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"GaN power devices: from technology to reliability challenges"

GaN power devices have excellent properties for application in the power conversion field. The wide bandgap, the high sheet channel density, the large breakdown field permit to substantially increase performance and reduce losses, compared to conventional silicon devices. Different device structures are available, from lateral normally-off transistors, to fully vertical device architectures. This tutorial reviews the main properties of gallium nitride, and the unique characteristics of GaN-based devices. Details on lateral and vertical device architectures will be given, to present a comprehensive overview on the topic. In the second part of the presentation, the main reliability challenges for GaN devices will be discussed, with focus on dynamic on-resistance and breakdown phenomena. Finally, perspectives in the GaN field will be presented.

Matteo Meneghini received his PhD in Electronic and Telecommunication Engineering (University of Padova), working on the optimization of GaN-based LED and laser structures. He is now associate professor at the Department of Information Engineering at the University of Padova. His main interest is the characterization, reliability and modeling of compound semiconductor devices (LEDs, Laser diodes, HEMTs), electronic and optoelectronic components, solar cells. Within these activities, he has published more than 400 journal and conference proceedings papers. He has given invited and tutorial talks to several conferences, including IEEE-IEDM, IEEE-IRPS, IWN, ICNS, Photonics West. He is/has been sub-committee member for relevant conferences in the field of electronics (IEEE-IEDM, IEEE-IRPS, ESREF, IWN, ESSDERC) and sub-committee chair for IEEE-IRPS and ESREF.

Carlo De Santi was born in Verona, Italy, in 1985 and obtained his Ph.D. in 2014. He is an assistant professor in the microelectronics group at the University of Padova. His main research activities are characterization, physical modeling and reliability of various GaN-, Ga₂O₃-, SiC-, GaAs-, InP-, Diamond-, CdTe- and Si-based electronic and optoelectronic devices for high frequency, power conversion, lighting, signal transmission and energy harvesting applications. He is author of more than 75 peer-reviewed journal papers, 110 contributions in conference proceedings and 5 book chapters.

Enrico Zanoni is professor of Microelectronics at the Department of Information Engineering of the University of Padova and an IEEE Fellow. He and his group are involved in research on the characterization, modeling and reliability of Gallium Nitride electronic and optoelectronic devices since 1999. At the University of Padova he contributed to establish a microelectronics research group involved in CMOS analog and rf integrated circuit design, CMOS reliability and radiation hardness, compound semiconductor characterization, modeling and reliability. Enrico Zanoni is coauthor of more than 600 publications reported in the Scopus database on the modeling and reliability physics of silicon and compound semiconductor devices with an h-index equal to 49. He is also coauthor of 4 patents.

Gaudenzio Meneghesso (IEEE S'95-M'97-SM'07-F'13) He graduated in Electronics Engineering at the University of Padova in 1992 working on the failure mechanism induced by hot-electrons in MESFETs and HEMTs. Since 2011 is with University of Padova as Full Professor. His research interests involve mainly the Electrical characterization, modeling and reliability of microelectronics devices. Within these activities he published more than 800 technical papers (of which more than 100 Invited Papers and 12 best paper awards). He has been nominated to IEEE Fellow class 2013, with the following citation: "for contributions to the reliability physics of compound semiconductors devices".