

Silicon Carbide power device design and fabrication: making the transition from Silicon

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Abstract

The tutorial will outline the advantages of SiC over other power electronic materials, and will introduce SiC devices currently developed for power electronic applications. ESD, high-voltage testing, and packaging aspects will be covered. The design and properties of SiC JFETs, MOSFETs, BJTs, IGBTs, Thyristors, and Junction Barrier Schottky and PiN diodes will be discussed, with an emphasis on their performance advantages over those of their Si counterparts. Common SiC Edge Termination techniques, which allow SiC devices to exploit their full high-voltage potential, will be rigorously treated and their impact on device performance will be highlighted. Aspects of device fabrication will be taught with an emphasis on the processes that do not carry over from the mature Si manufacturing world and are thus tailored to SiC. In particular, the tutorial will stress in more detail the design and fabrication of SiC MOSFETs, which are being inserted in the majority of SiC based power electronic systems. Device reliability will be reported through exemplary hard switching results. Exemplary SiC-based power electronics systems like hybrid loaders, fast chargers, PV inverters, EV traction, and circuit breakers will highlight the significant advantages of these systems over their Silicon based counterparts.

This tutorial is intended for intermediate level audiences.

Biography

Victor Veliadis received the Ph.D. degree in Electrical and Computer Engineering from Johns Hopkins University in 1995. From 1996 to 2000, he was with start-up Nanocrystals Imaging Corporation where he developed quantum-dot phosphors for imaging applications. From 2000 to 2003, he was with Lucent Technologies where he designed InP-based tunable photonic integrated circuits for telecommunication applications. In 2003, Victor was Adjunct Physics Professor at Ursinus College and St. Joseph's University. After a brief military service, Victor joined Northrop Grumman Corporation in 2004 where he designed, fabricated, and tested SiC SITS, JFETs, MOSFETs, Thyristors, and JBS, Schottky, and PiN diodes in the 1-12 kV range. In 2016 Victor was appointed CTO and in 2017 CTO/Deputy-Director of Power America, which is a U.S Department of Energy wide bandgap device Manufacturing Institute managed by NCSU. In 2016, Victor also became Professor in Electrical and Computer Engineering at NCSU. Victor has given over 60 invited presentations/keynotes/tutorials, authored/co-authored 108 peer-reviewed technical articles, authored 3 book chapters, and has 24 issued patents to his credit. He is a Senior Member of IEEE, an IEEE EDS Distinguished Lecturer, and has served in the ECSCRM, ICSCRM, WiPDA, and ISPSD organizing committees.