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Peripheral defects related to processing technique in GaN-on-GaN vertical devices

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In recent years, there has been a notable interest in GaN devices for power applications, particularly in the context of vertical structures such as GaN/GaN. This growing interest stems from the recognition of GaN's potential to surpass traditional semiconductor technologies like Si, SiC, and even GaN/Si. Despite the promising advancements in GaN technology, the performance of these devices can be significantly affected by the presence of defects within the material [1]. Defects, such as dislocations, vacancies, impurities (etc...) can have a huge impact on the device's reliability and efficiency [2][3]. Therefore, understanding and analyzing these defects is crucial for optimizing GaN device performance. Toward this end, DLTS (Deep Level Transient Spectroscopy) and micro-Raman spectroscopy measurements were realized on GaN-on-GaN vertical Schottky diodes [4].

DLTS measurements were realized on circular GaN/GaN vertical Schottky diodes with different sizes in the range of (130-330 μm as diameter) and the analysis of the results pointed out the existence of certain defects that could be assigned as peripheral defects related to the processing of the devices. This relation between these defects and the processing was concluded by studying the variation of the DLTS peak amplitude as a function of the diode perimeter to area ratio (P/A) (fig.1). This P/A factor makes it possible to compare the periphery effects to the volume effects and therefore to probe the influence of technological processes leading to the periphery of the diode.

For instance, the DLTS peak amplitude of the defects $E_c - 0.23$ eV and $E_c - 0.26$ eV shows a linear increase with the factor P/A in the range between 121 and 308 cm^{-1} (fig.2) This demonstrate that these 2 levels originate mainly from the periphery of the diode and could be clearly attributed to the technology process of mesa etching or from the following passivation process. On the other hand, the DLTS peak amplitude of a common well-known defect attributed to Fe impurity [5][6] in GaN, whose energy level is located at $E_c - 0.55$ eV, shows almost no variation depending on the factor P/A demonstrating its expected volume origin (fig.2).

Further investigations on other diode devices (PiN and Schottky) are in progress and these DLTS results will be compared to other characterization methods such as micro-Raman spectroscopy to study the existence and the origin of the traps and their relationship to the technology process of the diodes.

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Supplement Information

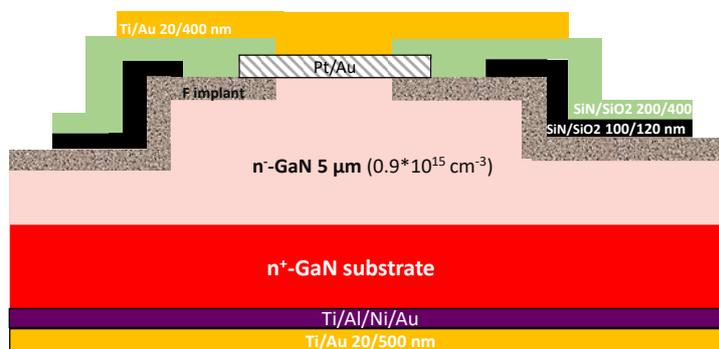


Figure 1: Schematic cross section of the vertical Schottky diode.

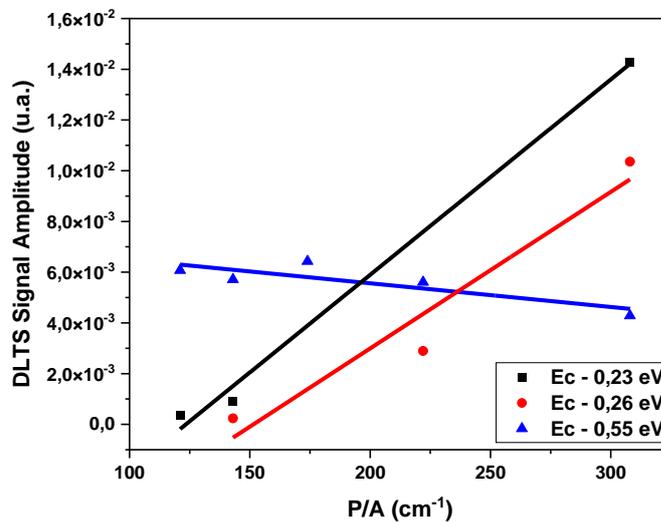


Figure 2: Amplitude variation of defect $E_c - 0.23$ eV, $E_c - 0.26$ eV, and $E_c - 0.55$ eV as a function of the factor P/A .