

Enrico Zanoni, Carlo De Santi, Matteo Meneghini, Gaudenzio Meneghesso / University of Padova

"Failure modes and mechanisms of GaN HEMTs for microwave and power applications"

Relevance of GaN High Electron Mobility Transistors for communication systems, avionics, energy management and control is becoming increasingly important. On one hand 5G systems will require power amplifiers with high efficiencies, increased bandwidth and operating frequencies; on the other, an increased demand is expected for high-voltage power converters and control systems with efficiencies close to 100%, higher frequency and temperature of operation, increased compactness and robustness. As device scaling and higher voltages, with consequent increase of electric field, represent a potential threat for the reliability of these devices, research on GaN HEMT failure physics has been intensified recent years. This tutorial will review failure modes and mechanisms of GaN HEMTs, including mechanisms leading to frequency dispersion effects, current collapse and dynamic Ron increase, mechanisms affecting the gate Schottky contact, time-dependent breakdown phenomena, hot-electron degradation related to device dynamic operation in microwave or switching systems

Enrico Zanoni is professor of Microelectronics at the Department of Information Engineering of the University of Padova and a 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. The facilities of the associated laboratories include several systems for the DC, rf and pulsed characterization of GaN HEMTs, current Deep Level Transient Spectroscopy up to 600 V, accelerated testing in a wide range of environmental conditions, failure analysis using electroluminescence spectroscopy and microscopy techniques, AFM and electron microscopy. Recent studies on GaN material and devices at the University of Padova have analyzed the effects of material defectivity and deep levels on GaN HEMTs, the correlation with dynamic on-resistance measurements, the study of breakdown mechanisms, the analysis of the reliability and of the physical failure mechanisms of GaN LEDs and heterojunction and quantum-dot lasers for silicon photonics. Enrico Zanoni is coauthor of more than 500 publications on the modeling and reliability physics of silicon and compound semiconductor devices and of 4 patents.

