PhD Position in School of Materials Science & Engineering, NTU

Project title: Failure analysis and reliability investigations of GaN-on-SiC/Si HEMTs

Project Overview:

The primary objective of this research is to investigate and understand the degradation mechanisms affecting the reliability of GaN-based High Electron Mobility Transistors (HEMTs), particularly in RF/mmWave systems. GaN HEMTs offer significant advantages over traditional semiconductor technologies, such as high electron mobility, high saturation velocity, a wide bandgap, and excellent thermal conductivity. These characteristics make them extremely promising for next-generation applications like 5G/6G communication systems, radar, aerospace electronics, and defence technology. However, reliability issues such as current collapse, unstable device operation due to traps, interface-related failures, and thermal degradation continue to limit their commercial adoption.

This project aims to address these reliability issues by carefully studying device failures through advanced failure analysis (FA) methods. Techniques such as Deep-Level Transient Spectroscopy (DLTS) for analysing defects, photoemission microscopy (PEM) for identifying early signs of failure, and electron microscopy (such as transmission electron microscopy (TEM) / scanning electron microscopy (SEM) - focus ion beam (FIB) microscopy) for observing structural defects will be employed. Additionally, long-term reliability studies under accelerated testing conditions, including high-temperature operation, high-voltage stress, pulse-driven stress, thermal cycling, and humidity, will simulate realistic operating scenarios. This approach will allow us to identify key relationships between stress conditions and device degradation, improving the accuracy of predictive reliability models. By better understanding these relationships, the project outcomes will directly guide improvements in GaN HEMT device design, fabrication methods, and reliability forecasting. Ultimately, this research will help overcome fundamental reliability challenges, promoting greater industrial confidence and broader adoption of GaN-based devices in high-frequency and high-power applications.

Intake: AY2025/26 Semester 2 (January 2026)

Qualifications: Bachelor degree in Electrical/Electronics Engineering, Materials Science/Engineering, or other relevant degrees with Honours (Distinction) or higher; strong interest in microelectronics/semiconductor materials and good aptitude for research

Supervisor: Prof Gan Chee Lip (Email: clgan@ntu.edu.sg)

Interested candidates to send their resume to Prof Gan by 30 July 2025