ELECTRIFICATION & POWER SEMICONDUCTORS

U. Hansen
VP Power Component Development
Robert Bosch GmbH, Reutlingen, Germany

Biography

Uwe Hansen received his PhD in Physics at the Technical University from Munich. He specialized in theoretical semiconductor physics. Uwe started his career at Bosch as a process engineer in the Bosch automotive Waferfab, held various functions within Bosch related to semiconductors and was responsible for advanced packaging for CE and automotive MEMS. Since 2018 he is heading the department for power component and module development at Bosch.

References

From Advanced Silicon Carbide to Ultra-Wide Bandgap Devices: Recent Research

M. Jank
Head of Department
Fraunhofer IISB, R&D Semiconductor Devices and
Processing, Erlangen, Germany

Abstract

The talk will review recent research activities on Silicon Carbide (SiC) MOSFETs and give an outlook on the novel ultra-wide bandgap materials Aluminum Nitride (AlN) and Gallium Oxide (Ga_2O_3).
The reduction of resistive components is a first order measure for improvement of power switches. Whereas in medium to high voltage SiC devices (i.e. > approx. 2 kV) the drift region plays a dominant role with respect to static losses, contact and channel optimization are in the focus for lower voltage classes. Recent architectural approaches towards low resistivity SiC devices, including 3-dimensional channel arrangements as well as super-junction structures for high-blocking voltage, low resistivity drift regions will be discussed.
Based on its long-standing expertise in nitride materials, Fraunhofer IISB pioneered the PVD growth of AlN crystals and is able to provide up to 1.5 in. epi-ready wafers to its research partners. A complete value chain leading to the successful preparation of 2.2 kV AlN/GaN high electron mobility transistors (HEMTs) with superior power density was established in a national research cooperation.
The presentation will conclude with an outlook involving materials properties and related device architectures.

Biography

Michael Jank earned a PhD in electrical engineering, electronics and information technology from Friedrich-Alexander University of Erlangen, Germany, in 2006. After his dissertation on simplified CMOS integration concepts, he established a research group for novel thin-film materials, processing and devices for systems on flex and display applications at Fraunhofer IISB. Since 2023 he is responsible for IISB's R&D activities into Semiconductor Devices and Processes, focusing on discrete and integrated Silicon Carbide power electronics.

References

TRANSFORM: Trusted European SiC Value Chain for a greener Economy

M. Koyuncu
Senior Project Manager
Robert Bosch GmbH, Reutlingen, Germany

Abstract

Power electronics systems based on wide band-gap materials play an essential role in future power conditioning and conversion systems. Among these SiC is at the forefront due to its advantages in efficiency and thermal behavior. The EU funded innovation project TRANSFORM demonstrates a complete European SiC based power electronics value chain. 32 partners from industry and academia cover materials, processing equipment, devices, power modules and systems to build up this value chain in essential application domains such as e-mobility, industry, agriculture, and renewable energy. Power MOSFETs are processed in series production lines on advanced SiC substrates. They are benchmarked to standard mono-SiC substrates in aspects of defectivity and processability. Device characteristics are compared to those on standard wafers and devices are used in real applications in various demonstrators. While showing some processing challenges, devices on advanced substrates have shown superior behavior in terms of RDSON, reverse recovery charge and bipolar degradation. Power modules with copper-based assembly and interconnection technologies, i.e. copper bonding on copper metallized SiC with copper sinter paste, are developed showing very promising reliability data. High density power modules as well as new manufacturing approaches are developed that improve thermal and electrical performance. An innovative current source gate driver is developed that enables gate shaping and in-system parameter identification to ensure optimal utilization of single as well as parallel connected power switches. Highest performance at lowest possible cost along the entire lifetime is maintained by taking degradation of power switches and interconnects into account. The innovative technologies are showcased in five demonstrators in above mentioned application domains. This project has received funding from the Key Digital Technologies Joint Undertaking (KDT JU) under Grant Agreement No101007237. The JU receives support from the European Union’s Horizon 2020 research and innovation program and Germany, France, Italy, Sweden, Austria, Czech Republic, Spain.

Biography

Metin Koyuncu joined Bosch in 2001 as an electronics packaging engineer. He has been active in the field of assembly and interconnection technologies for signal and power packages for automotive and photovoltaics, flexible electronics and molded interconnect devices. Currently he is working as a project manager in the power semiconductors and modules unit of Bosch in Reutlingen, active in publicly funded projects. He is the project coordinator of “TRANSFORM” funded by the KDT-JU.

References

SiC End to End Manufacturing Fab Management

L. Riva
SiC Campus Fab Manager Director
ST Microelectronics, Quality Manufacturing
Technology, Catania, Italy

Abstract

Silicon Carbide, thanks to its electronic and thermal properties, is a revolutionary bulk substrate for Power Devices Schottky Diodes and Field Effect Transistors, both in the automotive and industrial market segments. SiC substrate, since its discovery in 1893, has been a case of study but only in the last few years has become a subject for manufacturing first at 150 mm and now also at 200 mm where fully vertical integration from powder to final product is a key factor of cost and quality success. Automation supported by Any Logic model is functional to industrial KPI. Most of the defects present in the crystal ingot, micropipes, polytype and others, only partially recovered during the epitaxy steps can determine electrical failures at device level. For that reason Artificial Intelligence with the associated statistical models is suitable to identify specific defects improving significantly the quality of the substrates and increment yield.

Biography

Luca Giovanni Riva was born in Monza Italy in 1969. He graduated in Solid State Physics with a thesis on Advanced Metalizzation Electromigration study. He has been working at ST Microelectornics since 1994. In the first ten years he worked in R&D focusing on new deposition models for micrometric vias filling. Later he developped the intregration of BEOL package of BCD devices with memories embedded. In 2001 he moved to reliqbility department focusing on the interaction between process and failure modes. From 2008 he took the responsibility for the Operations of Analog products in the Analog & Power Group and since 2023 he has been appointed Director of Operations in Catania SiC Campus.

References

SiC Technology – Transfer to 200mm Wafer Size

S. Schwaiger
Automotive Electronics
Robert Bosch GmbH, Automotive Electronics,
Reutlingen, Germany

Abstract

Silicon carbide (SiC) technology has proven to be advantageous compared to silicon technology for high power applications like automotive traction inverters. While the electrification of modern vehicles pushes the maturity of SiC technology, several quality issues associated with the new material system have been discovered and must be tackled to maintain a low level of devices failures during operation.

Within this decade, SiC technology will make an important step: The step from 150 mm wafer size to 200 mm wafer size. While this transfer exhibits several advantages, e.g. better process stability and uniformity due to the more modern processing equipment, maintaining the same quality of the products has to be ensured. This talk focuses on the benefits and challenges of the transfer from 150 mm to 200 mm wafer size of SiC technology.

Biography

Stephan Schwaiger studied physics at the university of Hamburg and finished with a doctorate degree in 2012. He started in semiconductor industry in Bosch's central research department working power semiconductors. Since 2015 he works on the development of SiC semiconductors for the section Automotive Electronics at Bosch focusing on technology and device development.

References