

## Master Thesis

### Arbeitsbereich:

Neue Halbleiter Devices

### Ausrichtung:

- Entwicklung & Simulation
- Layout
- Charakterisierung
- Programmierung
- Hardware-Entwicklung
- Messtechnik
- Machbarkeitsstudie

### Studiengang:

- Elektro- und Informationstechnik
- Physik
- Biologie
- Informatik
- Maschinenbau

### Einstieg:

01.11.2020

### Umfang:

6 Monate

### Vorkenntnisse:

- digitale Schaltungstechn.
- analoge Schaltungstechn.
- TCAD Simulation
- Layout-Erfahrung
- Programmierkenntnisse
- elektr. Messtechnik

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Investigation and verification of enhancement mode GaN HEMTs using TCAD simulation tool SILVACO in 3D

### Motivation

Gallium Nitride (GaN)-based high electron mobility transistors (HEMTs) are rapidly emerging as front-runners in high-power mm-wave and DC switching circuit applications. Traditionally AlGaN/GaN HEMT has a normally-on behavior. However, Enhancement mode GaN HEMTs are required for several applications including complementary circuits in digital electronics and ensuring safe state operations. There are multiple methods of developing E-mode HEMTs for example using p-GaN gate or treating the gate with fluorine or creating a trench at the gate in AlGaN.

Here at IMS, the E-mode HEMT devices have been successfully developed by etching nanostructures (in various configurations) under the gate in AlGaN/GaN

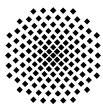
### Scope of Work

For better understanding of the nanostructured gate recess E-mode devices in 3D needs to be simulated and verified. Different TCAD simulations using SILVACO ATLAS tool need to be implemented and some proposed design configurations are to be investigated. In the scope of this thesis, the following tasks should be scientifically investigated and documented:

- ✓ Understanding of physical basics of the GaN HEMT device operation
- ✓ Literature review and comparison between the state-of-the-art E-mode GaN devices.
- ✓ Numerical device TCAD simulations of E mode nanostructures using SILVACO ATLAS tool
- ✓ Measurement of the fabricated devices and feedback to the simulations

### References

- [1] *GaN Electronics*, Rüdiger Quay
- [2] *Power GaN Devices, Materials, Applications and Reliability*, Meneghini, Matteo, Meneghesso, Gaudenzio, Zanoni, Enrico (Eds.)
- [3] M. Zhu, J. Ma, L. Nela, C. Erine and E. Matioli, "High-Voltage Normally-off Recessed Tri-Gate GaN Power MOSFETs With Low on-Resistance"



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**Key Words**

GaN Technology, E-mode GaN HEMTs, 3D TCAD simulations