The program begins this year with our series of tutorial workshops. This year's workshop theme is "Fabrication Potpourri." Please see the CS MANTECH WORKSHOP section for details.
- Also, on Monday CS MANTECH is pleased to be hosting the internationally recognized Reliability of Compound Semiconductor (ROCS) workshop. This workshop is the premier forum for the presentation of the latest results and new developments related to compound semiconductor reliability. The JEDEC Committee JC-14.7 sponsors the ROCS workshop. Please see <http://www.jedec.org/home/gaas> for details.
- On Monday evening, the Exhibits open at 6:00 pm with the traditional Exhibits Reception. The CS MANTECH exhibits are an excellent opportunity to view suppliers of materials, services, and equipment from around the world. This is also a great time to reconnect with your friends and establish new

connections to identify new opportunities and help grow your success.

- At 6:15pm we will open the Exhibitor forum in the Exhibit hall. The Exhibitors' Forum provides an opportunity for exhibitors to present short marketing/technical presentations to the conference attendees.

Tuesday, April 30th

- The CS MANTECH Conference formally begins in the morning at 8:00 am with opening ceremonies that include the 2018 Best Paper awards, sponsorship recognition, and a conference overview along with a review of the conference mobile app. Please see the mobile app section for details.
- Following the opening ceremonies, we will have our traditional plenary session, which features three talks covering a wide spectrum of CS Industry topics. Tom Deitrich from Itron will give his perspective on the solutions and needs of IoT, utilities, and smart cities. Wayne Lam from IHS Markit will reflect on how mobile use cases dictates electronic design and Andrew Barnes from the European Space Agency will report on the first ESA missions to use gallium nitride (GaN).
- After lunch in the Exhibits Hall, we will reconvene for a full program of parallel sessions throughout the afternoon. Parallel sessions have been structured so that attendees can move between talks and sessions, with minimal overlap between the parallel sessions.
- We will also continue our Exhibitor forum in the Exhibit hall throughout the afternoon.
- The Tuesday technical session will conclude with the Student Forum. The Student Forum provides an opportunity for students to explore career options through networking with members of the CS community from industry, academia, and government.
- In the evening, CS MANTECH will host the International Reception (IR) at the Minneapolis Institute of Art. This annual event has been a fun and memorable highlight of past conferences and we anticipate an exciting evening again this year.

Wednesday, May 1st

- For a mid-week rejuvenator, join us in the morning at 6:00 am for a non-competitive run or walk along the Loring Greenway through Loring Park. More details can be found on our website.
- Wednesday morning begins with breakfast in the Exhibitor Hall where attendees can follow up on questions from the Exhibitors' Forum or meet with one or two new vendors.
- We will open the technical program on Wednesday with our first dedicated Power Electronics plenary at 8:00 am. John Palmour from Wolfspeed will focus on

the current status of SiC materials and devices for use in power applications. Dr. Koji Shiozaki from Nagoya University will present a new mobility concept called all GaN vehicles (AGV), and Dr. Frank Wischmeyer from Aixtron reviews the latest developments of epitaxy production technology for SiC and GaN.

- Following the morning break, a full program of parallel sessions will take place throughout the day.
- Lunch will be at your own leisure (or time to explore Minneapolis), with parallel sessions continuing in the afternoon starting at 1:30 pm.
- We will close the day with our traditional Rump session starting at 6:00 pm with a reception. Please see the Rump Session section for details.
- At 8:00 pm the SEMI Standard Meeting will be held.

Thursday, May 2nd

- On Thursday, we will open the technical program with our first dedicated Optoelectronics plenary at 8:00 am. Chuck Mattera from II-VI will provide an overview and perspective on vertical-cavity-surface-emitting-lasers (VCSELs). Fred Kish of Infinera Corporation will discuss key elements of success for volume manufacturing of InP based photonic integrated circuits, and Eric Virey of Yole Développement will present on the hype, reality, hopes and challenges of MicroLED displays.
- Following the morning break, we will continue with parallel sessions.
- At noon, all conference attendees are invited to join us for the CS MANTECH conference luncheon.
- After lunch, we will hold our last two parallel sessions followed by the poster session. The closing reception features prizes for the conference contest (best semiconductor joke or meme), as well as for best poster and conference feedback. We will also have a special guest, John DeBoer (<http://www.johndeboer.com>). Come see the posters, join the contest, and enjoy our conference closing reception.
- CoInnovateCS open its doors at 6:00pm (please see <https://coinnovatecs.com> for more details and registration information)

Thank you again for being part of this year's conference and welcome to Minneapolis!

Thorsten Saeger
Qorvo
Technical Program Chair
2019 CS MANTECH

2019 CONFERENCE SPONSORS

CS MANTECH is an independent not-for-profit organization whose mission is to promote technical discussion and scientific education in the compound semiconductor manufacturing industry. The continued success of the conference is enabled by donations from corporate sponsors. The 2019 CS MANTECH Conference Committee gratefully acknowledges the support from our sponsors.

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2019 CS MANTECH WORKSHOP

Monday, April 29th, 2019
8:00 AM – 4:30 PM

The theme of this year’s workshop is “Fabrication Potpourri”.

The technology that we use and produce in our day-to-day work lives is constantly changing. This year's workshop will take some time to refresh some basic skills and knowledge of value to the semiconductor engineer and also look forward to opportunities for the industry.

The morning talks will focus on changing trends in semiconductor foundry operations and process optimization. The first talk comes from SkyWater Technology Foundry. Tom Legere, the Senior Vice President of Operations, will discuss how to manage a high mix technology foundry in the age of “more than Moore.” The following extended talk from Joseph Holyoak at Qorvo will provide an overview of Six Sigma (6σ) practices describing how statistical analysis and proper design of experiments (DOEs) can be used for process optimization and to ensure high quality of output.

Shifting focus, the afternoon workshop talks will begin with discussions on emerging opportunities for the compound semiconductor industry. Michael O’Neal, Senior Director of Design and Advanced Engineering at Qorvo, will provide an overview of 5G networks and the role compound semiconductor technologies can play. The next workshop talk comes from Dr. Dennis Deppe of sdPhotonics in which he will discuss vertical-cavity surface-emitting lasers (VCSELs). Various VCSEL technologies will be described along with market drivers and applications.

Following the afternoon break, the final talk of the day will be jointly presented with the Reliability of Compound Semiconductors (ROCS) workshop. Dr. Mike Salmon, a Scientific Fellow from EuroFins-EAG, will discuss destructive physical analysis (DPA) describing various imaging and analytical techniques. Methodologies for determination of underlying root cause in unique failures addressed through multi-technique case studies will be presented.

2019 ROCS WORKSHOP

Reliability Of Compound Semiconductors

Monday, April 29th, 2019

8:30 AM – 5:00 PM

The 35th annual ROCS Workshop will be held in conjunction with the CS MANTECH Conference on Monday April 29th, 2019, at the Hyatt Regency Minneapolis in Minneapolis, Minnesota, USA. This workshop is sponsored by the JEDEC JC-14.7 Committee on GaAs Reliability and Quality Standards. The ROCS Workshop brings together researchers, manufacturers and users of compound semiconductor materials, devices and circuits. Papers presenting latest results, including work-in-progress and new developments in all aspects of compound semiconductor reliability will be presented.

2019 CoInnovateCS

Friday, May 3rd, 2019

8:00 AM – 1:15 PM

Held in the US for the first time and co-located with CS-MANTECH in Minneapolis, CoInnovateCS provides a unique opportunity to collaborate with experts in compound semiconductor manufacturing. CoInnovateCS is a unique and intense interactive one day event fostering innovation across the compound semiconductor supply chain, by exploring industry-led next generation challenges and opportunities. This year's CoInnovateCS event will focus on emerging trends across the compound semiconductor industry. The conference promises an agenda with engaging activities, including inspirational talks, panel sessions, technology pitches and CoSynergy workshops where we will explore challenges and opportunities in a more innovative and collaborative way. More details can be found online: <https://coinnovatecs.com/>

INDUSTRY EXHIBITS

2019 will continue the CS MANTECH tradition of holding a robust exhibits program in parallel with the technical conference to facilitate interactions and exchange amongst members of the compound semiconductor industry. Exhibitors spanning the full range of materials, equipment, and services relevant to the compound semiconductor industry will be on hand to interact with conference attendees. Vendors of substrates, process gas and specialty material suppliers, fabrication, inspection and test equipment providers, technical and manufacturing consulting services, and industrial publication venues will be there.

To facilitate interactions between exhibitors and attendees, an **Exhibits Reception will be held on Monday evening, April 29th**, in the exhibition hall. The exhibits will also be open all day Tuesday, April 30th through Wednesday morning, May 1st until 11:00 AM, with breakfasts, coffee breaks, and lunch on Tuesday during the conference all taking place in the exhibition hall. Additionally, **a series of Exhibitor Forum events will take place on Monday from 6:15 PM – 8:55 PM and Tuesday from 1:00 PM to 5:10 PM in the Exhibit Hall.** These events provide participating exhibitors an opportunity to more fully showcase their products and services.

2019 EXHIBITORS

ABLEtech
Accel-RF
Advanced compound semiconductors beijingCo., Ltd
AIXTRON Inc.
ANNEALSYS
ASAP AXR
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II-VI Advanced Materials
II-VI EpiWorks
Innovion Corporation
Insaco, Inc

Inspectrology LLC
Intelligent Epitaxy Technology Inc.
IQE plc
JEOL USA, INC
JST
k-Space Associates, Inc
LayTec
Matheson Tri-Gas, Inc.
MEI Wet Process
MicroChem Corp
MSE Supplies
Nanotronics
Nel Hydrogen
Neutronix Quintel
Oxford Instruments - Plasma Technologies
Picosun USA LLC
Plasma-Therm
Pozzetta
R2D Automation
Reedholm Systems
Revasum
Samco, Inc.
Semilab
SGL Carbon
Shin-Etsu MicroSi
SPTS Technologies
StratEdge Corporation
Sumitomo Chemical Advanced Technologies
Toho Technology
ULVAC, Inc.
Vacuum Engineering & Materials
Veeco
Virginia Diodes Inc.
Visual Photonics Epitaxy Co., Ltd
Vital Materials Co., Limited
Wafer World Inc.
Wolfspeed, A Cree Company
Yield Engineering Systems, Inc.

EXHIBITOR FORUM SCHEDULE

MONDAY, April 30th, 2019

Location: *Exhibits Hall*

6:15 PM to 6:25 PM Wolfspeed
6:30 PM to 6:40 PM Canon USA
6:45 PM to 6:55 PM Bruker Semiconductor
7:00 PM to 7:10 PM EpiGaN
7:15 PM to 7:25 PM Evatec
7:30 PM to 7:40 PM ANNEALSYS
7:45 PM to 7:55 PM Fujimi Corp
8:00 PM to 8:10 PM DISCO Hi-Tec
8:15 PM to 8:25 PM Inspectrology LLC
8:30 PM to 8:40 PM Beneq
8:45 PM to 8:55 PM LayTec

EXHIBITOR FORUM SCHEDULE (Continued)

TUESDAY, May 1st, 2019

Location: *Exhibits Hall*

1:00 PM to 1:10 PM AIXTRON
1:15 PM to 1:25 PM EAG Laboratories
1:30 PM to 1:40 PM GT Advanced Technologies
1:45 PM to 1:55 PM II-VI Advanced Materials
2:00 PM to 2:10 PM ePak
2:15 PM to 2:25 PM PlasmaTherm
2:30 PM to 2:40 PM Evatec
2:45 PM to 2:55 PM SPTS Technologies
3:00 PM to 3:10 PM Revasum
3:15 PM to 3:25 PM Samco
3:30 PM to 3:40 PM Yield Engineering Systems
3:45 PM to 3:55 PM Nanotronics
4:00 PM to 4:10 PM Nel Hydrogen
4:15 PM to 4:25 PM Oxford Instruments

INTERNATIONAL RECEPTION

On Tuesday, April 30th evening, CS MANTECH will host the International Reception. This annual event has been a fun and memorable highlight of past conferences and we anticipate an exciting evening again this year. This year the International Reception will be held at the Minneapolis Institute of Art (MIA). Join us to socialize with your colleagues and experience diverse art from around the world. (<https://new.artsmia.org/>).

CS MANTECH CONFERENCE CONTEST

The conference contest this year will test both your wit and semiconductor knowledge. The goal is to submit your best (clean) semiconductor meme or joke. The best entry wins a prize and is shared at the conference closing. Good luck!

2019 CS MANTECH ONLINE DIGEST

CS MANTECH will again be offering an online digital version of the conference technical proceedings. Digital copies of the papers presented at the 2019 International Conference on Compound Semiconductor Manufacturing Technology will be available for download and viewing from our online site during the conference. Printed 2019 digests were offered to attendees who requested a copy at the time of conference registration and if registration was completed by the early registration deadline, April 5th.

To access the 2019 online digest, go to to www.csmantech.org and click on “2019 Online Digest”.

SEMI STANDARDS MEETING

The SEMI Standards meeting is scheduled for Wednesday May 1st, from 8:00 pm to 9:00 pm in the St. Croix meeting room on the 2nd floor. The SEMI Compound Semiconductor (GaAs, InP and SiC) Committee invites CS MANTECH Conference attendees interested in the development of internationally approved standards for wafer specifications to attend this meeting. Topics being addressed are GaAs, InP, and SiC dimensions/orientations and electrical properties, epitaxial layer specifications (which properties should be specified, and how they are to be verified), and non-destructive test methods.

Based in Milpitas, CA, SEMI is an international trade association serving more than 2,400 companies participating in the semiconductor and flat panel display equipment and materials markets. SEMI maintains offices in Berlin, Grenoble, Tokyo, Seoul, Hsinchu, Shanghai, Singapore, Bangalore, and Washington, DC. For additional information, please contact: Co-Chair: James Oliver of Northrop Grumman at 410-765-0117 or j.oliver@ngc.com, Co-Chair: Russ Kremer of Freiburger Compound Materials at 937-291-2899 or russ@fcm-us.com, or at SEMI Standards contact Kevin Nguyen at 408-943-7997 or knguyen@semi.org.

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Technical Program Committee - continued

Randy Lewis, *Northrop Grumman*
Chuanxin Lian, *Qorvo*
Chuck Liu, *San'an-IC*
Shenghou Liu, *San'an-IC*
Earl Lum, *EJL Wireless Research*
Steve Mahon, *Feldman Engineering*
David Meyer, *Naval Research Laboratory*
Greg Mills, *AXR*
Peter Moens, *ON Semiconductor*
Bobb Mohondro, *S-cubed*
Karen Moore, *NXP Semiconductors*
Stephen Myers, *Lumentum*
Mitsuhiro Nakamura, *Sony*
Corey Nevers, *Qorvo*
Yogi Ota, *Duet RF Solutions*
Yohei Otoki, *SCIOCS*
Anita Pacheco, *Qorvo*
Paul Pinsukanjana, *IntelliEPI*
Fabian Radulescu, *Wolfspeed, A Cree Company*
Karen Renaldo, *Northrop Grumman*
Kelli Rivers, *Vacuum Engineering & Materials Co.*
Thomas Roedle, *Ampleon*
Mariam Sadaka
Robert Sadler, *MACOM Technology Solutions*
Thorsten Saeger, *Qorvo*
Chris Santana, *IQE*
Gerhard Schoenthal, *Virginia Diodes, Inc.*
Rüdiger Schreiner, *Consultant*
Shyh-Chiang Shen, *Georgia Tech*
Scott Sheppard, *Wolfspeed, A Cree Company*
Alex Smith, *Brewer Science, Inc.*
Andy Souzis, *II-VI Advanced Materials*
Joerg Spletstoesser, *United Monolithic Semiconductor GmbH*
Christopher Stender, *MicroLink Devices, Inc.*
Kevin Stevens, *IQE*
Susan Stevens, *Analog Devices, Inc.*
Eric Stewart, *Northrop Gumman*
Hermann Stieglauser, *United Monolithic Semiconductor GmbH*
Mike Sun
Jim Tatum, *Photon Sciences*
Shiban Tiku, *Skyworks Solutions*
Naveen Tipirneni, *Texas Instruments*
Matthew Tyhach, *Raytheon*
Jansen Uyeda, *Northrop Grumman*
Kevin Vargason, *IntelliEPI*
Glen "David" Via, *Air Force Research Laboratory*
David Wang, *Global Communication Semiconductors, LLC*
Russ Westerman, *Plasma-Therm LLC*
Keith Wieber, *Qorvo*
Walt Wohlmuth, *Win Semiconductors Corp.*
Barry Wu, *Keysight Technologies*
Takuji Yamamura, *Sumitomo Electric*
Wei Zhang, *AXT*
Guoliang Zhou, *Skyworks Solutions*
Heribert Zull, *OSRAM Opto Semiconductors GmbH*

TECHNICAL PROGRAM

Monday, April 29th

CS MANTECH WORKSHOP

“Fabrication Potpourri”

- Location:** *Nicollet B-C*
Chairs: Gerhard Schoenthal, *Virginia Diodes*
Glen “David” Via, *Air Force Research Laboratory*
- 7:00 AM **REGISTRATION**
- 7:30 AM **WORKSHOP BREAKFAST**
- 7:50 AM **WELCOME AND INTRODUCTIONS**
- 8:00 AM **Making Moore Happen: Managing a High Mix Technology Foundry**
Tom Legere, *SkyWater Technology Foundry*
- 9:00 AM **6 σ – What it is and how to use it**
Joseph Holyoak, *Qorvo*
- 10:00 AM **BREAK**
- 10:30 AM **6 σ – What it is and how to use it (continued)**
Joseph Holyoak, *Qorvo*
- 12:00 PM **WORKSHOP LUNCH**
(CS MANTECH & ROCS)
- 1:00 PM **5G: Changing the way we work, live and play**
Michael K O’Neal, *Qorvo*
- 2:00 PM **Oxide and Oxide-Free VCSELs for High Market Volume Manufacturing and New Applications**
Dennis Deppe, *sdPhotonics LLC*
- 3:00 PM **BREAK**
- 3:30 PM **Advanced Failure Analysis of Compound Semiconductors**
Mike Salmon, *EuroFins-EAG*
- 4:30 PM **WRAP UP**
- 6:00 PM **EXHIBITS RECEPTION**

Monday, April 29th

ROCS WORKSHOP

- Location:** *Nicollet A*
Chair: *Don Gajewski, Wolfspeed, A Cree Company*
- 7:30 AM **ROCS REGISTRATION**
- 7:30 AM **WORKSHOP BREAKFAST**
- 8:30 AM Welcome & Opening Remarks
- 8:40 AM ROCS Session 1: GaN Voltage Stress Testing
- 10:30 AM ROCS Session 2: GaN Qualification Testing
- 12:00 PM **WORKSHOP LUNCH**
(CS MANTECH & ROCS)
- 1:00 PM ROCS Session 3: CS Reliability Potpourri
- 2:00 PM Tutorial – GaN Reliability Testing
David Sanderlin, *Accel-RF*
- 3:00 PM ROCS Shocks! Photo Contest
- 3:30 PM Combined ROCS/CS MANTECH Talk:
Advanced Failure Analysis of Compound Semiconductors
Mike Salmon, *EuroFins-EAG*
- 4:30 PM **WRAP UP**
- 6:00 PM **EXHIBITS RECEPTION**

Tuesday, April 30th

CONFERENCE OPENING

Location: *Nicollet A-C*

- 8:00 AM **Opening Ceremonies**
Patrick Fay, Conference Chair
University of Notre Dame
- 8:10 AM **2018 Conference Best Paper Awards**
Patrick Fay, Conference Chair
University of Notre Dame
- 8:20 AM **Technical Program Highlights**
Thorsten Saeger, Technical Program Chair
Qorvo

SESSION 1: PLENARY

Location: *Nicollet A-C*

Chairs: Patrick Fay, *University of Notre Dame*
Thorsten Saeger, *Qorvo*

- 8:30 AM *Invited Presentation*
1.1 A Perspective on the Solutions and Needs of IoT, Utilities, and Smart Cities
Tom Detrich
Itron
- 9:30 AM **BREAK**
- 10:00 AM *Invited Presentation*
1.2 Form follows function: Mobile use-cases dictates electronic design, not the other way around
Wayne Lam
HIS Markit – Technology, Media & Telecom
- 11:00 AM *Invited Presentation*
1.3 First ESA missions to use gallium nitride (GaN) – a disruptive technology for space based payloads
Andrew Barnes
European Space Agency
- 12:00 PM **EXHIBITS LUNCH**
Exhibits Hall

Tuesday, April 30th

SESSION 2: 5G

Location: *Nicollet A*

Chairs: Takuji Yamamura, *Sumitomo Electric*
Yogi Ota, *Duet RF Solutions*

1:30 PM *Invited Presentation*

2.1 5G Implications for the Compound Semiconductor Industry

Earl J. Lum

EJL Wireless Research LLC

2:00 PM *Invited Presentation*

2.2 How Will 5G Influence the RF Compound Semiconductor Industry?

Eric Higham

Strategy Analytics

2:30 PM **2.3 Development of InP DHBTs with High Breakdown Voltage for Ka-Band PA Applications**

Yuefei Yang¹, Dheeraj Mohata¹, David Rasbot¹, R. Soligo¹, David Wang¹, Robert Bayruns², John Bayruns², David Osika² and Joseph Brand²

¹*Global Communication Semiconductors, LLC.*

²*Duet Micro Electronics, Inc.*

2:50 PM **2.4 5G impact on mobile RF Front End**
Ezgi Dogmus, Cédric Malaquin and Claire Troadec

Yole Développement

3:10 PM **BREAK**

Tuesday, April 30th

SESSION 3: MANUFACTURING CULTURE

Location: *Nicollet B-C*

Chairs: Keith Wieber, *Qorvo*
Sarang Kulkarni, *Skyworks Solutions*

- 1:30 PM *Invited Presentation*
3.1 Complexity vs. Continuous Process Improvement
Gad (Gadi) Dvir
Strategy Implementation LLC Managing Member
- 2:00 PM **3.2 Fast Throughput Improvement Through Speed Modeling Using Tool Matching and Process Optimization**
Marino Arturo
The MAX Group
- 2:20 PM **3.3 Improving Root Cause Analysis Accuracy Using Advanced Sensor Trace Analytics**
Michael Zhao¹, Kim Kok Gan²
¹Global Foundries, ²BISTel America
- 2:40 PM *Invited Presentation*
3.4 Implementation of Automated Process Dashboards
Jens Riege, Donnie Lee, Rainier Lee, Nercy Ebrahimi
Skyworks Solutions, Inc.
- 3:10 PM **BREAK**

Tuesday, April 30th

SESSION 4: RF DEVICES AND FILTERS

Location: *Nicollet A*

Chairs: Haldane Henry, *Qorvo*
Serge Karboyan, *University of Bristol*

3:40 PM *Invited Presentation*

4.1 Dynamic Range-enhanced Electronics and Materials

Young-Kai Chen¹, Tsu-Hsi Chang², Abirami Sivananthan³

¹*Defense Advanced Research Projects Agency,*

²*HetInTec Corp.*

³*Booz Allen Hamilton*

4:10 PM

4.2 Investigation of RF Performance of InGaP/GaAs HBT Power Stage with Flip-Chip Bumping Technology

Fan-Hsiu Huang, Jung-Hao Hsu, Tung-Yao Chou, Shu-Hsiao Tsai, Cheng-Kuo Lin, Dennis Williams, and Yu-Chi Wang

WIN Semiconductors Corp.

4:30 PM

Invited Presentation

4.3 Epitaxial material for RF filters

Andrew Clark¹, Rytis Dargis¹, Mukul Debnath¹, Robert Yanka¹, Rich Hammond², Rodney Pelzel³, Mingyo Park⁴, Azadeh Ansari⁴

¹*IQE NC*

²*IQE Silicon*

³*IQE PA*

⁴*Georgia Institute of Technology*

5:00 PM

4.4 Monolithic integration of surface acoustic wave (SAW) filters on GaN HEMT dies: Avoiding impedance matching through energy trapping

Stefano Valle¹, Manikant Singh², Martin Cryan¹, Martin Kuball², and Krishna C. Balram¹

¹*University of Bristol*

²*Centre for Device Reliability and Thermography, University of Bristol*

5:20 PM

Student Presentation

4.5 High-quality AlN/sapphire-based Surface Acoustic Wave Filter With 5.75 dB Insertion Loss

Qiong Feng¹, Yun Zhang¹, Shuai Yang¹, Yujie Ai¹, Zhe Cheng¹, Lian Zhang¹, Lifang Jia¹, Boyu Dong², Baohui Zhang²

¹*Institute of Semiconductors, Chinese Academy of Sciences*

²*NAURA Technology Group Co., Ltd*

Tuesday, April 30th

SESSION 5: GaAs PROCESS CONTROL & YIELD

Location: *Nicollet B-C*

Chairs: Marty Brophy
Susan Stevens, *Analog Devices, Inc.*

- 3:40 PM **5.1 High-Volume pHEMT Yield Improvement Through Mitigation of Incomplete Removal of InGaP**
Robert Waco, Yiping Wang, Chang'e Weng, David Punsalan, Ron Herring
Qorvo
- 4:00 PM **5.2 A Systematic Data Mining Approach to separate Epitaxial Impacts from Process Impacts for GaAs pHEMT Technologies**
Peter Gretz, Franck Bourgeois, and Michael Hosch
United Monolithic Semiconductors GmbH
- 4:20 PM **5.3 Modelling of Backside-induced ESD Defects in GaAs Front End Manufacturing**
Michael Hosch, Raphael Ehrbrecht, Markus Lanz, Holger Weiner, and Dag Behammer
United Monolithic Semiconductors GmbH
- 4:40 PM **5.4 Addressing 0.25 um T-Gate Lithography Defects through Data Driven Fit Model Analysis**
Monique Farrell, Kai Shin, Brittany Janis, Kevin Frey, John Mason, Gary Hughes, Christopher Ridpath, Megan Snook, Aditya Gupta, H. George Henry, David Lawson, Jim Arnold, Josephine Chang, Eric Seabron
Northrop Grumman Corporation
- 5:00 PM **5.5 Gold Electroplating Optimization in Diffusion-Limited Regime**
Vinh Ho, Justin van Staden, Rainier Lee and Daniel Weaver
Skyworks Solutions, Inc.
- 5:20 PM **5.6 Investigation of MIM Top Metal Peeling in Relation to Transitional Flow during Metal Deposition Process**
Chang'e Weng, Tertius Rivers, Moreen Minkoff, Ron Herring, Richard Ducusin, Jinhong Yang and Joseph Chinn
Qorvo
- 5:45 PM **STUDENT FORUM**
- 7:00 PM **INTERNATIONAL RECEPTION**
Minneapolis Institute of Art

Wednesday, May 1st

SESSION 6: POWER ELECTRONICS PLENARY

Location: *Nicollet B-C*

Chairs: Naveen Tipirneni, *Texas Instruments*
Martin Kuball, *University of Bristol*

8:00 AM *Invited Presentation*

6.1 Current Status of SiC Materials and Devices for use in Power Applications

John Palmour

Wolfspeed, A Cree Company

9:00 AM *Invited Presentation*

6.2 GaN-based Electrified Mobility for Sustainable Society

Koji Shiozaki¹, Y. Nakayama¹, Y. Kanazawa²
¹*Nagoya University*, ²*Naturanix Co.*

9:30 AM *Invited Presentation*

6.3 Epitaxy production technologies enabling next generation product roadmaps of wide band-gap semiconductor device industry

Frank Wischmeyer

AIXTRON SE

10:00 AM **BREAK**

SESSION 7: WIDE BANDGAP POWER DEVICES

Location: *Nicollet B-C*

Chairs: Don Gajewski, *Wolfspeed, A Cree Company*
Martin Huber, *Infineon Technologies Austria AG*

10:30 AM *Invited Presentation*

7.1 Advances in Vertical GaN Power Devices on GaN Substrates

T. Oka, T. Ina, Y. Ueno, N. Tanaka, J. Kurosaki, T. Suzuki, J. Nishii, K. Hasegawa, K. Yasunishi, G. Nishio, S. Murakami, and N. Murakami

TOYODA GOSEI Co., Ltd.

11:00 AM *Invited Presentation*

7.2 Accelerating Commercialization of Wide-Bandgap Power Electronics – The Power America Manufacturing Initiative

Victor Veliadis

North Carolina State University

Wednesday, May 1st

- 11:30 AM *Invited Presentation*
7.3 SiC Power MOSFET Manufacturing, Performance and Reliability for the Electric Vehicle Market
B. Hull, S.-H. Ryu, E. Van Brunt, D. Lichtenwalner, S. Sabri, M. McCain, A. Romero, P. Steinmann, J. Richmond, S. Ganguly, D. Gajewski, A. Barkley, S. Allen, J. Palmour
Wolfspeed, A Cree Company
- SESSION 8: HETEROGENEOUS INTEGRATION AND PROCESSING**
- Location: *Nicollet A*
Chairs: Hermann Stieglauer, *United Monolithic Semiconductor GmbH*
Greg Mills, *AXR*
- 10:30 AM **8.1 Layer transfer of high-voltage, GaN-on-GaN pn diodes through epitaxial lift-off**
Chris Youtsey¹, Robert McCarthy¹, Rekha Reddy¹, Andy Xie², Ed Beam², Lou Guido³, Jingshan Wang⁴, and Patrick Fay⁴
¹*MicroLink Devices, Inc*, ²*Qorvo*
³*Virginia Tech*, ⁴*University of Notre Dame*
- 10:50 AM *Invited Presentation*
8.2 Heterointegration of III-V Device Structures on Si Substrates via Direct MBE Growth
A. W. K. Liu¹, D. Lubyshev¹, J. M. Fastenau¹, M. Fetters¹, H. Krysiak¹, J. Zeng¹, M. Kattner¹, P. Frey¹, S. A. Nelson¹, X.-M. Fang¹, A. O. Morgan², S. A. Edwards², and M. J. Furlong³
¹*IQE PA*, ²*IQE Silicon*, ³*IQE IR*
- 11:20 AM **8.3 GaN quasi-MMIC HPAs with IPDs on HRS using via first TSV process**
Sangmin Lee, Seokgyu Choi, Ho Geun Lee, Sung Won Lee, Young Jae Kim, Min Han, and Jinman Jin
Wavice Inc.
- 11:40 AM *Invited Presentation*
8.4 CMP Process Development on III-V Substrates for 3D Heterogeneous Integration
Miguel Urteaga¹, Andrew Carter¹, Sangki Hong², Robert Patti², Carl Petteway², Gill Fountain²
¹*Teledyne Scientific & Imaging*
²*NHanced Semiconductors Inc.*
- 12:15 PM **OPEN** - Lunch on your own

Wednesday, May 1st

SESSION 9: GaN LATERAL POWER DEVICES

Location: *Nicollet B-C*

Chairs: Nicholas Dellas, *Texas Instruments*
Mitsuhiro Nakamura, *Sony*

- 1:30 PM *Invited Presentation*
9.1 AlGa_N/Ga_N Power Devices in a Si World : From R&D to Manufacturing and Reliability
P. Moens, P. Kostelnik and A. Constant
ON Semiconductor
- 2:00 PM **9.2 Demonstration of GaN-on-silicon material system operating up to 3 kilovolts with reduced trapping effects**
R. Kabouche¹, I. Abid¹, M. Zegaou¹, K. Cheng², and F. Medjdoub¹
¹*IEMN-CNRS*, ²*Enkris Semiconductor*
- 2:20 PM **9.3 Process Development Enabling Lateral GaN JFET Devices for Robust Power Switching on 200 mm Engineered Substrates**
Travis J. Anderson¹, James C. Gallagher², Geoffrey M. Foster², Andrew D. Koehler¹, Marko J. Tadjer¹, Ozgur Aktas³, Vladimir Odnoblyudov³, Cem Basceri³, Karl D. Hobart¹
¹*U.S. Naval Research Laboratory*
²*ASEE Postdoctoral Fellow Residing at NRL*
³*Qromis, Inc.*
- 2:40 PM *Student Presentation*
9.4 Improved Dynamic ON-resistance of a Normally Off p-GaN Gate High-Electron-Mobility Transistor Using a Nongated-Region Oxidation Technique
Chia-Hao Liu¹, Hsuan-Ling Kao¹, Hsien-Chin Chiu¹, Yi-Sheng Chang¹, Hao-Yu Wang¹, Chao-Wei Chiu¹, Hsiang-Chun Wang¹, Chong Rong Haung¹, Xin-ke Liu²
¹*Chang Gung University*
²*Shenzhen University*
- 3:00 PM *Student Presentation*
9.5 Low Interface Noise of p-GaN Gate Normally-off HEMT with Microwave Ohmic Annealing Process
Yi-Sheng Chang¹, Chia-Hao Liu¹, Chi-Chuan Chiu¹, Hsiang-Chun Wang¹, Hsien-Chin Chiu¹, Rong Xuan² and Chih-Wei Hu²
¹*Chang Gung University*
²*Episil-Precision Inc.*

Wednesday, May 1st

SESSION 10: DEVICE PROCESSING I

Location: *Nicollet A*

Chairs: Thomas Roedle, *Ampleon*
Walter Wohlmuth, *WIN Semiconductors Corp.*

1:30 PM *Invited Presentation*

10.1 Process Optimization for Improved Adhesion of Ti/Pt/Au to SiN and GaAs

Ganesh Dindukurthi, Yashwanth Konakalla, Carl Miester, David Troy, Prasanta Modak
TRUMPF Photonics Inc.

2:00 PM *Invited Presentation*

10.2 Damage-less Wet Etching for Normally-off AlGaIn/GaN HEMTs using Photo-electrochemical Reactions

Taketomo Sato, Keisuke Uemura, and Masachika Toguchi
Research Center for Integrated Quantum Electronics, Hokkaido University

2:30 PM

10.3 Fabrication of Gallium Nitride Deep-Trench Structures by Photoelectrochemical Etching

Fumimasa Horikiri¹, Hiroshi Ohta², Naomi Asai², Yoshinobu Narita¹, Takehiro Yoshida¹, and Tomoyoshi Mishima²
¹*SCIOCS*, ²*Hosei University*

2:50 PM

10.4 Development of Advanced Lift Off Processes for 5G and VCSEL Applications

Phillip Tyler¹, Jonathan Fijal¹, Kenji Nulman¹, Anil Vijayendran¹, David Rennie², Jennifer Rieker², Alberto Dioses², John Zook², John Sagan², Phil Greene³, Shihu Deng³, Laura Mauer³
¹*Veeco Instruments*, ²*EMD Performance Materials*, ³*Ferrotec Corporation*

3:10 PM

10.5 Backside Processing of RF GaN-on-GaN HEMTs Considering Thermal Management

N. Okamoto, A. Takahashi, Y. Minoura, Y. Kumazaki, S. Ozaki, K. Makiyama, A. Yamada, J. Kotani, T. Ohki, Y. Kawano, N. Nakamura and K. Watanabe
Fujitsu Limited and Fujitsu Laboratories Ltd.

3:30 PM

BREAK

Wednesday, May 1st

SESSION 11: TEST & CHARACTERIZATION – CS DEVICES

Location: *Nicollet B-C*

Chairs: Anita Pacheco, *Qorvo*.
Randy Lewis, *Northrop Grumman Corp.*

4:00 PM *Invited Presentation*

**11.1 Application-Specific, Comprehensive
Technology and Product Qualification of
GaN on Silicon Power Conversion Devices**
Timothy McDonald
Infineon Americas Corporation

4:30 PM **11.2 Channel temperature determination
for GaN HEMT lifetime testing – Impact
of package and device layout**

Filip Gucmann, James W. Pomeroy, Andrei
Sarua, and Martin Kuball
*Center for Device Thermography and
Reliability (CDTR), University of Bristol*

4:50 PM *Student Presentation*

**11.3 Extreme Temperature Operation of
Ultra-Wide Bandgap AlGaN High
Electron Mobility Transistors**

P. H. Carey IV¹, F. Ren¹, A. G. Baca², B. A.
Klein², A. A. Allerman², A. M. Armstrong²,
E. A. Douglas², R. J. Kaplar², S. J. Pearton¹
¹*University of Florida*
²*Sandia National Laboratories*

5:10 PM *Invited Presentation*

**11.4 JEDEC Guidelines and Standards for
Compound Semiconductors**
Donald A. Gajewki
Wolfspeed, A Cree Company

Wednesday, May 1st

SESSION 12: DEVICE PROCESSING II

Location: *Nicollet A*

Chair: *Corey Nevers, Qorvo*

- 4:00 PM **12.1 Elimination of Metal Fencing by Optimizing Evaporator Dome Alignment**
Kezia Cheng
MACOM Technology Solutions
- 4:20 PM **12.2 The State-of-Art of GaN/Diamond HEMT Manufacturing Technology and Device Performance**
Daniel Hou¹, Dan Benveniste¹, Won Sang Lee², Riccardo Soligo¹, and Kyung Won Lee³
¹Global Communication Semiconductors, LLC, ²RFHIC USA, ³RFHIC Corporation
- 4:40 PM **12.3 Optically-Defined 150-nm, 28-V GaN HEMT Process for Ka-Band**
Kyle M. Bothe, Bruce Schmukler, Satyaki Ganguly, Terry Alcorn, Jennifer Gao, Chris Hardiman, Evan Jones, Dan Namishia, Fabian Radulescu, Jeffrey Barner, Jeremy Fisher, Don A. Gajewski, Scott T. Sheppard and Jim W. Milligan
Wolfspeed, A Cree Company
- 5:00 PM **12.4 3D Nanoprinting of Grayscale Features in GaN Devices to Reduce Peak Electric Fields**
Andrew D. Koehler¹, Geoffrey M. Foster², James C. Gallagher², Joseph G. Tischler¹, Travis J. Anderson¹, Karl D. Hobart¹, Fritz J. Kub¹
*¹U.S. Naval Research Laboratory
²ASEE Postdoctoral Fellow Residing at NRL*
- 5:20 PM **12.5 Activation of Ion Implanted Si in Semi-Insulating C-Doped GaN by High Pressure Annealing for Photoconductive Semiconductor Switch (PCSS) Applications**
James C. Gallagher¹, Travis J. Anderson², Andrew D. Koehler², Geoffroy M. Foster¹, Alan G. Jacobs¹, Boris N. Feigelson², Michael M. Mastro², Jennifer K. Hite², Karl D. Hobart²
*¹ASEE Postdoctoral Fellow Residing at NRL
²U.S. Naval Research Laboratory*

6:00 PM **RUMP SESSIONS RECEPTION**

6:30 PM **RUMP SESSIONS**

Chair: Jansen Uyeda, *Northrop Grumman*

The long honored tradition of CS MANTECH's rump session is back for more lively and "friendly" discussions among your peers in an informal and open setting. This is a perfect venue to give your take on the industry and CS technologies, as well as hear your colleagues call-it as they see it. Please join us to weigh-in on four topics centered on the future of CS technologies and the upcoming 5G roll-out. Who knows... you may find a new best friend or may flip 180 on your views. Reception to precede the discussions to help lighten the mood and make the discussion more entertaining!

Rump Session A: "Si, SiC, GaN, GaO... Which Power CS Technology will Dominate for New Power Systems?"

Moderator: Martin Kuball, University of Bristol

Location: *Nicollet D1*

Power electronics is getting more momentum and increasingly more multi-faceted. Si has provided significant benefits in the past, though in some technology areas it is starting to get superseded (or not ?) by SiC and GaN. As SiC and GaN battle for domination, Ga₂O₃ is emerging as a further alternative... so who will win? Will there be winners or losers? Are there more alternatives? Please join us for what will be an epic match, which team will you be on and who has the force to sway things... Let the games begin!

Rump Session B: "Who needs mmWave devices for 5G?"

Moderators: Earl Lum, *EJL Wireless Research*

Gerhard Schoenthal, *Virginia Diodes, Inc.*

Location: *Nicollet D2*

Is 5G really here and who needs it? Major U.S. mobile providers such as Verizon, AT&T, and Sprint have posted information on their 5G offerings for the first half of 2019, with T-Mobile offering their 5G network in 2020 (source: CNBC). The 2020 Summer Olympic Games in Tokyo, Japan will see full implementation of 5G. However, will the full vision of 5G be realized? Are the right technologies involved and is CS technologies in the mix? Will high-frequency devices reaching to the THz regime be needed? If so, it's prime time for InP-based CS technologies... are manufacturers ready for this? Let's have a fun discussion on the ground breaking possibilities that 5G will bring to our everyday life, what CS technologies are needed, and is the CS industry ready to produce these at high yield and low cost.

Rump Session C: “Future of Automotive - What is Required for Successful CS Technology Integration?”

Moderator: Yohei Otoki, *SCIOCS*

Location: *Nicollet D3*

The automotive industry is advancing and transforming at lightning speed... from new safety features to autonomous driving vehicles, all enabled with CS technologies. With this rapid development of new capabilities, what is required to ensure the reliability of CS technologies in automotive systems... and what is on the horizon? If you are a car enthusiast... this is the session for you.

8:00 PM SEMI STANDARDS MEETING

Location: *St. Croix (2nd floor)*

Thursday, May 2nd

SESSION 13: OPTOELECTRONICS PLENARY

Location: *Nicollet B-C*

Chairs: Stephen Myers, *Lumentum*
Travis Abshire, *nLight*

8:00 AM *Invited Presentation*

13.1 VCSELs at a Glance

Dr. Vincent D. Mattera, Jr
II-VI

9:00 AM *Invited Presentation*

13.2 Volume Manufacturing of Highly Integrated System-On-Chip (SOC) InP-Based Photonic Integrated Circuits

Fred A. Kish, Steve Maranowski, Peter Debackere, Adam James, Andrew Dentai, Paul Liu, Payam Abolghasem, Nikhil Modi, Bala Vaddepaty, Peter Evans, Vikrant Lal, Gloria E. Hoefler, Jianping Zhang, S. Stockman, and Mehrdad Ziari
Infinera Corporation

9:30 AM *Invited Presentation*

13.3 MicroLED Displays: Hype and Reality, Hopes and Challenges

Eric Virey, Zine Bouhamri, Pars Mukish
Yole Développement

10:00 AM **BREAK**

Thursday, May 2nd

SESSION 14: VCSEL

Location: *Nicollet B-C*

Chairs: Heribert Zull, *OSRAM Opto Semiconductors GmbH*
Chris Stender, *MicroLink Devices, Inc.*

10:30 AM **14.1 3D Sensing/Imaging – The Next Killer Application for VCSELs? Yes If...**
Pierrick Boulay, Pars Mukish
Yole Développement

10:50 AM *Invited Presentation*
14.2 ~~Future~~ Present Foundry Model for III-V Manufacturing
Al Yuen
Lumentum

11:20 AM *Invited Presentation*
14.3 Volume Manufacture of 150 mm VCSEL Epi-wafers
Ben Stevens, Adam Jandl, Aidan Daly,
Andrew Clark, Hugues Marchand, Andrew
Joel and Rodney Pelzel
IQE PLC

11:50 AM *Invited Presentation*
14.4 Crystal Growth and Wafer Processing of 6" GaAs Substrates for Lasers
Tomonori Morishita
Sumiden Semiconductor Materials Co., Ltd.

Thursday, May 2nd

SESSION 15: TEST & CHARACTERIZATION OF WIDE BANDGAP HETEROSTRUCTURES

Location: *Nicollet A*

Chairs: David Via, *Air Force Research Laboratory*
David Meyer, *Naval Research Laboratory*

10:30 AM *Student Presentation*

15.1 Misinterpretation of Drain Transient Spectroscopy in GaN HEMTs:

Explanation using a floating buffer model

Manikant Singh¹, M. J. Uren¹, S. Karboyan¹,
H. Chandrasekar¹, T. Martin², and M. Kuball¹

¹*CDTR, University of Bristol*

²*IQE Europe*

10:50 AM **15.2 WITHDRAWN**

10:50 AM *Student Presentation*

15.3 Interfacial fracture toughness of GaN film on diamond substrate for application in ultra-high power RF devices

Dong Liu, Stephen Fabes, Daniel Francis and
Martin Kuball

CDTR, University of Bristol

11:10 AM *Student Presentation*

15.4 Electrical and Thermal Characterisation of

β -(Al_xGa_(1-x))₂O₃/Ga₂O₃ HEMTs

Taylor Moule¹, Manikant Singh¹, Serge
Karboyan¹, Elisha Mercado¹, Stefano
Dalcanale¹, Michael J Uren¹, Yuewei Zhang²,
Zhanbo Xia², Siddharth Rajan², Martin
Kuball¹

¹*CDTR, University of Bristol*

²*The Ohio State University*

11:30 AM **15.5 New Generation of Corona-charge Noncontact C-V (CnCV) Metrology for Characterization of Wide Bandgap Interfaces and Deep Interface Traps**

M. Wilson, A. Savtchouk, C. Almeida, B.
Schroyer, J. D'Amico and J. Lagowski
Semilab SDI

12:20 PM **CS MANTECH LUNCHEON**

Thursday, May 2nd

SESSION 16: PROCESS AND YIELD

Location: *Nicollet B-C*

Chairs: Guoliang Zhou, *Skyworks Solutions*
Kevin Stevens, *IQE*

- 1:30 PM **16.1 Yield Improvements in a High-Mix Fabrication Environment**
Rathnait D. Long¹, Sarah R. El-Helw^{1,2}, Ian Dalton¹, Maik Katko¹, Kezia Cheng¹, Marco Bonilla¹, William Allen¹ & Craig Pastrone¹
¹*MACOM Technology Solutions*
²*Virginia Polytechnic Institute & State University*
- 1:50 PM *Student Presentation*
16.2 Effects of Electrochemical Etching on InP HEMT Fabrication
T. Saranovac, D. C. Ruiz, D. Han, A. Hambitzer, A. M. Arabhavi, O. Ostinelli, and C. R. Bolognesi
Millimeter-Wave Electronics Group (MWE) ETH-Zürich
- 2:10 PM **16.3 Lift-off Challenges in using CAMP Negative Photoresist Patterning in III-V IC Fabrication**
Daniel Berkoh and Shiban Tiku
Skyworks Solutions
- 2:30 PM **16.4 Gross Die Per Wafer and Yield Optimization for GaAs ICs with Sub-Micron Features**
Robbie Best and Shiban Tiku
Skyworks Solutions
- 2:50 PM **16.5 Development of stepper solutions for new IoT device challenges**
Bunsuke Takeshita¹, Douglas Shelton², Neel Chopra², Hiroyuki Miyazaki¹, and Ken-Ichiro Mori¹
¹*Canon Inc.*, ²*Canon U.S.A.*
- 3:10 PM **16.6 Applications of Natural Exponential Functions in Semiconductor Processes**
Xiaokang Huang, Linlin Chen, Arif Choudhury, Duofeng Yue, Qidu Jiang, Mengdi Mueller, John Griffin, Van Tran, Amit Kelkar
Qorvo

Thursday, May 2nd

SESSION 17: MATERIALS AND GROWTH

FUNDAMENTALS

Location: *Nicollet A*

Chairs: Rüdiger Schreiner, *Consultant*
Wei Zhang, *AXT*

1:30 PM *Invited Presentation*

17.1 P-type semiconductors in gallium oxide electronics

Kentaro Kaneko¹, Shu Takemoto¹, Shin-ichi Kan¹, Takashi Shinohe², Shizuo Fujita¹

¹*Kyoto University*, ²*FLOSFIA Inc.*

2:00 PM

17.2 Development of Large Diameter Semi-Insulating Gallium Oxide (Ga₂O₃) Substrates

J.D. Blevins¹, K. Stevens², G. Foundos², A. Lindsey², L. Sande²

¹*Air Force Research Laboratory (AFRL)*,

²*Northrop-Grumman SYNOPTICS*

2:20 PM

Invited Presentation

17.3 Machine Learning for SiC top-seeded solution growth - Prediction, Optimization and Visualization

Toru Ujihara^{1,2,3}, Yosuke Tsunooka^{1,2}, Goki Hatasa¹, Can Zhu¹, Kentaro Kutsukake³, Taka Narumi¹, Shunta Harada¹, Miho Tagawa¹

¹*Nagoya University*, ²*National Institute of Advanced Industrial Science and Technology*

³*Center for Advanced Intelligence Project,*

RIKEN

2:50 PM

Student Presentation

17.4 Analysis of High Mg-Incorporation into GaN via PAMBE Modulation Doping and Molecular Dynamics Simulations

Fawad Hassan Ismail, Matthew Landi, Frank Putnam Kelly, Kyekyoon (Kevin) Kim

University of Illinois at Urbana-Champaign

3:10 PM

17.5 Understanding GaN Homoepitaxial Growth and Substrate-Dependent Effects for Vertical Power Devices

Jennifer K. Hite¹, Travis J. Anderson¹, James C. Gallagher², Michael A. Mastro¹, Karl D. Hobart¹, Francis J. Kub¹, and Charles R. Eddy, Jr.¹

¹*U.S. Naval Research Laboratory*

²*ASEE Postdoctoral Fellow Residing at NRL*

Thursday, May 2nd

SESSION 18: POSTER

Chairs: Barry Wu, *Keysight Technologies*
Shyh-Chiang Shen, *Georgia Tech University*
Shiban Tiku, *Skyworks Solutions*
Andrew Green, *Air Force Research Laboratory*

3:40 PM -

4:30 PM

18.1 RF GaN Market and Technology Trends

Ezgi Dogmus, Antoine Bonnabel and Hong Lin
Yole Développement

18.2 Addressing Cycle Time to Accelerate Yield Improvement and Improve Output

Michael Mandracchia
The MAX Group

18.3 Templated Liquid Phase Growth Combined with MOCVD for Growth of Crystalline III-V's Directly on Oxide and Nitride Surfaces

Debarghya Sarkar, Mitchell Dreiske, P. Daniel Dapkus, Rehan Kapadia
University of South California

Student Presentation

18.4 GaN High-Performance Low-Leakage p-Islet MPS Diodes Enabled by PAMBE-Based Selective Area Growth

Palash Sarker, Frank Putnam Kelly, Riley Elis Vesto, Fawad Hassan Ismail, Kyekyoon (Kevin) Kim
University of Illinois at Urbana-Champaign

18.5 β -Ga₂O₃ and related alloys grown by MOCVD on a Multi-wafer production system

Nazar Orishchin, Fikadu Alema and Andrei Osinsky
Agnitron Technology, Inc.

18.6 WITHDRAWN

18.7 200 V – 20 A AlGaIn/GaN MIS-HEMTs on Silicon Substrate with 60 mm Gate Width

Chia-Jui Yu¹, Tz-Chau Lin¹, Chien-Ju Chen¹, Jyun-Hao Liao¹, Meng-Chyi Wu¹, Wen-Ching Hsu², Chih-Yuan Chuang², and Jia-Zhe Liu²
¹*National Tsing Hua University,*
²*Global Wafers Co., Ltd.*

Thursday, May 2nd

18.8 A High Uniformity, High Yield 0.15 μm pHEMT Technology Manufactured by KrF 248 nm Stepper

Chao-Min Chang¹, Pei-Chin Chiu¹, Jeng-Han Tsai², Hui-Hsin Sun², Yun-Yue Hsieh², Zhi-Jie Zeng¹, Kun-Lin Lu¹, Chih-Peng Lin¹, Bo-Chin Wang¹, Sheng-Chun Wang¹, Chin-Fu Lin¹

¹*Wavetek Microelectronic Corp.*

²*National Taiwan Normal University*

Student Presentation

18.9 High Thermally Stable AlGaIn/GaN High Electron Mobility Transistors (HEMTs) on Bulk Semi-Insulating GaN Substrates

Hao-Yu Wang¹, Hsien-Chin Chiu¹, Chong-Rong Huang¹, Hao-Chung Kuo², Sung-Wen Huang Chen², Xinke Liu³

¹*Chang Gung University*

²*National Chiao Tung University*

³*Shenzhen University*

Student Presentation

18.10 Reconfigurable 43 Gb/s Optical Link Test Based Upon On-Wafer Probes of GaAs Photodetectors and VCSELs up to 85 °C

Yu-Ting Peng, Junyi Qiu, Dufei Wu, Milton Feng

University of Illinois at Urbana-Champaign

Student Presentation

18.11 Development of GaN Vertical High-Power Devices Enabled by Plasma-Assisted Molecular Beam Epitaxy

Frank Putnam Kelly, Riley Elis Vesto, Palash Sarker, Fawad Hassan Ismail, Kyekyoon (Kevin) Kim

University of Illinois at Urbana-Champaign

Student Presentation

18.12 Comparative investigation of lattice-matched ternary and quaternary barriers for GaN-based HEMTs

S.Riedmüller^{1,2}, J. Grünenpütt¹, M. Madel¹, and H. Blanck¹

¹*United Monolithic Semiconductors GmbH*

²*University of Ulm*

Thursday, May 2nd

Student Presentation

18.13 A Novel AlGaIn/GaN MIS-HEMT with Enhanced Breakdown Voltage and Reduced Interface Trap Density

Chao Yang, Xiaorong Luo, T. Sun, A. Zhang, D. Ouyang, S. Deng, J. Wei, and Bo Zhang
University of Electronic Science and Technology of China

18.14 Buffer development for GaN power electronic applications using extrinsic carbon doping for a super-lattice structure

D. Fahle, M. Marx, H. Behmenburg, M. Kortemeyer, M. Heuken
AIXTRON SE

18.15 Dynamic Hydride Vapor Phase Epitaxy (D-HVPE) as a route to inexpensive, high-performance III-V materials and devices

John Simon, Kevin L. Schulte, Wondwosen Metaferia, Alessandro Cavalli, and Aaron J. Ptak
National Renewable Energy Laboratory

18.16 Innovative relaxed InGaIn engineered substrates for red-green-blue μ LEDs applications

Eric Guiot¹, David Sotta¹, Olivier Ledoux¹, Amélie Dussaigne², Sébastien Chenot³, Benjamin Damilano³
¹SOITEC S.A., ²Univ. Grenoble Alpes
³Université Côte d'Azur, CNRS

4:30 PM CONFERENCE CLOSING

Chairs: Eric Stewart, *Northrop Grumman*
Greg Mills, *AXR*

Make sure to stay for the fun at the conference closing this year! Local comedian John DeBoer will be giving a short stand-up routine about Minnesota, cold weather, and engineers. Take a moment to enjoy a few laughs at the end of the week.

2018 BEST PAPERS AWARDS

On Tuesday morning, CS MANTECH will formally recognize the authors of the best paper and best student paper from the 2018 conference. Both awards are based on conference attendee on-line feedback. The Best Paper Award is named in honor of Dr. He Bong Kim, the founder of the International Conference on Compound Semiconductor Manufacturing Technology.

2018 He Bong Kim Best Paper:

Looking for reliability and high performance in RF and power conversion applications? Use GaN.

Umesh Mishra

University of California Santa Barbara & Transphorm Inc.

2018 He Bong Kim Best Paper Honorable Mention:

Automotive Industry Trends and Their Impact on the Future Vehicle

Kamal Khouri

NXP Semiconductors

2018 Best Student Paper:

Controlling Impurity-Induced Disorder Via Mask Strain for High-Performance Vertical-Cavity Surface-Emitting Lasers

Patrick Su, Thomas O'Brien, Jr., Fu-Chen Hsiao, and John. M. Dallesasse

University of Illinois at Urbana-Champaign

Congratulations to these award winning teams for their excellent presentation and technical contribution to our field!

TRANSPORTATION INFORMATION

Transportation Centers:

MSP International Airport (MSP): 12 miles from the hotel

Amtrak Station: 8 miles from the hotel

Public Transit Centers:

Light Rail station: 8 blocks from the hotel and takes you toward downtown, Mall of America, the airport, and St. Paul

Greyhound Bus Station: located 7 blocks from the hotel

Taxi:

Taxi transportation between the Hyatt Regency Minneapolis and the airport is approximately \$45 - \$50 for one passenger.

Ride-share:

Ride-share services from Uber & Lyft between the Hyatt Regency Minneapolis and the airport are approximately \$23 - \$42 for one passenger

Local Transit:

Single ride is \$2.50. Day pass is \$5. From the airport, take the blue line towards Target Field to Nicollet Mall stop. Then walk 8 blocks south on Nicollet Mall to the Hyatt Regency.

Airport SuperShuttle:

Transfer from the airport to the hotel is \$14.40 per person with discount code BN5F2. Reservations are recommended from the airport to the hotel, and advance pickup arrangements must be secured to travel from the hotel to the airport. <https://group.supershuttle.com/group-page/2019-cs-mantech-conference/>

PARKING:

The Loring Parking Ramp is privately owned and is managed by Allied Parking Inc.

Overnight Self-Parking: \$24

Overnight Valet parking: \$39.00

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