AlGaN/GaN Power Device Reliability

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Abstract

AlGaN/GaN power devices have made tremendous progress over the past few years, and first commercial products have entered the market. The quality of MOCVD has reached a level that allows the fabrication of large area transistors with high yield and good reproducibility. Although GaN power devices achieve substantial higher system efficiency compared to their Si counterparts, the widespread adoption of GaN power devices in the market is still hampered by the unknown field reliability.

The tutorial will focus on the current understanding of the different intrinsic and extrinsic reliability mechanisms of AlGaN GaN power devices, and will cover following aspects:

- A methodology on how to extract important information on the conduction mechanisms in the GaN buffer structure out of relatively simple measurements on TLM structures (back-gating or substrate ramp) and transistors (current DLTS).
- Overview of the main intrinsic reliability mechanisms: gate reliability (both MISHEMT and pGaN gate), NBTI/PBTI of MISHEMTs, accelerated drain stress and hot carrier stress (semi-on-state stress). Recoverable versus permanent degradation.
- GaN-specific failure and degradation modes such as the inverse piezo-electric effect and dynamic Ron.
- Acceleration models and statistical distribution models (Weibull, lognormal) applied to GaN.
- Extrinsic reliability (HTRB, HTGB, thermal cycling etc).
- Switching reliability (double pulse testing, boost converter, …)
- Introduction to the new upcoming JEDEC standard for AlGaN/GaN power devices (JC 70.1).

The topic will be treated in-depth and is for an intermediate-advanced audience.

Biography

Peter Moens received a M.Sc. and a Ph.D. in solid state physics from the University of Gent, Belgium, in 1990 and 1993 respectively. From 1993 till 1996, he worked as a post-doctoral fellow in collaboration with Agfa-Gevaert, Mortsel Belgium. In 1996, he joined ON Semiconductor, Oudenaarde, Belgium where he was involved in the technology and device development for smart power applications, and the related reliability aspects. Since 2008 he is responsible for the development of 600+V discrete power devices, both in silicon as well as in wide band gap materials. He is/was a member of the technical program committees of IEDM, ISPSD, IRPS, IRW, ESSDERC and ESDEOS Symposium. He was Vice-chair of the integrated power subcommittee of IRPS 2005 and 2008, and Chair of the same committee of IRPS 2006 and IRPS 2007. He was the Technical program chair of ISPSD 2009, and the General chair of ISPSD 2012. He was the subcommittee chair of the Power and Compound semiconductor devices subcommittee for IEDM 2014. He authored and co-authored over 150 publications in peer reviewed journals or conferences. He authored or co-authored of 12 invited papers and is the recipient of 3 best paper awards. He also presented tutorials on smart power reliability at IRPS 2005, IRPS 2006 and ISPSD 2007, and on GaN power device reliability at IRPS2015 and IRPS2017. He holds over 30 patents.