

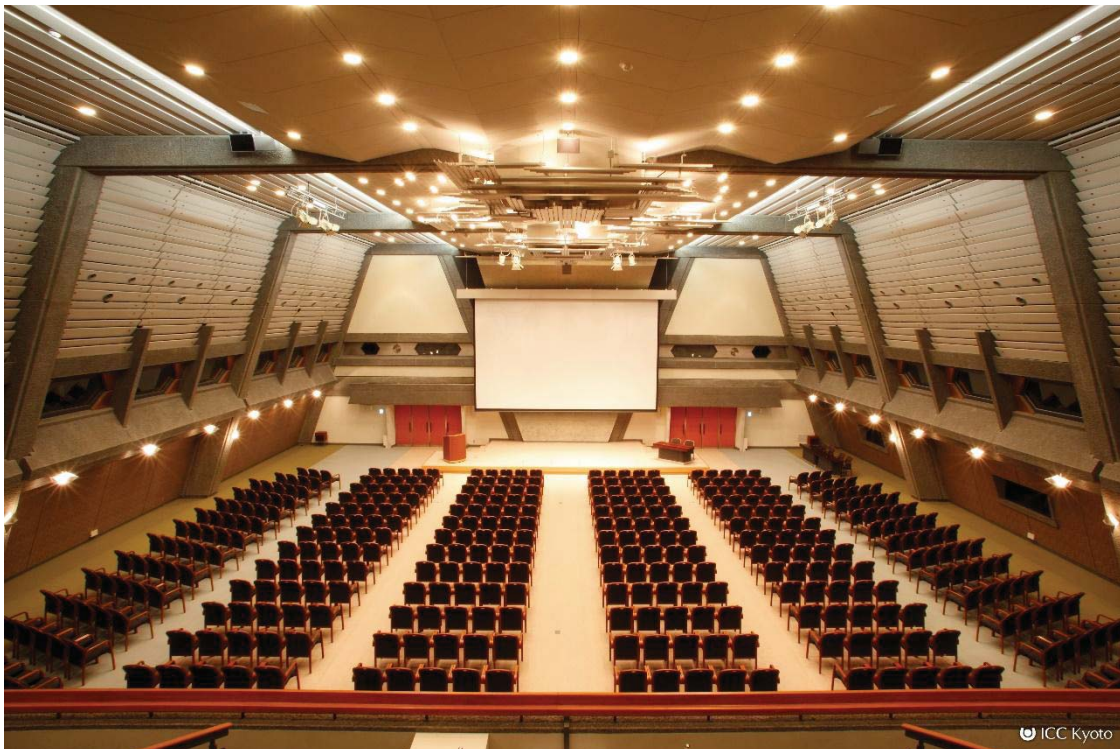
**International Conference on
Silicon Carbide and Related Materials 2019**
September 29 - October 4, 2019 / Kyoto, Japan

Tutorial Day

“SiC-MOSFETs; Features and Applications”

September 29, 10:30 – 17:00

Kyoto International Conference Center, Room A



Tutorial Day Program

Title; "SiC-MOSFETs; Features and Applications"

September 29, 2019

Kyoto International Conference Center, Room A

Time	Title	Speaker	Institution
9:00 -	Registration		
10:20 - 10:30	Welcome Remarks	Satoshi Tanimoto	NISSAN ARC, LTD.
10:30 - 11:15	Device Design and Characteristics of SiC MOSFETs	Prof. Noriyuki Iwamuro	University of Tsukuba
11:15 - 12:00	SiC Power Device Reliability Considerations	Prof. Philip Mawby	University of Warwick
12:00 - 13:30	<i>Lunch</i>		
13:30 - 14:15	Packaging and Modules with SiC MOSFETs and Related Reliability Aspects	Prof. Josef Lutz	Chemnitz University of Technology
14:15 - 15:00	Driving Methods for SiC Devices at High-Frequencies	Prof. Juan Rivas-Davila	Stanford University
15:00 - 15:30	<i>Coffee Break</i>		
15:30 - 16:15	Multi-Level Inverter Topologies for Full Exploitation of SiC MOS Characteristics	Prof. Alberto Castellazzi	Kyoto University of Advanced Science
16:15 - 17:00	SiC MOSFETs at Industrial Applications – Addressing Challenges and Reaping Benefits	Dr. Samuel Araujo	Robert Bosch GmbH

Tutorial Organizing Committee

Satoshi Tanimoto

NISSAN ARC, LTD., Japan

Takafumi Okuda

Kyoto University, Japan

Yasunori Tanaka

AIST, Japan

Tutorial Day Lecturers

Prof. Noriyuki Iwamuro received the ph.D degree in electrical engineering from Waseda University, Tokyo. Since 1988, he has been engaged in research and development of Si IGBTs in Fuji Electric Co.,Ltd. In 1992, he was a visiting scholar of Power Semiconductor Research Center (Director: Prof. B.Jayant Baliga) at North Carolina State University. In 2009, he has been in National Institute of Advanced Industrial Science and Technology, and engaged in development of SiC MOSFETs and SBDs. In 2013, he became a professor of University of Tsukuba. His current research interest is a study of SiC power semiconductor devices.



Prof. Philip Mawby holds the Chair of Power Electronics within the School of Engineering at Warwick. He is also Head of Research for the school. He has been at the University for just over 14 years, and has established a world leading research group in SiC based power electronics. He is one of the UK's leading authorities on Silicon Carbide power device technology and applications and has been working on the topic for more than 25 years. He also has an internationally recognized activity in the modelling of power devices, particularly in the area of compact modelling and fast systems modelling.



Prof. Josef Lutz graduated in Physics at the University of Stuttgart, from 1983 he was with Semikron Electronics, in Nuremberg. He invented the Controlled Axial Lifetime (CAL) diode and holds several patents. In 1999 he graduated as PhD in electrical engineering at the University of Ilmenau. Since August 2001 he is Professor for Power Electronics and Electromagnetic Compatibility at Chemnitz University of Technology. He is senior member of IEEE and serves in several international committees (PCIM, EPE, ISPS, CIPS) and in the advisory board of the Journal Microelectronics Reliability. His book "Semiconductor Power Devices - Physics, Characteristics, Reliability" is printed in German (2006, 2012), in English (2011, 2018) and in Chinese (2013). His focus of research is on power semiconductor devices, ruggedness and reliability.



Prof. Juan Rivas-Davila is an Assistant Professor at Stanford's Electrical Engineering department. Before, he served as an Assistant Professor at the University of Michigan and worked for GE Global Research in the high-frequency power electronics group. He has extensive experience in the design of dc-dc power converters working at MHz frequencies. He has published peer-reviewed work on power converters reaching up to 100 MHz using Si and WBG devices. He obtained his doctoral



degree from MIT in 2006. His research interests include power electronics, resonant converters, resonant gate drive techniques, high-frequency magnetics, and finding new applications for power converters.

Prof. Alberto Castellazzi is a Professor at Kyoto University of Advanced Science (KUAS), in Kyoto,



Japan, where he leads research and teaching in solid-state power processing. His focus is on the characterization, deployment, packaging and thermal-management of novel wide-band-gap (WBG) semiconductor devices (silicon carbide, SiC; gallium nitride, GaN) to achieve breakthrough joint improvements in the efficiency, power density and reliability of switching power converters. He has authored or co-authored over 200 papers in specialist journals and conference proceedings and has held a number of invited talks, tutorials and seminars on SiC-based power electronics. Prof. Castellazzi is a member of the technical program committee of a number of international conferences and is active as a reviewer and editor.

Dr. Samuel Araujo studied Electrical Engineering and graduated (Bachelor) in 2006 at the Federal



University of Ceará, Brazil. In the same year, he started the Master Course on Renewable Energies and Energy Efficiency (RE2) from the University of Kassel in Germany, concluding in the end of 2007. He worked as a research associate from 2007 until the beginning of 2009 in the Power Electronics Group at the Institute of Solar Energy (ISET) in Kassel and later moved to the Centre of Competence for Distributed Electric Power Technology (KDEE) at the University of Kassel; where he assumed the research group leadership in 2012. He

finished his Ph.D. degree at the same university on 2013, benchmarking the performance of several SiC device technologies and investigating their potential on renewable energy sources. Since 2016, he is working at Robert Bosch GmbH in the Corporate Sector Research and Advance Engineering, assuming the coordination of the power electronics team in the middle of 2017. His main fields of interest are the design and optimization of power circuits and the investigation of innovative semiconductor devices.



ICSCRM2019 Tutorial

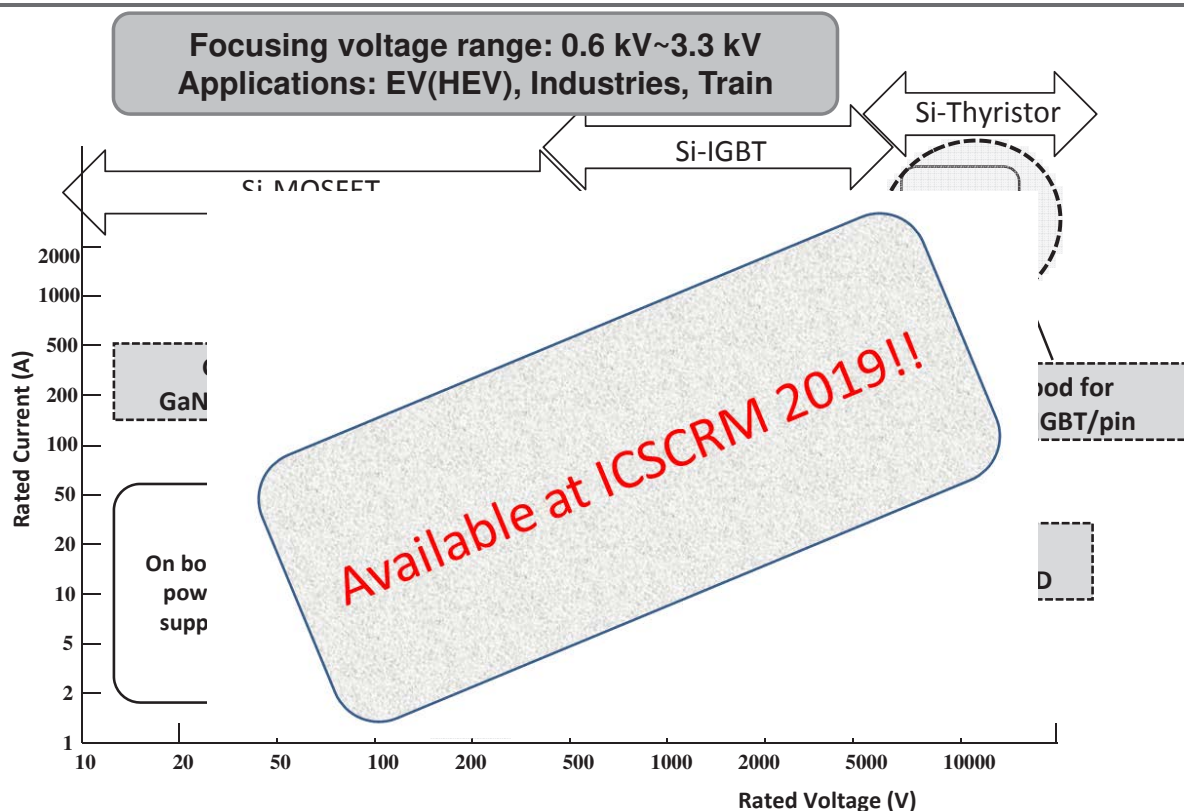
Device Design and Characteristics of SiC MOSFETs

Noriyuki Iwamuro

Faculty of Pure and Applied Sciences
University of Tsukuba



Power Semiconductor Devices and Their Applications



SiC Power Device Reliability Considerations

Professor Phil Mawby Professor Layi Alatise
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Sunday 29th September 2019 - Kyoto



Contents

- Packaging Technology Brief Overview
- MOS interface and gate oxide overview
- Gate oxide reliability in SiC MOSFETs
- Implications of Bias Temperature Instability
- Reliability and Qualification
- Electrothermal Robustness
- Temperature Sensitive Electrical Parameters in SiC



Packaging and Modules with SiC MOSFETs and Related Reliability Aspects

Josef Lutz, TU Chemnitz



using work of:

S. Palanisamy, J. Kowalsky, Peter Seidel, Md. K. Ahmed,
Erping Deng (TU Chemnitz)

Thomas Basler, J. Moazzami-Fallah (Infineon)

Ralf Schmidt (Siemens)

1 Challenges to SiC Packaging

2 Power cycling test methods for SiC MOSFET

2.1 TSEP and test method compared to Si IGBT

2.2 SiC specific measurement errors and correction possibilities

3 New technologies with increased power cycling capability

3.1 Standard technology

3.2 Reduced chip thickness

3.3 Ag-Sinter technology, Cu-sinter technology

3.4 „Direct Pressed Die“ technology

3.5 Cu topside metal and Cu bond wires

3.6 Die TOP system

3.7 AlCu ribbons

4 Summarizing remarks



Stanford
University

Stanford University Power Electronics Research Laboratory (SUPER Lab)

Driving Methods for SiC Devices at High-Frequencies

Prof. Juan Manuel Rivas Davila

jmivas@stanford.edu

September 29, 2019

Introduction: WBG at MHz?

ICSCRM2019 – Kyoto, Japan
Sep. 29th, 2019

Tutorial:

Multi-Level Inverter Topologies for Full Exploitation of SiC MOSFETs Characteristics

Alberto Castellazzi

Nagamori Institute of Actuators

Outline

➤ **Inverters in power electronics**

SiC MOSFETs in multi-level inverters

Short-circuit withstand

Conclusion

SIC MOSFETS AT INDUSTRIAL APPLICATIONS

ADDRESSING CHALLENGES AND REAPING BENEFITS

SAMUEL ARAUJO



ROLE OF POWER ELECTRONICS IN THE 21ST CENTURY

