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Summary Report of International Electron Device Meeting (IEDM) 2022

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Abstract

Teo attended the 68th annual international Electron Device Meeting (IEDM) 2022 held in San Francisco, California, USA. The meeting is considered as the gold standard conference for reporting the latest development and breakthrough in semiconductor and device technology. This is his summary report.

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Summary Report of International Electron Device Meeting (IEDM) 2022

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Executive Summary

Teo attended the 68th annual international Electron Device Meeting (IEDM) 2022 held in San Francisco, California, USA. The meeting is considered as the gold standard conference for reporting the latest development and breakthrough in semiconductor and device technology. This meeting was very well attended by the in-person conference of more than 2000 participants.

Similar to the previous years, this year conference includes areas in device design, multi-physics and device modeling, manufacturing, etc. In particular, it also includes nanometer CMOS technology, advanced novel quantum and nano-scale devices technology, optoelectronics, negative capacitance, advanced process technology and analog memory devices for AI. As for GaN technology, there were about 15 papers presented, which has one of the highest number of papers for a given technology at this meeting.

Specifically, papers using compact models of MRAM, memory devices such as ferroelectric devices, and ultra low temperature CMOS for quantum computing were presented. Models achieved uSec fast simulation using analytical functions as solutions. There were a few papers on SiC and one of which review conventional superjunction SiC power device, with the focus of using high-energy (MeV) implantations. There is also a paper on the use negative capacitance FETs which for the first time, reported the device design using a single-layer (SL)-graphene to achieve a subthreshold slope (SS) of 31 mV/dec with unnoticeable hysteresis.

As expected, Intel reported a new generation of integration architectures. Intel demonstrated that its performance includes 9x+ interconnect power reduction and density improvements.

GaN applications as usual, are chiefly divided into RF and power electronics. For power electronics, GaN device was reported to have a 10 A/cm^2 current density at supply voltage of 50 V, which is higher than the state-of-the-art Si devices. In another paper a 1200V/70mΩ GaN-on-sapphire devices demonstrates a high efficiency of >99% in hard-switched conditions of 900:450V buck converter at frequency of 50kHz. A vertical GaN superjunction p-n diodes are *shown for both GaN and sapphire substrates with a breakdown voltage* performance over 1100 V. A final paper on current and future potentials of vertical GaN power devices grown on GaN substrates was presented. Development of GaN bulk substrate, fundamental material properties, device epitaxial growth, advanced ion implantation and latest MOS interface are presented.

There were more paper presented on GaN for the RF applications. N polar GaN with breakthrough performance at 94GHz at 5.8W/mm with 38.5% power efficiency. Monte Carlo thermal modelling of GaN and InP devices validated by partial experimental data was reported. Both transient and steady state studies were carried out and it reveals peak temperature increases are threefold larger than conventional study using bulk diffusion. A first demonstration of GaN HEMTs for both Power and RF applications on a common platform with Fe/C Co-doped Buffer was presented. In another paper, trapping in back barrier (BB) of GaN HEMTs was examined. BB trapping is alleviated by increasing 2DEG density Nsheet concentration. A novel device BB design criterion was proposed. There is also another report on a comprehensive analysis of ESD for GaN on Si HEMTs. Transient I-V curves were verified with TCAD and pinpointed 3 different types of failure mechanisms. A heat spreader for GaN HEMTs is implemented with polycrystalline diamond. With a 500nm-thick all-around diamond, it lowers gate temperature at 9.5W/mm DC power without impact in device performances. In another paper, a high-K GaN NMOS transistor was demonstrated. A 100nm-source-field-plated with a 30nm LG GaN demonstrates a record f_{MAX}=680GH. In another paper, a novel Hybrid gate p-GaN power HEMT technology is proposed to enhance Vth stability. It is experimentally demonstrated that the-HEMT can achieve higher gate reliability than commercial products.

IEDM is a conference that covers many areas of semiconductor devices and technology. Though there were more than average number of papers presented on GaN at this meeting, the areas of application still only confined to RF and power electronics applications. Potentially, GaN has many more other applications, such as ultra-high and ultra-low temperature operations, audio engineering and cable applications, etc, which this meeting fails to address.

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