SESSION 15
GaN POWER ELECTRONICS

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GaN-based power electronics have the potential to provide significant efficiency and performance improvements over conventional, Si-based MOSFET devices. This session provides a diverse range of papers across this rapidly evolving area.

To start the session we have an invited talk from Avogy, a Silicon Valley start-up company developing high-power switches with vertical architectures on bulk GaN substrates. GaN vertical devices have the potential to achieve very high performance with compact devices that can potentially solve some of the challenges associated with lateral devices and thin-film surfaces. Vertical devices require low dislocation density material, however, and this paper presents new work on fabricating vertical GaN p-n diodes on high-quality bulk GaN substrates made using ammonothermal growth.

Lateral GaN devices grown on low-cost Si substrates are undergoing intense development. The use of 6” or 8” substrates enables the use of existing, depreciated CMOS silicon wafer fabs and also offers the possibility of CMOS integration with GaN power devices. From the Institute of Electronics, Microlectronics and Nanotechnology in France we have a paper describing the novel use of localized Si substrate removal beneath the channel of an AlGaN/GaN heterostructure. This approach helps to suppress the parasitic substrate conduction at high electric fields and enables increased breakdown voltages.

Electrically active defects in GaN materials can negatively impact device operation by increasing on resistance (Ron) as well as threshold voltage instabilities. From Ohio State we have recent work to correlate these degradations to a specific trap, with experiments that identify its physical location and clarify its possible origin in metal-insulator-semiconductor high electron mobility transistors (MIS-HEMTs).

In order to fully realize the high-voltage potential of GaN materials, much work remains to understand the reliability and failure mechanisms that occur under high electric field and high temperature conditions. From MIT we have a paper that studies the oxide reliability of MIS-HEMTs. A new experimental methodology has been developed to characterize the time-dependent dielectric breakdown (TDDB) using current-voltage and capacitance-voltage measurements.

Finally, from International Rectifier we have a paper describing a new methodology to screen for long-term performance degradations in high-voltage GaN-on-Si power devices. In conventional Si production lines parametric end-of-line tests are used to screen out devices, but new approaches are needed for GaN-on-Si devices that that can better predict failures and correlate accelerated life testing results with inline process parametric data.