GaN Power Device Technology and Reliability

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Abstract: Excellent material properties of Gallium Nitride (GaN) have promised superior device performance over conventional silicon technologies in power electronics applications. Combination of large critical electric field and high electron mobility makes it possible to scale down power devices, which provides numerous benefits such as smaller input/output capacitances and low on-resistance. In addition, lack of body diode in GaN devices eliminates reverse recovery delay, allowing high frequency operation and opening possibilities for new circuit topologies. Thanks to these benefits, extensive research has been conducted in both academia and industries over the last few decades. Various process technologies have been developed and numerous studies on diverse reliability issues have been conducted. Based on all these efforts, performance and reliability of GaN power devices have improved tremendously and several manufacturers have announced commercial products in recent years. Market adoption is also growing rapidly in various areas from consumer electronics to industrial applications.

This tutorial introduces a broad overview of GaN power device technology. First of all, basics of GaN, including polarization, device structure, and fabrication process will be covered. Then, various reliability issues will be reviewed, starting from intrinsic device level to real applications. Finally, the tutorial will conclude with a discussion of the recent progress and future of GaN technology.

Bio: Dong Seup Lee is a semiconductor technologist and currently works in Texas Instruments (TI) as device and process integration engineer for GaN technology. He joined TI in 2014 and has made major contributions on 600V GaN technology development, reliability improvement, and successful qualification & production.

He received M.S. degree in Electrical Engineering from Seoul National University, Korea in 2009 and Ph.D. degree in Electrical Engineering and Computer Science from MIT in 2014. He has researched various semiconductor devices including advanced CMOS, tunneling FET, single electron transistors (SET), GaN-based RF amplifier and high voltage power devices. He has authored or coauthored more than 30 papers in technical journals and international conferences as well as numerous patents. Also, he has been a reviewer for various major journals such as EDL, TED and JAP. He was a technical committee member on power devices and compound semiconductor high speed devices in IEDM conference in 2018 and 2019.