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The 14th International Seminar on Power Semiconductors (ISPS) was organised by the IET Czech Network in co-operation with the IEEE Czechoslovakia Section and co-sponsored by the Faculty of Electrical Engineering, Department of Electrotechnology, Czech Technical University in Prague in August 2018. This event provided a forum for technical discussion in power semiconductor devices and their applications. There was a wide range of topics covered in the seminar in the form of invited papers, tutorials, contributory oral papers and poster sessions, chosen through a peer review process.

Following the successful conclusion of the conference, it was decided that a selection of the papers would be chosen for this Special Issue in IET Power Electronics based on the recommendation by a panel of experts from both industry and academia and the authors were invited to submit their manuscripts to the IET Power Electronics. After extensive and independent peer review, nine significant manuscripts were accepted for publication. In the present issue, the manuscripts are aligned in the sequence of low voltage devices, IGBT-technology, reliability, and GaN-devices.

The Special Issue starts with a review article on low voltage MOSFETs. Phil Rutter's contribution "**Considerations in the design of a low-voltage power MOSFET technology**" summarises the tutorial he gave at the seminar in Prague. It covers all aspects of the devices from technological details and chip structures over packaging and reliability aspects all the way to intellectual property and standards. The paper provides an excellent overview of state-of-the-art low voltage MOSFETs and is an ideal reading for those who would like to get acquainted with the subject matter or to brush up knowledge, which gets outdated very quickly given the rapid progress of the industry.

At high voltages, IGBT is the most important silicon power device, which has pushed thyristor-based devices into niches. However, the IGBT itself is challenged by super junction MOSFETs and wide band gap devices. Thus, the cost pressure for IGBTs is continuously high. In the article "**Fabrication of IGBTs using 300 mm magnetic Czochralski substrates**" Schulze et al point out the challenges involved in the transition from 200 mm to 300 mm wafers and what the respective measures are to achieve homogeneity in the properties of devices under manufacture. Their success allows for a significant step forward in productivity and strengthens the IGBT's competitiveness even further.

The injection-efficiency of the back-side collector-zone is one of the most important design parameters of an IGBT. For low voltage IGBTs, the injection-efficiency is usually controlled by a back-side implant after thinning the wafer. This technique is sensitive and can lead to rather high leakage currents preventing high temperature operation of those IGBTs, if not managed properly. Andenna et al proposed a new approach in their article "**Soft-punch-through buffer concept for 600-1200 V IGBTs**". The technique based on an epitaxial layer technique to provide better control of the injection-efficiency and to reduce the leakage current, such that 200℃ operation can be within reach.

The over-all optimisation of the IGBT is the topic of a review article by Honda et al, which is entitled "**Multidirectional development of IGBTs and diodes: low loss and tough but gentle (user-friendly) power devices**". The authors stress the fact that IGBT technology is quite advanced and that further optimisation requires multi-directional and interdisciplinary efforts, including contributions from device technology, chip design and the surrounding circuitry, i.e., from the application. In any case, the safe-operation-are (SOA) and the reliability are inevitable must, which leads on to the three reliability papers of this Special Issue.

In their research article "**Al modification as indicator of current filaments in IGBTs under repetitive SC operation**" Mysore et al investigate the impact of repetitive short circuit events on IGBTs. During a short circuit, the IGBT is subjected to extreme heating and chip temperatures reach critical levels, even affecting the structure of top metal. The resulting patterns indicate a rather localised current flow at lower DC-voltages, while at higher voltages the current distribution is more homogenous. The authors support their findings by simulations.

Another lifetime-limiting factor of power semiconductor device is the power cycling capability. Due to the variety of materials and their coefficients of thermal expansion the repetitive heating and cooling generates mechanical stress and finally fatigue. Hoffmann et al show in their article "**Evaluation of the V_{SD}-method for temperature estimation during power cycling of SiC-MOSFETs**" that the phenomenon is also limiting factor in terms of the lifetime of SiC-MOSFETs but that the usually deployed methods to estimate the junction temperature of the devices might be subject to drift and imprecise temperature readings in SiC devices. As the power cycling capability strongly and non-linearly depend on the junction temperature swing, the discovered effect could compromise the validity of reported power cycling results.

The third paper on reliability deals with the radiation hardness of SiC devices. In their article "**Displacement damage and total ionisation dose effects on 4H-SiC power devices**" Hazdra et al investigate the impact of high-energy electrons, fast neutrons and alpha particles on various SiC-devices. They found a variety of defects, which are mostly unstable and give rise to the assumption that they will not impact the device operation, in particular not at high temperatures and will enable high radiation operation of SiC devices.

Gallium Nitride (GaN) enjoys the most dynamic development in power semiconductor devices and lateral devices are commercially available today. However, the potential of GaN devices is much higher and vertical devices promise to be even better than SiC devices. The review article "**Lateral and vertical power transistors in GaN and Ga_2O_3**" by Hilt et al provides an excellent summary of state-of-the-art GaN devices, discusses future vertical GaN devices and looks even another step ahead on Gallium Oxide (Ga_2O_3) devices, which could benefit from a much cheaper starting material process, made by melt-growth processes just like silicon.

In any case, the benefits of GaN devices can only be fully exploited if the control of the devices can cope with the extremely fast switching transients. As the ideal solution for such a tight control, monolithically integrated driver circuits, are a bit down the road at least for power devices, a different approach is required. In their contribution "**Gate driver IC for enhancement mode GaN power transistors with senseFET reverse conduction detection circuit**" Zhang et al show a method and IC to optimise the deadtimes required when commutating the current from one path to another. As a consequence, they demonstrate an efficiency improvement of 3% points, which is quite substantial and provides additional design degrees of freedom for further improvements.

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Author Biographies

Prof. Nando Kaminski has been a full professor of power semiconductor devices at the University of Bremen, Germany, since 2008. His current research interests include alternative semiconductor materials, material basics, device concepts, simulation, packaging, reliability, influence of parasitics, and electromagnetic compatibility. Before he was with ABB Semiconductors, Switzerland, for 11 years, where he was involved in insulated-gate bipolar transistors (IGBT), integrated gate-commutated thyristors, diodes, packaging, and reliability, finally as department manager and head of the IGBT module production line. Prof. Kaminski was the Chair of the 14th International Symposium on Power Semiconductors and is the guest editor of this special issue.

Prof Shankar Ekkanath Madathil is a Professor of Power Electronics Systems at the University of Sheffield. He was a Royal Society Industry Fellow in Rolls-Royce where he worked on the systems impact of next generation power electronic technologies between July 2013 and July 2017 and prior to that was he a Royal Academy of Engineering Chair in Power Electronics

(2007–2013). He was the Chair of the 13th International Symposium on Power Semiconductors. He is an associated editor of IET Power Electronics and is the guest co-editor of this special issue.