Session 2: Power and Compound Semiconductor Devices – Focus Session on Power Devices
Monday, December 15, 1:30 p.m.
Continental Ballroom 5
Co-Chairs: Mikael Ostling, KTH Royal Institute of Technology
Kevin J. Chen, Hong Kong University of Science and Technology

1:35 p.m.
2.1 Social Impact of Power Semiconductor Devices (Invited), B. J. Baliga, North Carolina State University

Power semiconductor devices are used in all the major sectors of our economy. The largest impact on society has been a cost savings of $ 15 Trillion and carbon dioxide emission reductions by over 75 Trillion pounds due to commercialization of the IGBT in the early 1980s.

2:00 p.m.
2.2 SiC Power Devices for HEV/EV and a Novel SiC Vertical JFET, T. Ishikawa, Y. Tanaka*, T. Yatsuo* and K. Yano**, Toyota Central R&D Labs., Inc., *AIST, **University of Yamanashi

We propose a novel SiC VJFET with low feedback capacitance Crss. The p+ screen grid, which is inserted between gate and drain, effectively reduces the Crss by about 80% compared to a conventional VJFET. The low Crss can result in the lowest total power dissipation among existing SiC power devices.

2:25 p.m
2.3 Application Specific Trade-offs for WBG SiC, GaN and High End Si Power Switch Technologies, R. Rupp, T. Laska, O. Haeberlen*, and M. Treu*, Infineon Technologies AG, *Infineon Technologies Austria AG

In the last decade the competition of power semiconductor switch technologies is enriched by 2 new members: SiC-FETs (MOSFETs and JFETs) and lateral GaN-HEMTs. Whereas the SiC devices convince with great performance but still suffer from high wafer costs and wafer diameter limitations, GaN-HEMTs can be manufactured on large and cheap Si-wafers – but still have deficiencies with respect to ruggedness and require significant nominal voltage derating. In parallel to this new semiconductor switch solutions, the traditional Si-based technologies like IGBT and compensation MOSFETs like CoolMOS have improved continuously. Especially in the 600V- 1200V blocking range this result in very competitive situation, no clear long term winner can be identified today – the race will be decided differently for different applications. This paper will deal – therefore – with some of these application-specific trade-offs and development trends related to the mentioned power switch technologies.

2:50 p.m.
2.4 High Voltage Silicon Based Devices for Energy Efficient Power Distribution and Consumption, A. Kopta, ABB Switzerland Ltd, Semiconductors

This paper gives an overview of future requirements and recent progress of silicon based semiconductor devices for very high power applications. The first part gives an outline of the future trends in the areas of power transmission and power consumption and the resulting requirements on device design and performance. The second part elaborates on the recent advances of bipolar power devices and the corresponding packaging technologies used in these high power applications.

3:15 p.m.
2.5 Progress in Ultrahigh-Voltage SiC Devices for Future Power Infrastructure, T. Kimoto, J. Suda, Y. Yonezawa*, K. Asano**, K. Fukuda* and H. Okumura*, Kyoto University, *National Institute of Advanced Industrial Science and Technology, **Kansai Electric Power Co. Inc.

Since the specific on-resistance of ultrahigh-voltage (UHV) unipolar devices becomes very high even with SiC, bipolar devices will be attractive, owing to the conductivity modulation effect. In this paper, recent progress in UHV (> 15 kV) SiC PiN diodes, BJTs, and IGBTs with improved on-state performance is presented.

3:40 p.m.
2.6 600 V JEDEC-Qualified Highly Reliable GaN HEMTs on Si Substrates (Invited), T. Kikkawa, T. Hosoda, K. Imanishi, K. Shono, K. Itabashi, Y. Asai, Y. Wu*, K. Smith*, J. Gritters*, P. Smith*, S. Chowdhury*, D. Dunn*, M.

Aguilera*, B. Swenson*, R. Birkhahn*, L. McCarthy*, L. Shen*, R. Lal*, U. Mishra* and P. Parikh*, Transphorm Japan, *Transphorm

In this paper, we demonstrate 600 V highly reliable GaN high electron mobility transistors (HEMTs) on Si substrates. GaN on Si technologies are most important for the mass-production at the Si-LSI manufacturing facility. High breakdown voltage over 1700 V was confirmed with stable dynamic on-resistance (RON) using cascode configuration package. These GaN HEMT on Si based cascode packages have passed the qualification based on the standards of the Joint Electron Devices Engineering Council (JEDEC) for the first time. High voltage acceleration test was performed up to 1150 V. Even considering most conservative failure mechanism, mean time to failure (MTTF) of over 1x107 hours at 600 V was predicted.

4:05 p.m.
2.7 Power Devices on Bulk Gallium Nitride Substrates: An Overview of ARPA-E's SWITCHES Program, T. Heidel, P. Gradzki*, Advanced Research Projects Agency – Energy, *Booz Allen Hamilton