GaN P-N Diode Realized With Selective Trench Refilling Epitaxial Technology

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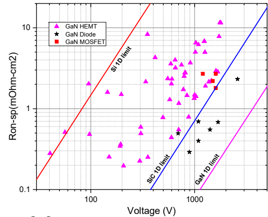
Overview

1. *Background*

- ❑ Edge termination is key building block for power devices.
- ❑ Floating ring-based terminations are usually adopted in Si/SiC device
- ❑ Similar structure is not available in GaN-based power devices, due to lack of selective doping technology.
- ❑ Existing field-plate, mesa, Ar-IMP can not deliver avalanche capability

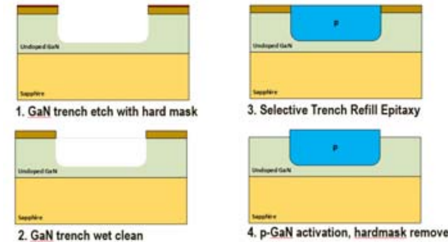


2. *Problem Statement*

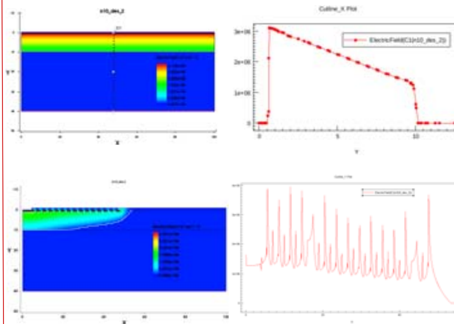
- ❑ Selective area doping is enabling technology for high performance edge termination.
- ❑ Conventional Mg implantation is not feasible as high temperature anneal can not activation p-dopant.
- ❑ We use selective trench refilling epitaxial growth method to prepare floating ring termination

Method

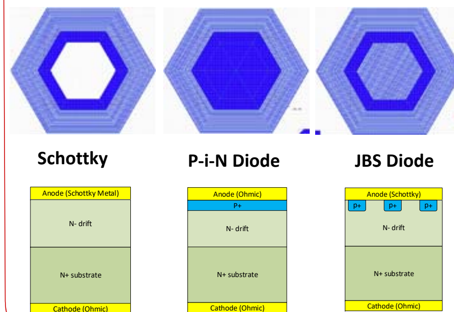
❑ **Process Diagram:**



❑ **TCAD simulation:**

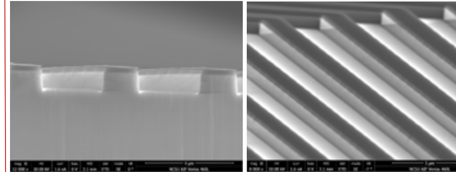


❑ **Diode Layout:**

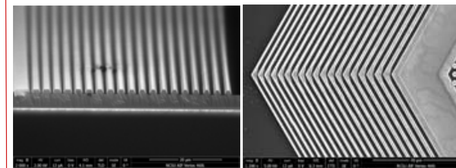


Results

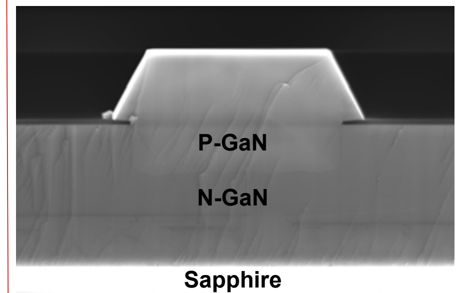
❑ **Trench Etch:**



❑ **Epitaxy Growth:**

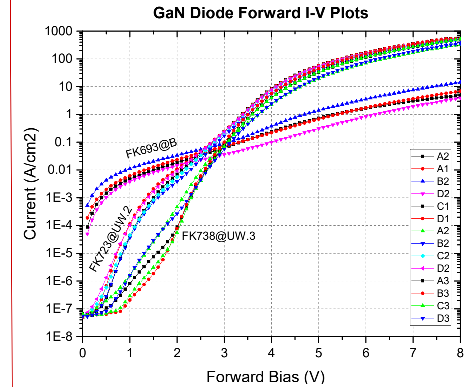


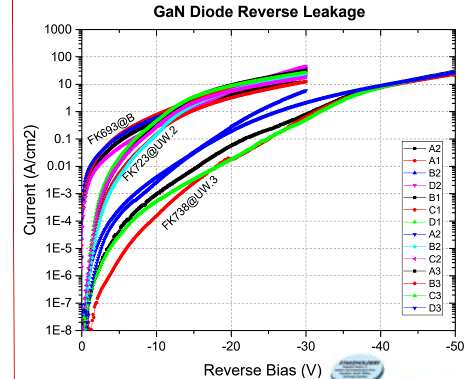
❑ **Final P+N cross-section:**



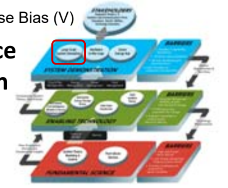
- ❑ Achievement: Established selective trench refilling epitaxial process, demonstrated prototype GaN diode with decent performance.
- ❑ In future, reduced reverse leakage and deliver high voltage GaN diode
- ❑ Impact: P+N junction can be integrated into HEMT to modulate electrical field, and enhance GaN lateral device figure-of-merit.

GaN Diode I-V





- ❑ Both trench surface and epitaxy growth are improved.
- ❑ I_{on}/I_{off} ratio: 1×10^6 (+/-4V)



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