

Session 25 - Microwave, Millimeter Wave, and Analog Technology - Advanced Si and Packaging Technologies for 5G and Beyond  
Tuesday, December 10, 2:15 p.m.  
Imperial Ballroom A  
Co-Chairs: Y. Sun, IBM  
D. Belot, CEA-Leti

**2:20 PM**      **25.1**      RF Performance of a Fully Integrated 3D Sequential Technology  
Xavier Garros, José Lugo, Laurent Brunet, Riadh Nait Youcef, Perrine Batude, Claire Fenouillet-Beranger, Mikaël Cassé, Benoit Sklenard, Pascal Scheiblin, Joris Lacord, Konstantinos Triantopoulos, François Andrieu, Gerard Ghibaudo, Fred Gaillard, CEA-Leti, IMEP-LAHC

RF performance of a fully integrated CMOS 3D Sequential Integration is deeply investigated. We highlight that Top Tier PMOS processed at 630°C can feature good RF Figure-Of-Merits with  $F_t = 55\text{GHz}$  and  $F_{\text{max}} = 80\text{GHz}$  at  $V_{\text{DD}} = -1\text{V}$ . An improved low temperature process ( $T < 530^\circ\text{C}$ ) able to boost this RF performance is also proposed.

**2:45 PM**      **25.2**      Record High-performance RF Devices in an Advanced FDSOI Process Enabling Integrated Watt-level Power Amplifiers for WiFi and 5G applications  
Thanh Viet Dinh, Bart Hovens, Marina Vroubel, Ihor Brunets, Hans Tuinhout, Luuk Tiemeijer, Nicole Wils, Guido Sasse, Paul Grudowski, Matthias Raucoules-Aime, Stefano Dal Toso, Carla Ghidini, NXP Semiconductors

A Watt-level power amplifier for both WiFi (5GHz) and 5G (28GHz) in sub-28nm FDSOI is enabled by a record high-performance of 3.3V / 5V RF-LDMOS ( $f_T \sim 115\text{GHz}$ ) and passive devices including 7V fringe capacitors (Q-factor  $> 100$  at 28GHz and  $\sim 340$  at 5GHz), 2-way transformers and 8-shaped inductors.

**3:10 PM**      **25.3**      Fabrication and Characterization of Millimeter Wave 3D InFO Dipole Antenna Array Integrated with CMOS Front-end Circuits  
Chung-Hao Tsai, Che-Wei Hsu, Kun-Yao Kao, Tzu-Chun Tang, Chun-Lin Lu, K-C Wu, Han-Ping Pu, Kun-You Lin, Huei Wang, Tzong-Lin Wu, Chung-Shi Liu, C.T. Wang, C.H. Yu, Taiwan Semiconductor Manufacturing Company, Ltd., National Taiwan University

A high performance 3D dipole antenna with metal thickness  $> 100 \mu\text{m}$  for wide bandwidth and lateral radiation is realized on InFO package. 25% wide FBW, 60-77 GHz, has been obtained. The beamforming capability of the system antenna array with 6 dBi gain is measured in 40nm CMOS RFIC co-designed system.

**3:35 PM**      **25.4**      Implementation of High Power RF Devices with Hybrid Workfunction and Oxide Thickness in 22nm Low-Power FinFET Technology  
Hyung-Jin Lee, Saurabh Morarka, Said Rami, Q. Yu, M. Weiss, Guannan Liu, Mark Armstrong, Chen-yi Su, Dyan Ali, Bernhard Sell, Ying Zhang, Intel Corporation

Unique High-Power FinFET device with multiple workfunction materials and oxide thickness under a common gate, dubbed as HyPowerFF, is introduced. The proposed devices are as reliable as high-voltage IO devices with up to 7.1V of breakdown voltage and equip speedy 290 GHz of  $f_{\text{MAX}}$  suitable for power-efficient RF power-amplifier (PA) design.

*4:00 PM COFFEE BREAK*

**4:25 PM 25.5** A Very Robust and Reliable 2.7GHz +31dBm Si RFSOI Transistor for Power Amplifier Solutions

Xavier Garros, Vincent Knopik, Nathalie Revil, Alexis Divay, Jacques Cluzel, José Lugo, Alexandre Giry, Xavier Federspiel, Guillaume Bertrand, Florian Cacho, Emmanuel Vincent, Eric Granger, F. Gaillard, CEA-Leti, STMicroelectronics

A robust and low cost Si RFSOI Power Transistor which deliver +31dBm output power with 74% of PAE and 18dB of Gain is optimized for 5G sub-6GHz Power Amplifier. It is proved that this great performance is achieved while maintaining a high level of reliability of the PA transistor.