Fabrication and characterization of GaN pin diodes for high frequency switching and protection

Context

Switches operating in the microwave band are key components for RF front-end since they can be used to select the path between transmitter and receiver, select a path for phase-shifter, etc. III-V semiconductors are widely used for applications with higher RF-power thanks to their excellent physical properties, particularly in terms of electron transport (high electron velocity, high mobility in high density electron gases). It is thus possible to manufacture High Electron Mobility Transistors (HEMTs) operating at high frequency which can be used for amplification but also for switching[1]. Compared to other semiconductors like silicon or gallium arsenide, gallium nitride (GaN) can sustain higher operation temperatures, can be used in harsh environment and presents a higher breakdown electric field[2]. With GaN, it's also possible to fabricate pin diodes which have higher linearity compared to their FET counterparts[3,4]. Pin diodes can also be used for the fabrication of limiters which are mandatory components to protect low noise amplifiers[5]. For both applications, low on resistance, low off-state capacitance and high-power handling are necessary to ensure the performances and the reliability of the final device.

Job description

In this thesis, pin diodes (Positive Intrinsic Negative) using GaN will be fabricated and characterized[6]. In order to realize this kind of diodes, some challenges need to be overcome, especially the realization of low losses ohmic contact on p-type GaN. This thesis will firstly focus on the optimization of the ohmic contact on GaN and the characterization of the interfaces between the different layers of the stack-up, using conventional tools (SEM, AFM, DC measurements). Then, using the optimal conditions of ohmic contact deposition, fabrication and measurement of GaN based diodes at multiple scale will be done. Conventional DC measurements ($I(V)$, leakage current, breakdown capability) as function of temperature and cycling will be used to quantify the robustness of the fabricated diodes. In addition, low/medium frequency electrical measurements (DLTS, I-DLTS) will be set up to identify deep-level carriers traps with their concentration at the different active layers and correlation with local measurements (C-AFM) and DC measurement will be done. Measurement at high frequency will also be carried out to access the performance of the diode in the GHz range and thus determine its potential for integration into a microwave circuit.

All the equipment required for this project are available at CERTeM technological platform (`http://certem.univ-tours.fr`), which is a fully equipped clean room facility and a electrical/physical characterization laboratory, hosted by STMicroelectronics Tours.

Profile: You will have a master in material science or microelectronics. Competence in clean room, material science and electrical measurement will be appreciated.

Location : At GREMAN beside STMicroelectronics site with easy access to the CERTeM platform, 16 rue Pierre et Marie Curie, 37100 Tours, France.

Application limit: 1st April 2026

Starting period: October 2026

Email: kevin.nadaud@univ-tours.fr, jerome.billoue@univ-tours.fr, pedro.fernandes@univ-tours.fr

[1] M. Marso et al., Conference Proceedings - The 6th International Conference on Advanced Semiconductor Devices and Microsystems, ASDAM'06, 229–232 (2006).

[2] U. Mishra et al., Proceedings of the IEEE **96**, 287–305 (2008).

[3] J. Yang et al., Electronics Letters **48**, 650 (2012).

[4] J. G. Yang et al., IEEE Microw. Wireless Compon. Lett. **23**, 37–39 (2013).

[5] S. Li et al., IEEE Microwave and Wireless Components Letters **32**, 1107–1110 (2022).

[6] K. Nadaud et al., IEEE Transactions on Electron Devices **72**, 1657–1662 (2025).