94th Session E: *Device Characterization and Modelling*

Session Chair: Leonard Hayden

E1 — **Measurement of the Channel Temperature of a GaN Microwave Power Transistor During Pulsed I-V Excitation**

3:40 PM 4:00 PM

Cristian Matei *(University of Surrey)*; Haris Vosti (University of Surrey); Peter Aaen (Colorado School of Mines)*

In this paper a thermoreflectance measurement technique is used to capture the channel temperature within a GaN-on-Si HEMT during pulsed I-V excitation. Using pulsed I-V measurements in combination with thermoreflectance measurements allows the direct assessment of the isothermal approximation that is often made during the characterization of the transistor for nonlinear model development. The thermoreflectance measurement has a temporal response of 50 ns, which is sufficiently fast to measure the temperature rise within the pulsed I-V excitation, across the I-V plane of the transistor. We first determine the minimum pulse duration needed to minimize the temperature rise as assessed from drain current measurements as a function of the excitation pulse width. The thermoreflectance measurements show that self-heating occurs during the pulse, revealing a maximum of 13.5 °C change over all pulsed I-V measurements. Transient thermoreflectance measurements were then performed to determine that sub-200 ns pulses are required to eliminate the self-heating for this device.

E2 — **Characterization of Thermal and Trapping Time Constants in a GaN HEMT**

4:00 PM 4:20 PM

Kevin C Kellogg *(Modelithics, Inc.)**

A commercial pulsed-IV system is used to test a GaN HEMT with the purpose of extracting exponential time constants used for dynamic electro-thermal and charge-carrier trapping models. The time constants of these different physical phenomena can not only vary by many orders of magnitude, but also have regions of overlap. Self-heating and trapping are common phenomena affecting GaN HEMTs, thus characterization and understanding these dynamics is critical for developing accurate compact models. We investigated the approach of recording the drain current transient response under a careful selection of the bias conditions, to approximately separate the two phenomena to derive useful estimate of the different associated time constants. Modeling of these time constants is of concern for modulated signal processing, where they fall within typical bandwidths of modern communication systems.

E3 — **De-mystifying AM-PM characteristics through the definition of the complex Transducer Gain ^G_T**

4:20 PM 4:40 PM ***Frederik Vanaverbeke*** *(NXP Semiconductors)**

Load-pull is a well-established measurement and simulation technique to characterize radio-frequency power transistors. The component-level information it provides is used to predict how the transistor will behave at system level. With the eye on linearity, the amplitude- and phase-modulation characteristics (AMAM- and AMPM-characteristics) are the most important metrics considered. This paper highlights a couple of pitfalls in the translation of the component-level characteristics to the system-level and how to circumvent them. It is explained how AMAM and AMPM characteristics depend on the fundamental source-impedance, but also how the precise knowledge of this source-impedance is irrelevant during the load-pull experiment itself, since its influence can be added in post-processing without loss of generality.

E4 — **Device Noise Parameter Characterization: Towards Extraction Automation**

4:40 PM 5:00 PM ***Luciano Boglione*** *(Naval Research Laboratory)*; Jason Roussos (Naval Research Laboratory); Alina Caddemi (Universita di Messina); Emanuele Cardillo (Universita di Messina); Giovanni Crupi (Universita di Messina*

For the first time, the experimental values of the noise parameters of a set of GaAs pHEMT obtained through the standard source tuner-based Lane technique and a new size-based, tuner-less technique, are compared. The noise parameter data has been obtained independently by 2 renowned microwave laboratories after sharing the same set of devices. The laboratories are located at the University of Messina, Italy, and at the US Naval Research Laboratory in Washington, DC. This paper demonstrates 2 new accomplishments: that the noise parameters obtained through the new tuner-less technique are equivalent to the noise parameters obtained through the standard tuner-based technique; and that the new tuner-less extraction has been extended successfully up to 26 GHz. The new size-based technique supports the implementation of an automatic noise parameters extraction in a similar fashion to the automatic determination of scattering parameters.