



CORPE - the Center of Reliable Power Electronics

6th CORPE Annual Symposium Programme

Wednesday May 9, 2018

**Auditorium of the Department of Energy Technology, Aalborg University, Pontoppidanstraede 111
DK-9220 Aalborg East, Denmark**

The objective of the Annual Symposium is to make the point on power electronics reliability, through invited speeches, technical presentations, and dialogue interaction. International recognized speakers are going to present their point of view in terms of current challenges; afterwards, a discussion about ultimate findings will take place together with the center roadmap. The symposium is free of charge (no-show fee) and open for stakeholders, companies and other whose interest falls in the field of reliability of power electronics. Sign up for the event [here](#).

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| 08:00 – 09:00 | Coffee, Networking and Registration |
| 09:00 – 09:10 | Welcome and a short introduction to CORPE – Center Leader Prof. Frede Blaabjerg, Aalborg University, Denmark |
| 09:10 – 09:45 | “Reliability challenges with IGBTs used in motor drives” – Garron Morris, Principal Engineer, Rockwell Automation, WI, USA |
| 09:45 – 10:20 | “A SiC technology overview from the user’s reliability perspective” – Dr. Muhammad Nawaz, ABB Västerås, Sweden |
| 10:20 – 10:35 | Coffee break |
| 10:35 – 11:10 | “On-chip temperature sensors for the characterization of thermosensitive electrical parameters” – Dr. Yvan Avenas, G2Elab, Grenoble University, France |
| 11:10 – 11:45 | “Parasitic and Reliability issues in GaN-based transistors” – Prof. Gaudenzio Meneghesso, University of Padua, Italy |
| 11:45 – 12:10 | “Gate oxide and threshold voltage reliability considerations for SiC MOSFETs” – Peter Friedrichs, Infineon AG, Germany |
| 12:10 – 13:30 | Lunch and Poster Session |
| 13:30 – 15:15 | CORPE activities (Selected presentations) |
| 13:30 – 13:45 | “Preventing Power Module Explosion via a Non-Invasive Condition Monitoring Sensor” – Postdoc Nick Baker |
| 13:45 – 14:00 | “Reliability of Power Electronics in Photovoltaic Systems” – Ph.D. student Ariya Sangwongwanich |
| 14:00 – 14:15 | Design for Reliability and Robustness (DfR²) Tool Platform for Power Electronic Systems” – Ph.D. student Ionuț Vernica |
| 14:15 – 14:30 | “Reliability of a Commercial GaN Power device in power cycling test” – Ph.D. student Sungyoung Song |

- 14:30 - 14:45** **“Improving the Short-Circuit Reliability in IGBTs: How to Mitigate Oscillations”** – *Postdoc Paula Díaz Reigosa*
- 14:45 - 15:00** **Analytical Thermal Modeling of PCB Vias and Copper Pads”** – *Ph.D. student Yanfeng Shen*
- 15:00 - 15:15** **“Reliability Evaluation of Power Capacitors in a Wind Power Converter”** – *Postdoc Dao Zhou*
- 15:15 - 15:30** **“Department of Materials and Productions”** – *Prof. Kjeld Pedersen/Prof. Jesper De Claville, Aalborg University, Denmark*
- 15:30 - 15:45** **CORPE overview + new grand initiatives: REPEPS and X-Power projects** – *Center Leader and Villum Investigator Prof. Frede Blaabjerg, Aalborg University, Denmark*
- 15:45 - 17:00** **Visit to CORPE Test Facilities**
- 17:00** **End of day**

AAU-1-DAY wireless network passwords: *TBA*

Registration no later than May 1: click [here](#)

We look forward to seeing you in Aalborg,

Frede Blaabjerg
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About CORPE

<http://www.corpe.et.aau.dk/>

*The **Center of Reliable Power Electronics (CORPE)** at Aalborg University, Denmark, inaugurated in 2012, aims at designing more reliable and more efficient power electronic systems for power generation, distribution and consumption. The center strives for a better understanding of how reliability of power electronic devices and systems is influenced by different stress factors such as temperature, overvoltage and current, overload, humidity and other environmental factors.*

The center was established in close collaboration with major Danish power electronic companies and Aarhus University, along with two leading European universities. Furthermore, the center develops device and system models enabling simulation and design of power electronic systems at predicted reliability. Such a knowledge is profitably used for online monitoring too, in order to predict remaining useful lifetime and to enable smart advanced strategies such as smart de-rating. A number of advanced test systems are available in CORPE. More than 30 researchers are active (around 15 PhD's) among universities and companies. The center is supported by the Danish Strategic Research Council and the Obel Foundation.

CORPE is sponsored by



For more info, please visit us at <http://www.corpe.et.aau.dk/>

In cooperation with





Poster Session

M.Sc. student Steffen Buhrkal-Donau	<i>Comparative study of wire bond degradation under power and mechanical accelerated tests</i>
Ph.D. student He Du	<i>Investigation on 1.0 kV/22 A SiC MOSFETs under Repetitive Short-Circuit Tests</i>
Ph.D. student Keting Hu	<i>Bond Wire Impact Elimination in IGBT Junction Temperature Estimation</i>
Ph.D. student Yingzhou Peng	<i>A Condition Monitoring Method for Three Phase Inverter Based on System-Level Signals</i>
Ph.D. student Zhan Shen	<i>Design and Reliability of Magnetic Components of Power Electronic Converters</i>
Ph.D. student Zhijian Yin	<i>Thermal characterization of a capacitor bank</i>
Ph.D. student Haoran Wang	<i>A Lumped Thermal Model for Capacitor Banks</i>
Ph.D. student Zhongxu Wang	<i>Thermal model characterization of multi-chip modules</i>
Ph.D. student Yi Zhang	<i>Simplified Thermal Modeling for IGBT Modules with Periodic Power Loss Profiles in Modular Multilevel Converters</i>
Post-Doc Saeed Peyghami	<i>Effect of Mission Profile on the Reliability of Power Electronic based Power Systems</i>

Speakers

Garron Morris, Rockwell Automation



Reliability challenges with IGBTs used in motor drives

Abstract: This presentation discusses IGBT reliability challenges that come from motor drive customers, IGBT manufacturers, and design integration. Over twenty years of increasingly challenging trends in motor drive usage, customer behaviors, and installation environments will be described. Design choices made by IGBT manufacturers force the inverter designer to understand limitations of the new IGBT's and their effects on design margins. Finally, integration challenges ranging from thermal interface material testing to IGBT module characterization will be presented. Real examples from Rockwell Automation motor drive customers and engineering development will illustrate the IGBT reliability challenges.

Bio: Garron Morris has over 22 years of experience in reliability and thermal management of IGBTs used in Rockwell Automation motor drives and GE Healthcare MRI medical imaging systems. As a Principal Engineer in the Rockwell Automation in the motor drives research and development group, he is currently focused on developing the next generation of reliable motor drives, implementing advanced predictive life models, and solving corrosion issues in power electronics. He has Bachelors and Masters degrees in Mechanical Engineering from University of Wisconsin at Milwaukee in the United States. Garron has authored over 30 conference and journal publications and has 15 US patents.



Dr. Muhammad Nawaz, ABB



A SiC technology overview from the user's reliability perspective

Abstract: Silicon carbide (SiC) technology has now entered in commercialization phase on various power electronics front; thanks to its superior physical properties compared to Si counterpart. Low voltage discrete SiC MOSFET devices and power modules from 0.6 – 1.7 kV are commercially available from various vendors. On the other side, medium voltage SiC-MOSFET devices of 3.3 – 6.5 kV and high voltage MOSFET devices of 10 - 15 kV are also visible in the scientific literature with excellent static and dynamic performance, illustrating the potential benefit for high power applications in energy transmission and distribution networks. This talk will address the requirement and issues using SiC MOSFETs facing high power converters. Reliability concerns from the end user's perspective will be addressed as well.

Bio: Dr. Muhammad Nawaz (Ph.D in 1996 from Oslo University, Norway) is a Principle Scientist at ABB corporate research, Västerås, Sweden where he is actively engaged in research activities in power electronics field with special focus on silicon and silicon carbide (SiC) based power semiconductor devices. He is a senior member of IEEE and distinguished lecturer of IEEE, electron device society. Currently, he is serving as an associate editor of IEEE Transactions on Industry Applications and IEEE Transaction on Power Electronics. He is author/coauthor of over 100 papers in peer reviewed international journals and conferences besides holding several industrial patents.

Dr. Yvan Avenas, G2Elab



On-chip temperature sensors for the characterization of thermosensitive electrical parameters

Abstract: Thermal characterization of power modules and assemblies is classically carried out using thermo-sensitive electrical parameters (TSEPs) based on off-line measurements. Since several years, there is a large growth of the research to determine new TSEPs able to accurately estimate the chip temperature in working converters. This presentation deals with the evaluation of solutions to characterize new TSEPs. These solutions are based on temperature sensors integrated on the top face of power semiconductor dies. Two types of sensors are analysed: one commercial solution based on the integration of diodes in the structure of the device and one other based on the deposition of a resistive sensor on the top metallization.

Bio: Yvan AVENAS received the Ph. D. degrees in 2002. He is currently Associate Professor at Grenoble Institute of Technology (France) since 2005 and carries out his research activities in Grenoble Electrical Engineering Lab (G2Elab) where he is co-head of the power electronics group since 2015. In the past, he specifically worked on thermal management through heat pipes and specific fluids (dielectric, magnetic, metallic fluids) for power electronics cooling. Now he is interested in thermal characterization, 3D integration and aging monitoring of power modules.



Prof. Gaudenzio Meneghesso, University of Padua



Parasitic and Reliability issues in GaN-based transistors

Abstract: The past few years have been exciting and extremely productive for the GaN community, and the research in the field of GaN-power devices has shown impressive advancements. In lateral GaN HEMTs, a two-dimensional electron gas (2DEG) is formed at the interface between GaN and AlGaIn; the high mobility of the 2DEG (in excess of 2000 cm²/Vs) results in current densities around 1 A/mm, and in a very low on resistance (25 mΩ for a 650 V/60 A device). This implies a significant reduction in the resistive and switching

losses, compared to silicon devices, and this has a positive impact on the efficiency of GaN-based power converters (kW-range power converters with efficiency higher than 99% have already been demonstrated, based on GaN HEMTs). A relevant aspect that is currently under study is the reliability of GaN-based transistors. In fact, during operation in high-voltage power converters, the HEMTs may be subject to extreme field and current levels that may favor device degradation. In real-life applications, several potentially harmful conditions may be reached, favoring the exposure to off-state bias, semi-on stress conditions, hard switching, and high gate bias.

This presentation, after a general description of the operating principles of GaN-based HEMTs, I will summarize the most important issues related to the parasitic and reliability issues in GaN-Based HEMTs

Bio: He graduated in Electronics Engineering at the University of Padova in 1992 working on the failure mechanism induced by hot-electrons in MESFETs and HEMTs. In 1997 he received the Ph.D. degree in Electrical and Telecommunication Engineering from the University of Padova. Since 2011 is with University of Padova as Full Professor. His research interests involves mainly the Electrical characterization, modeling and reliability of several semiconductors devices (microwave, optoelectronics, WBG, MEMS, ...). Within these activities he published more than 800 technical papers (of which more than 100 Invited Papers and 12 best paper awards). He has been nominated to IEEE Fellow class 2013, with the following citation: "for contributions to the reliability physics of compound semiconductors devices".

Dr. Peter Friedrichs, Infineon



Gate oxide and threshold voltage reliability considerations for SiC MOSFETs

Bio: Dr. Peter Friedrichs was born in 1968 in Aschersleben, Germany. After achieving his Dipl.-Ing. in microelectronics from the Technical University of Bratislava in 1993, he started a Ph.D work at the Fraunhofer Institut FhG-IIS-B in Erlangen. In 1996 he joined the Corporate Research of the Siemens AG and was involved in the development of power switching devices on SiC, mainly power MOSFETs and vertical junction FETs. He holds more than 10 patents in the field of SiC power devices and technology and was an author or co-author of more than 50 scientific

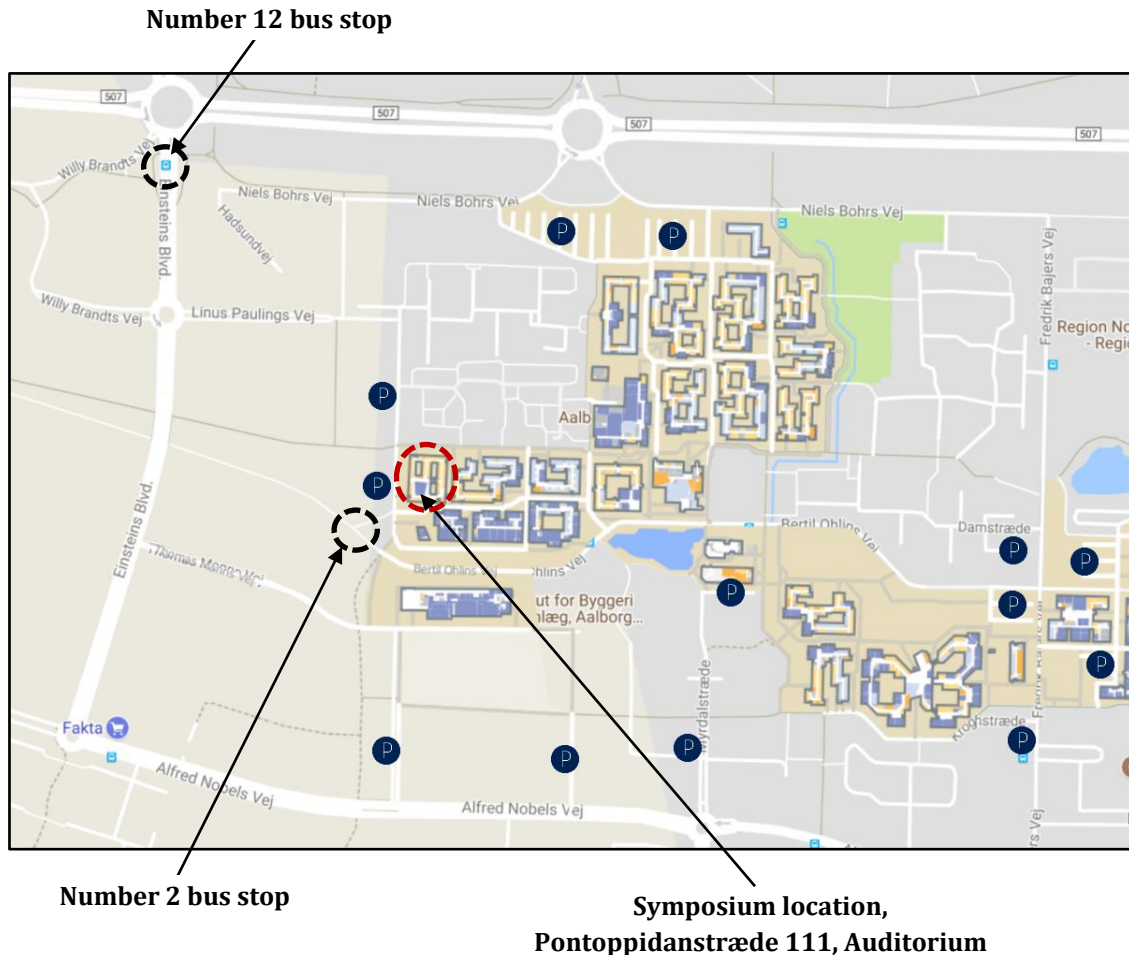
publications and conference contributions in this field.

Peter Friedrichs joined SiCED GmbH & Co. KG, a company being a joint venture of Siemens and Infineon and originated from the former Siemens research group, on March the 1st, 2000. Since July 2004 he was the managing director of SiCED, responsible for all technical issues. After the integration of SiCED's activities into Infineon he joined Infineon as Senior Director Silicon Carbide from April 1st, 2011.



Map and Directions

Venue: Aalborg University, Department of Energy Technology, Pontoppidanstræde 111, 1st floor, room 1.177
Aud. 9220 Aalborg East



Directions from Aalborg Airport

The bus stop is directly outside the terminal building. Any number 12 bus will take you to both Aalborg city centre and directly to the university. The bus takes approximately 20 minutes to the centre and 40 minutes to the university. Alternatively, it is possible to take a taxi, which takes approximately 15 minutes to the city centre, or 25-30mins to Aalborg University.

Arriving by Car

If you arrive by car from the highway E45, you choose Exit 26: Th Sauers Vej/Universitetsboulevarden.

From Universitetsboulevarden you enter the roundabout and take the exit Einsteins Boulevard. In the next roundabout you take the third exit: Linus Paulings Vej. At the end of Linus Paulings Vej turn right. On your right side is Pontoppidanstræde's parking lot. Turn right when you exit the parking lot on foot. The main entrance of Pontoppidanstræde 111 is on the corner of Toppentuestien and Pontoppidanstræde.

Directions from Aalborg City Centre

The bus routes number 2 and 12 go directly to the Department of Energy Technology, both stopping close to the Symposium venue, Pontoppidanstræde 111. If taking number 12, get off at the stop 'Willy Brandts Vej (Einsteins Boulevard)' and it is around a 10-minute walk to the symposium venue. The number 2 bus stops at



Pontoppidanstræde (Bertil Ohlins Vej), which is directly outside the symposium venue. Both bus stops and symposium venue are identified on the map above.

You can check detailed bus schedules at www.rejseplanen.dk (also available in English).

Phone number for Aalborg Taxi: +45 7025 2525 or +45 9810 1010.