Mechanisms of alternating-state degradation of GaN power amplifier transistors

In 5G telecommunication, high free-space pass loss demands high output power from transmitters. The GaN high electron mobility transistor (HEMT) with its high current density and breakdown voltage is a competent candidate as a 5G RF power amplifier (PA). Note that although fresh GaN HEMTs provide high performance with fantastic intrinsic III-N material properties, reliability issues in high-power operation of PA may seriously degrade performance over time. Imec has demonstrated GaN HEMTs on 8" Si wafers for high-frequency power amplifier applications. The GaN-on-Si HEMT is a cost-efficient solution that attracts strong industrial interests. But because of a large GaN-to-Si lattice mismatch, the GaN-on-Si HEMT meets two major challenges: high self-heating and dislocation density. These also imply more reliability challenges with GaN-on-Si HEMTs.
As a PA transistor operates with large gate voltage and drain voltage swings, the overall PA degradation mechanism is complex. There are several stressful gate/drain voltage combinations in on, semi-on, and off states that are contained in each cycle of PA operation. In imec, we have been carrying out systematic DC and pulsed analysis to fully understand degradation mechanism of each gate/drain voltage combination. We look forward to gaining further PA-pertinent insights by studying alternating-state stress of a PA transistor. In this way, we will understand distinct and common mechanisms of DC and AC stress.

In this PhD investigation, you will explore the physical mechanism behind GaN-on-Si HEMT performance degradation. You will begin with comprehending the DC degradation mechanism. You will then set up alternating state stress with pulsed setups in imec lab. The GaN-on-Si transistors with various flavors will be fabricated in imec 200mm production line with teamwork. You will communicate frequently with different experts in integration, epitaxy, device physics and reliability domains. You will contribute your insights to improving performance stability of GaN PA transistors.

REQUIREMENTS:

Candidates are expected to have a Master's degree in Nanoelectronic/Engineering /Material Science with a strong interest in semiconductor physics and reliability

TYPE OF WORK

Literature study: 30% Characterization: 50% Modelling: 20%

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