Session 17 - Microwave, Millimeter Wave and Analog Technology - III-Nitride Devices and Co-Integration
Tuesday, December 10, 9:00 a.m.
Imperial Ballrom A
Co-Chairs: D. Meyer, Naval Research Laboratory
N. Collaert, imec

9:05 AM **17.1** Deep Submicron III-N HEMTs – Technological Development and Reliability (Invited)
Ruediger Quay, Michael Dammann, T. Kemmer, Peter Brückner, Maciej Cwiklinski, Dirk Schwantuschke, Sebastian Krause, Stefano Leone, M. Mikulla, Fraunhofer IAF

This paper gives the state-of-the-art of the technological development and the reliability status of deep-submicron Gallium Nitride high electron mobility transistors with gate lengths of 100 nm or below. Several epitaxial and process options are given. Promising GaN MMIC results are also provided leading to G-band operation near 200 GHz.

9:30 AM **17.2** CMOS-compatible GaN-based Devices on 200mm-Si for RF Applications: Integration and Performance
Uthayasankaran Peralagu, AliReza Alian, Vamsi Putcha, Ahmad Khaled, Raul Rodriguez, Arturo Sibaya-Hernandez, Shane Chang, Eddy Simoen, Simeng Zhao, Brice De Jaeger, Daniel Fleetwood, Piet Wambacq, Ming Zhao, Bertrand Parvais, Niamh Waldron, Nadine Collaert, imec, KU Leuven, National Chiao Tung, Vanderbilt University, Vrije Universteit Brussels

We report on the integration, and optimization of Al(Ga,In)N HEMTs, MISHEMTs and MOSFETs on 200-mm Si wafers using Au-free, CMOS compatible processing, and discuss performance tradeoffs, limitations and solutions. We show that MISHEMTs have the potential to outperform the other device types in terms of device scalability for high-frequency operation.

9:55 AM **17.3** 3D Heterogeneous Integration of High Performance High-K Metal Gate GaN NMOS and Si PMOS Transistors on 300mm High-Resistivity Si Substrate for Energy-Efficient and Compact Power Delivery, RF (5G and beyond) and SoC Applications
Han Wui Then, Sansaptak Dasgupta, Marko Radosavljevic, Pavel Agababov, Ibrahim Ban, Robert Bristol, Manish Chandhok, Siddharth Chouksey, Brandon Holybee, Cheng-Ying Huang, Brian Krist, Kimin Jun, Kevin Lin, Nidhi Nidhi, Thoe Michaelos, Brennen Mueller, Rajat Paul, Jason Peck, Willy Rachmady, David Staines, Tushar Talukdar, Nicole Thomas, Tristan Tronic, Paul Fischer, Walid Hafez, Intel Corporation

We demonstrate industry's first 300mm 3D heterogeneous integration of high-performance, low-leakage high-K dielectric enhancement-mode GaN-NMOS and Si-PMOS transistors on high-resistivity 300mm-Si(111) substrate, enabled by 300mm GaN MOCVD-epitaxy and 3D layer-transfer, for integration of energy-efficient, compact power-delivery and RF solutions with CMOS circuitries for next-generation power-delivery, RF (5G&beyond) and SoC applications.

10:20 AM *COFFEE BREAK*

10:45 AM **17.4** High-Power-Density AlGaN/GaN Technology for 100-V Operation at L-Band Frequencies
Sebastian Krause, Peter Brückner, Michael Dammann, Ruediger Quay, Fraunhofer IAF

This paper reports on the development of a 0.5 µm AlGaN/GaN on SiC HEMT technology for operation at bias levels of 100 V. Load Pull measurements reveal a power density of more than 17 W/mm and a power-added efficiency in excess of 77 % at 1.0 GHz and 100 V.

11:10 AM **17.5** GaN-based Periodic High-*Q* RF Acoustic Resonator with Integrated HEMT
Vikrant Gokhale, Brian Downey, D. Scott Katzer, Laura Ruppalt, David Meyer, US Naval Research Laboratory

This work demonstrates the first on-chip integration of a high overtone bulk acoustic resonator (HBAR) with a HEMT using an epitaxial AlGaN/GaN/NbN/SiC heterostructure. This pairing combines the robust structure, periodic mode spacing, high mode density, and high *Q*- of the HBAR with the amplification and non-reciprocal characteristics of the HEMT.

11:35 AM **17.6** 452 MHz Bandwidth, High Rejection 5.6 GHz UNII XBAW Coexistence Filters Using Doped AlN-on-Silicon
Jeffrey Shealy, Ya Shen, Pinal Patel, Ramakrishna Vetury, Akoustis Technologies, Inc

5.66GHz XBAW filters, utilizing doped AlN, are reported. The filters exhibit high -3dB bandwidth of 452MHz, a minimum insertion loss of 1.79dB, >50dB rejection and power handling up to 32.5dBm. Resonators show k^2 eff of 10.24%, Qmax of 1479, and FOM of 151 at 5.4GHz.