Electrification & Power Semiconductors

SiC Power Technologies and business – empower a greener future

P. Friedrichs
Vice President SiC
Infineon Technologies AG, IFAG IPC T, Neubiberg,
Germany

Abstract
SiC power devices have shown a tremendous growth over the last few years, targeting to a multi-billion dollar business by the end of the decade. Many driving applications belong to the segment of emerging applications related to the electrification of mobility and enhanced use of green energy. Those new applications, however, might need device solutions which differ substantially from the known portfolio based on silicon. One trend is for instance a much wider range of rated blocking voltages in order to be more application specific. The presentation will explain this trend in more detail and give concrete examples how such an adapted portfolio impacts the future of wide band gap power semiconductors.

Biography
Dr. Peter Friedrichs received his Dipl.-Ing. in microelectronics from the Technical University of Bratislava in 1993and his Ph.D work at the Fraunhofer Institut FhG-IIS-B in Erlangen. His focus area of expertise was the physics of the MOS interface in SiC. In 1996 he joined the Siemens AG and was involved in the development of power devices on SiC.
Peter joined SiCED GmbH & Co. KG, a company being a joint venture of Siemens and Infineon, on March the 1st, 2000. Since July 2004 he was the managing director of SiCED. In 2009 he achieved the Dipl.-Wirt.-Ing. From the University of Hagen. After the integration of SiCED's activities into Infineon he joined Infineon on April 1st, 2011 and acts currently as Vice President SiC.

Silicon carbide boosting the path to e-mobility in various applications

C. Kokkinos
Productmanagent HV Components for eMobility Applications
Robert Bosch GmbH, Reutlingen, Germany

Abstract
The auto industry has now pushed through the start button in the direction of e-mobility!

Our session provides details on why and how Silicon carbide power semiconductors support this move – and this - not only by increasing efficiency.
Together we will look at several mobility onboard applications, identify its drivers and present what makes the range of Silicon carbide power semiconductors perfectly suited for them.

Biography
Christina Kokkinos is responsible for product management in the Engineering & Business Line for power semiconductors and modules for all Bosch internal customers at Robert Bosch GmbH.
She started her career at Bosch in 2003 in the area of industrialization of power electronics products. Since then, she has been responsible for the manufacturing execution of power electronics and low temperature cofired ceramics products for several years.

Improving 4H-SiC MOSFETs by Gate Engineering

A. O'Neill
Professor
Newcastle University, School of Engineering,
Newcastle upon Tyne, United Kingdom

Abstract

Metal Oxide Semiconductor (MOS) interfaces have been a major challenge in the fabrication of SiC MOSFETs. This has resulted in poor MOS electrical performance with electron mobilities below 10 $cm^2/V.s$ compared with bulk values close to 1000 $cm^2/V.s$. Restricted MOS gate stack reliability means that an upper temperature limit of 150 °C is imposed by leading manufacturers of SiC power MOSFETs, despite 4H-SiC having an energy bandgap of 3 eV, compared with just 1 eV for Si. High-performance 4H-SiC lateral MOSFETs have been fabricated, with a peak effective mobility of 265 $cm^2/V.s$ in 2 μm gate length MOSFETs. The gate-stack was designed to minimize 4H-SiC/SiO_2 interface defect states and comprised a thin 0.7-nm thermally grown SiO_2 on 4H-SiC, followed by a deposited dielectric and a gate contact. In this way, residual carbon relate defects following SiC oxidation are significantly reduced. A density of interface traps (D_{it}) in the range of $6 \times 10^{11} – 5 \times 10^{10} cm^{-2}eV^{-1}$ is thus obtained, a reduction of 100x compared with a conventional gate stack with a thermally grown thick oxide.

Biography

Anthony O'Neill is Siemens Professor on Microelectronics at Newcastle University, having joined in 1986 from Plessey Research (Caswell) Ltd. He is well known for pioneering work in strained silicon, which improves CMOS electronics performance without shrinking dimensions. It's still used in most electronic systems today, from smartphones to server farms. Since then he has re-engineering SiC MOSFETs to achieve record electrical performance with channel resistance now approaching Si. He has held visiting appointments at MIT, EPFL, Monash University and Atmel.

Overview of the normally-OFF GaN-on-Si MOSc HEMT transistor in the fully recessed gate architecture

V. Sousa
Head of Laboratory for Power Semiconductor Devices
CEA, Leti MINATEC, DCOS/SITEC/LAPS, Grenoble, France

Abstract
Gallium nitride power switches have emerged in industry to provide solutions for a wide range of power applications. Different approaches are considered to obtain a normally-off operation of the GaN transistor. While the pGaN gate architecture is more mature and already commercially available, the recessed gate technology including an insulated gate potentially offers better performance. In this presentation, we will detail the latest integration process developed at Leti to fabricate fully recessed gate MOSc-HEMT transistors. We will present the electrical characteristics of the devices, evaluated both at the wafer level and on packaged devices. We will thus highlight the advantages of this recessed-gate technology with respect to the pGaN gate technology, in particular the lower temperature coefficient of the resistance of the device, or the reduced gate current, or the shorter switching time.

Biography
Véronique Sousa graduated in 1994 from the University of Grenoble Alpes in the field of Materials Science and Engineering. She joined the CEA-Leti-MINATEC-Campus in 1998. For twenty years, she conducted R&D projects dedicated to the optimization of various resistive memory technologies, including phase change memories. Since 2018, the focus of her work has shifted to solid-state power devices. In 2020, she took over as head of the CEA-Leti Power Semiconductor Devices Laboratory.

(Ultra-)Wide Bandgap Semiconductors for Sensor and Power Electronic Applications

J. Schulze
Full Professor and Managing Director
Fraunhofer-Gesellschaft, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB, Erlangen, Germany

Abstract

As Silicon carbide has turned into an established material for high voltage power semiconductor devices, materials with even wider bandgap are receiving increasing attention for power electronic applications and beyond.

This talk will start with a brief recap of the evolution of SiC device technology.

On the basis of this success, the presentation will then focus on ways to exploit similar concepts using materials with even wider bandgap. The availability of large diameter crystals and processing equipment is a prerequisite for efficient commercialization of such technologies as silicon, silicon carbide and gallium nitride are now already solutions in this field.

Also, the presentation will provide an outlook towards the application of ultra-wide bandgap materials towards (quantum) sensing applications.

Biography

J. Schulze studied experimental physics at the TU Braunschweig, Germany. In 2000 he received the Ph.D. degree (Dr.-Ing.) in EE from the EE&IT Faculty of the University of the German Federal Armed Forces Munich. From the same faculty he received in 2004 his post-doctoral degree (Habilitation). He was active as Senior Consultant for Technical Risk Management and as Head of Competence Field "Robust Design Optimization" in Siemens Corporate Technology (2005-2008). From 2008 to 2021, he worked at the University of Stuttgart, Germany, as Professor of EE and Head of the Institute of Semiconductor Engineering. Since 2021, he is working at the Friedrich-Alexander University of Erlangen-Nürnberg, Germany, as Professor of EE and Head of the Chair of Electron Devices (LEB). In parallel, he is the managing director of the associated Fraunhofer-Institute of Integrated Systems and Device Technology (IISB). His main interest is directed to group-IV-based epitaxy, power-, nano- and quantum-electronics, photonics and spintronics.