Session 12 - Power Devices and Systems - Advances in Silicon and Gallium Oxide Power Device Technologies
Tuesday, December 10, 9:00 a.m.
Continental Ballroom 1-3
Co-Chairs: S. Madathil, University of Sheffield
M. Higashiwaki, NICT

**9:05 AM** **12.1** Modeling Needs for Power Semiconductor Devices and Power Electronics Systems (Invited)
Ramchandra Kotecha, Gilberto Moreno, Bary Mather, Sreekant Narumanchi, National Renewable Energy Laboratory

As energy systems move towards wide-spread electrification, penetration of power semiconductor devices and power electronics continue to grow at a rapid pace. The modeling needs for semiconductor devices vary depending on the end-goal and the level of abstraction needed towards model formulation also changes with the size

**9:30 AM** **12.2** Progress in Si IGBT Technology – As An Ongoing Competition with WBG Power Devices (Invited)
Thomas Laska, Infineon

Starting from state of the art Insulated Gate Bipolar Transistors (IGBT) and its underlying device concepts, an outlook on next IGBT development steps is given resulting in ongoing significant power density and efficiency increase. So Si IGBT technology will still play an important role also for the next years.

**9:55 AM** **12.3** Dynamic Avalanche Free Design in 1.2kV Si-IGBTs for Ultra High Current Density Operation
Peng Luo, Sankara Madathil, Shin-ichi Nishizawa, Wataru Saito, University of Sheffield, Kyushu University

Detailed analysis of 1.2 kV trench gated IGBTs are undertaken through experiments and simulations to show the fundamental cause of the dynamic avalanche as well as a method to achieve DA free design for ultra-high current density operation and reliability in 1.2 kV Si-IGBTs.

10:20 AM COFFEE BREAK

**10:45 AM** **12.4** Single and Multi-Fin Normally-off $Ga_2O_3$ Vertical Transistors with a Breakdown Voltage Over 2.6kV
Wenshen Li, Kazuki Nomoto, Zongyang Hu, Tohru Nakamura, Debdeep Jena, Huili Xing, Cornell University, Hosei University

Record-high performance is achieved in normally-off $\beta$-$Ga_2O_3$ vertical fin power transistors: a breakdown voltage of 2.66 kV (at ->$V_{gs}$ =0 V) and a specific on-resistance of 25.2 m$\Omega\cdot cm^2$. The effective channel mobility is significantly improved up to ~130 $cm^2$ /V·s with a post-deposition annealing process. A unique fin orientation dependence is revealed.

**11:10 AM** **12.5** First Demonstration of Waferscale Heterogeneous Integration of $Ga_2O_3$ MOSFETs on SiC and Si Substrates by Ion-Cutting Process
Wenhui Xu, Yibo Wang, Tiangui You, Xin Ou, Genquan Han, Haodong Hu, Shibin Zhang, Fengwen Mu, Tadatomo Suga, Yuhao Zhang, Yue Hao, Xi Wang, Chinese Academy of Sciences, Xidian University, Meisei University, Virginia Polytechnic Institute State University

We for the first time demonstrate the heterogeneous integration of 2-inch crystalline β- $Ga_2O_3$ thin films onto the SiC and Si substrates by ion-cutting process and the fabrication of high-performance β- $Ga_2O_3$ MOSFETs on heterogeneous wafers. This is promising to overcome the fundamental thermal limitations of $Ga_2O_3$ power devices.