PC-Mon-P18* - Random telegraph noise and excess leakage current due to intrinsic defects in p-i-n diodes on GaN-on-Si substrate

2. Physics and characterization

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Abstract text: GaN high electron mobility transistors (HEMTs) for power applications are typically built on Si substrates, resulting in dislocation densities of 1-6×10^9 cm^{-2} within the GaN epitaxial layers [1,2]. The role of dislocations in the electrical properties and reliability of GaN HEMTs is still discussed [1-3]. However, a study of reverse current in quasi-vertical GaN-on-Si p-i-n diodes has revealed that the density of electrically active defects causing an excess leakage current (ELC, i.e. outlier of current distribution) is only about 5×10^3 cm^{-2} [4]. Low-frequency noise spectroscopy, particularly random telegraph noise (RTN), is useful for characterizing intrinsic or stress-induced defects in GaN devices [5-8]. In this work, we investigate RTN and ELC in GaN-on-Si p-i-n diodes and relate them to the presence of active intrinsic defects.

The p-i-n diode is a fundamental part of every gate stack of a normally-off HEMT. Here, an AlGaN barrier (15nm) and uid-GaN (420nm) layer are placed in between the top p-GaN and 1µm thick n-AlGaN at the bottom [4]. Devices with a diameter of 10-75µm have a boron-implanted sidewall to reduce the perimeter leakage.

Two or multi-level RTN, with amplitude ΔI in pA - nA range, is observed at both bias polarizations, mostly in devices having an ELC at reverse bias. The bias dependence of ΔI in both polarizations follows the IV characteristics of the ELC component, attributing thus RTN to fluctuations in ELC. The large relative RTN amplitude, ΔI/I, up to 30% indicates that ELC flows through a constriction related to an extended defect, e.g. closed-core dislocation [4]. Defect- and/or electric field-assisted processes are the origin of ELC. The bias dependence of RTN mean pulse widths (10ms to 10s range) suggests that RTN is due to capture/emission or structural reconfiguration processes on a single point defect which takes part of the extended defect. The work was supported by ALL2GaN EU project no. 101111890.

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