

## Review of the 2023 IRPS

Edited by Paula Chen

The IEEE International Physics Reliability Symposium (IRPS) has been the premiere conference for engineers and scientists to present new and original work in the area of microelectronics reliability for more than 60 years. Drawing participants from the Americas, Europe, Asia, and all other parts of the world, IRPS seeks to understand the reliability of semiconductor devices, integrated circuits, and microelectronic systems through an improved understanding of both the physics of failure as well as the application environment.

The 2023 IRPS was held in a hybrid format starting on March 26 and running until March 30, 2023—the duration of which the recorded presentations were accessible to the registrants. The virtual event was attended by almost 500 registered participants, which was 25% higher than the previous year and a record for recent years.

2023 IRPS special focus topics were:

- Embedded / In-product memory / neuromorphic compute: Reliability of emerging memory devices and design architectures with embedded memory as function/performance booster
- GAA, nanosheet, RibbonFET, Forksheets: TDDB, BTI, HCI, process charging, HV effects.
- 3D IC advanced packaging: 3D, 2.5D, interposer MIM, embedded bridge, hybrid bonding reliability.

The highlights of the 2023 technical program include

- 18 technical committees and 244 TPC members
- 4 keynotes, 28 tutorials, 10 workshops and 3 year-in-reviews
- 3-day technical sessions comprising 111 oral presentations, 81 poster presentations, 20 invited/focus talks
- 11 exhibitors and 23 patrons

The conference encompassed a wide range of topics, ranging from Circuit Reliability and Aging, Emerging Memory Reliability, ESD and Latchup, Failure Analysis, Gate/MOL/BEOL Dielectrics, MEMS, Beyond CMOS Device Reliability, Memory Reliability, Metallization/BEOL Reliability, Emerging memory Reliability, Packaging and 2.5/3D Assembly, Process Integration, Reliability Testing, RF/mmW/5G Reliability, Radiation Effect Reliability, Silicon Photonics, System Electronics Reliability, Transistor Reliability, to Wide-Bandgap Semiconductors- GaN and SiC.

This year, a 2-day tutorial session was offered prior to the technical sessions which gave the attendees greater flexibility to not only to listen to focused lectures from domain experts but also to learn about the latest research discoveries. Tutorials were given by instructors who are authorities in their respective reliability fields—either veteran IRPS presenters for established topics or invited specialists in emerging topics. A total of 28 tutorials were offered on topics ranging from 3D integration, 5G/mmW/RF, GaN, memory reliability, automotive, advanced interconnect, cryogenic electronics, design automation, ESD, Radiation Effect Reliability, to FinFET self-heating.

The 2<sup>nd</sup> day of tutorial ended with three Year-In-Review (YIR) talks, a segment always appreciated by IRPS attendees, allowing them to quickly catch up on recent developments in multiple areas. In this year's Year-in-Review several speakers covered the past year of literature on (YIR1) Soft Error in Planar, FDSOI, FinFET and GAA, (YIR2) Advances in Reliability Testing and Understanding for SiC Vertical Power MOSFETs, and (YIR3) FEOL reliability of FinFETs, Nanowire, and Nanosheet FETs.

The conference formally kicked off on March 28<sup>st</sup>, 2023, with a welcome address by the General Chair Chris Conner, Intel, Inc., and an overview of the technical program by the Technical Program Chair Susumu Shuto, Toshiba. Each day started with a plenary keynote by industry executives listed below.

- Day 1: Dr. Ann Kelleher, EVP and GM of Technology Development, *Intel*  
“On the Advance of Moore's Law and Resulting Trends in Reliability”
- Day 1: Gary Hicok, SVP, *NVIDIA*  
“Transforming Industries with Trustworthy Cloud-to-Edge Compute Platforms”
- Day 2: Mark Fuselier, SVP, Technology & Product Engineering, *AMD*  
“Reliability Challenges for the Next Decade of High-Performance Computing”
- Day 3: Rohit Vidwans, EVP and Chief Engineering & Manufacturing Officer, *Ampere*  
“Building Reliability into the Modern Cloud”

Technical session presentations consisted of 111 Oral (of which 20 were invited) and 81 Poster papers, previously selected by 18 subcommittees. Due to the virtual nature of the conference, the papers were typically presented as prerecorded video clips which resulted in higher quality presentations. Poster presenters were allotted limited time to introduce their work and, to emulate the poster session experience, they could discuss their work with interested audience members in separate video calls. Workshops were held on Day 2 where attendees enjoyed informal discussions on specific reliability topics with the guidance of experienced moderators. As an added perk for this year's attendees, all recorded talks were available after the conference.

The IRPS subcommittees highlighted the following contributed papers:

- S. Mukhopadhyay *et al.*, Intel Corporation, A Unified Aging Model Framework Capturing Device to Circuit Degradation for Advance Technology Nodes
- Y. Zhou *et al.*, UIUC, Collector Engineering of ESD PNP in BCD Technologies
- J. Mendoza *et al.*, UT Arlington, Advanced Methods of Detecting Physical Damages in Packaging and BEOL Interconnects
- A. Yamada *et al.*, University of Tokyo, ReRAM CiM Fluctuation Pattern Classification by CNN Trained on Artificially Created Dataset
- M. Asaduz *et al.*, Purdue University, Transient Leakage Current as a Non-destructive Probe of Wire-bond Electrochemical Failures
- Z. Gao *et al.*, University of Padova, Thermally-activated failure mechanisms of 0.25 um RF AlGaN/GaN HEMTs submitted to long-term life tests

- S. Kim *et al.*, Samsung Electronics, Reliability Assessment of 3nm GAA Logic Technology Featuring Multi-Bridge-Channel FET
- P. Moens *et al.*, OnSemi, The Concept of Safe Operating Area for Gate Dielectrics: the SiC/SiO<sub>2</sub> Case Study

Next year, IRPS 2024 will be from April 14 to April 18, 2024 in Dallas, Texas. Best Paper, Best Student Paper, Best Poster, People's choice Awards for IRPS 2023 will be announced prior to that in the EDS Newsletter. The latest information can be found on <https://www.irps.org/>.

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