Session 11: Power and Compound Semiconductor Devices – High Voltage and RF Devices
Tuesday, December 16, 9:00 a.m.
Continental Ballroom 4
Co-Chairs: Keisuke Shinohara, HRL Laboratories LLC
Matteo Meneghini, University of Padova

9:05 a.m.
11.1 Extremely Low On-resitance Enhancement-mode GaN-based HFET using Ge-doped Regrowth Technique, A. Suzuki, S. Choe, Y. Yamada, M. Hiraiwa, N. Otsuka and D. Ueda*, Panasonic Corporation, *Kyoto Institute of Technology

We present a normally-off GaN-based transistor with extremely low on-state resistance fabricated by using Ge-doped n++GaN layer for ohmic contact. We developed a new GaN regrowth technique using Ge. The fabricated device showed the record-breaking R_{on} of 0.95 Ω•mm with maximum drain current and transconductance of 1.1 A/mm and 490 mS/mm, respectively.

9:30 a.m.
11.2 Wide Temperature (10K- 700K) and High Voltage (~1000V) Operation of C-H Diamond MOSFETs for Power Electronics Application, H. Kawarada, H. Tsuboi, T. Yamada, D. Xu, T. Saito, A. Hiraiwa, Waseda University

By a highly stable Al_2O_3 gate oxide on H-terminated diamond, high-temperature (673K) and high-voltage diamond MOSFET has been realized. The maximum breakdown voltage is 996V at a gate-drain distance of 9µm. The maximum breakdown field showed 3.6MV/cm. These values are competitive to those of lateral SiC or GaN FETs.

9:55 a.m.
11.3 GaN-based Gate Injection Transistors for Power Switching Applications, T. Ueda, H. Handa, Y. Kinoshita, H. Umeda, S. Ujita, R. Kajitani, M. Ogawa, K. Tanaka, T. Morita, S. Tamura, H. Ishida and M. Ishida, Panasonic Corporation

State-of-the-art technologies on GaN power switching devices to extract the potential of the new devices are demonstrated. These technologies are for normally-off Gate Injection Transistors (GITs) on Si and include extension of the wafer diameter of Si up to 8 inch, InAlGaN quaternary alloy to reduce the series resistances, shortening the gate length to improve the device performances, integration of the gate driver and flip-chip assembly for faster switching.

10:20 a.m.
11.4 Schottky-on-Heterojunction Optoelectronic Functional Devices Realized on AlGaN/GaN-on-Si Platform, B. Li, X. Tang, Q. Jiang, H. Wang, Y. Lu, J. Wang and K. J. Chen, The Hong Kong University of Science and Technology

GaN band-edge ultraviolet electroluminescence at 364 nm has been generated from forward biased metal-AlGaN/GaN Schottky junction at room temperature, facilitated by the creation of III-nitride surface with low surface state density, thus filling the void of UV light sources compatible with AlGaN/GaN heterojunction-based photodetectors and power devices.

10:45 a.m.
11.5 The Super-Lattice Castellated Field Effect Transistor (SLCFET): A Novel High Performance Transistor Topology Ideal for RF Switching, R. Howell, E. Stewart, R. Freitag, J. Parke, B. Nechay, H. Cramer, M. King, S. Gupta, J. Hartman, P. Borodulin, M. Snook, I. Wathunthanthri, P. Ralston, K. Renaldo, H. Henry and R. Clarke, Northrop Grumman Electronic Systems

NGES reports the development of a novel transistor structure based on a GaN super-lattice channel with a 3D gate, named the SLCFET (Super-Lattice Castellated Field Effect Transistor). Transistor measurements provided median values of I_{MAX}>2.7 A/mm, V_{PINCH}<-9V, with R_{ON}=0.41 Ω-mm and C_{OFF}=0.19 pF/mm, for an RF switch FOM of F_{CO}=2.1 THz.

11:10 a.m.
11.6 MIT Virtual Source GaNFET–RF Compact Model for GaN HEMTs: From Device Physics to RF Frontend Circuit Design and Validation, U. Radhakrishna, P. Choi, S. Goswami, L.-S. Peh, T. Palacios and D. Antoniadis, Massachusetts Institute of Technology

GaN HEMT based power amplifiers (PAs) are gaining foothold in high-power transceiver circuit design at microwave frequencies. The high breakdown voltage, high-current capability together with low on-resistance and on-capacitance of GaN HEMTs enables improved efficiency and linearity at higher output-power PAs. To take advantage of the performance gains of these devices in RF circuit design, accurate non-linear, large signal device models suitable for high frequency and high power operation regimes are required. It is also desirable that these compact models be grounded on appropriate device physics in order to gain insight into the impact of the behavioral nuances of the GaN HEMTs on RF circuit performance, which is not the case with most of the available models such as EEHEMT, Curtice, and Angelov models. This work is a first demonstration of a physics-based GaN HEMT compact model that is calibrated and verified all the way from device- to an RF-front-end transceiver circuit-level. The MVS-G-RF model captures static and dynamic device behavior through self-consistent current and charge expressions. In addition, access regions, which play an important role in device linearity are modeled as implicit-gate transistors. The model includes the effect of self-heating, gate leakage, device parasitics and RF device-noise. The model requires a small number of parameters with straightforward physical meanings and is validated against DC–IV, S-parameter, load pull and noise figure measurements of fabricated devices. The model can then be used to design and validate an RF circuit which in this case is an RF front-end for the 802.11p standard demonstrated on CREE 0.25 um GaN-on-SiC platform.