Proceedings of the
32nd European Symposium on the

RELIABILITY OF ELECTRON DEVICES, FAILURE PHYSICS AND ANALYSIS

Bordeaux - France
October 4th - 7th 2021

Organised by:

With the technical co-sponsorship of:

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Welcome to ESREF 2021

The 32nd European Symposium on Reliability of Electron Devices, Failure Physics and Analysis, ESREF 2021. ESREF 2021 is organized by IMS laboratory, University of Bordeaux in collaboration with LAAS-CNRS, University of Toulouse.

Due to the unprecedented health, travel and social distance restrictions imposed in France and all over the world as a result of the COVID19 pandemic, all participants and exhibitors are invited to join a virtual ESREF2021 from October 4 to 7, 2021.

Bordeaux is the European capital for optical and laser engineering, with the so called " Laser Mégajoule", one of the most powerful lasers in the world. Some of the largest companies involved in aeronautic and aerospace industry are located around Bordeaux. Dassault Falcon series private jets are built there as well as the French military aircraft Rafale; the Airbus A380 cockpit, the boosters of Ariane 5.

The University of Bordeaux is leading the "Initiative of Excellence" (Idex) program in association with national research organizations and higher educational institutes. 53 000 students take benefit of the multidisciplinary and international framework of the "Investments for the Future" program.

Hosting ESREF 2021, even in a virtual environment is a great opportunity since reliability in these particular applications is a very hot topic with strong challenges such as zero ppm failure and harsh environments.

This international symposium continues to focus on recent developments and future directions in Quality and Reliability Management of materials, devices and circuits for micro-, nano-, and optoelectronics. It provides a European forum for developing all aspects of reliability management and innovative analysis techniques for present and future electronic applications.

For this 32nd edition, in addition to the core topics of the conference, we would like to involve the major actors of aeronautics, space and embedded systems industry to provide specific topics such as radiation hardening, very long-term reliability, high/low temperature challenges, obsolescence and counterfeit issues, wide band gap power devices for the more electric aircraft and other embedded system applications.

The Technical Programme of ESREF 2021 has been defined by the Technical Programme Committee (TPC) organised in nine sub-committees with more than 216 experts in the field of reliability of electronic devices and systems. The TPC has processed to a careful selection from 153 extended summaries of 72 papers to be presented during oral sessions and 39 as posters.

Afterwards, authors of accepted papers have carefully addressed the reviewer comments in the manuscript submitted for this special issue and a strict reviewing of manuscripts has been implemented with the Elsevier Editorial System by two anonymous reviewers. The overall quality of this special issue has been improved thanks to the commitment and expertise of all contributors and to the editorial effort provided by the ESREF 2021 Guest Editor team and the Elsevier staff.

Accepted papers, from all around the world are covering the following topics:

Topic A - Quality and Reliability assessment techniques and methods for Devices and Systems
Topic B – Semiconductor Failure Mechanisms & Reliability for Si technologies & Nanoelectronics
Topic C – Progress in Failure Analysis: Defect detection and analysis

Topic D – Reliability of Microwave devices and circuits
Topic E – Packaging and Assembly Reliability and Failure Analysis
Topic F - Power Devices and Microelectronic System: Reliability and Failure Analysis
F1 - Smart-power devices, IGBT, thyristors,
F2 - SiC and GaN power devices
F3 - Power Electronic System
Topic G – Photonics Reliability
Topic H – MEMS and sensors Reliability
Topic I - Extreme environments and radiation

On Monday October 4, **two tutorials** are offered to allow attendees refreshing and expanding their knowledge on the following topics:

« Machine learning based data and signal analysis methods for the application in failure analysis » by Michael Kögel, Sebastian Brand, Fraunhofer IMWS, GERMANY

« GaN power transistors: devices, technology and reliability » by Matteo Meneghini, University of Padova, ITALY

Ten Invited speakers who are recognised experts in their fields give an overview of the state-of-the-art and special focus on advanced research work. Each invited talk focuses on leading work in the areas of:

Key note paper: « Nanoscale InGaAs Electronics: Lessons towards transistor innovation in new material systems » by Jesus del Alamo, MIT, USA

Key note paper: "FD-SOI, the path to energy efficiency for 5G, AI and Automotive applications" by Philippe Flatresse, SOITEC, FRANCE

Key note paper: "Runtime Reliability Hardening for Edge AI and Automotive applications" by Vincent Huard, DOLPHIN Design, FRANCE

"AI Techniques for Fault Analysis" by Konstantin Schekotihin , AAU Klagenfurt Institute for Applied Informatics, Alpen-Adria-Universität Klagenfurt, AUSTRIA

"Buffer Trap-Induced Current Saturation and Current Collapse in GaN Devices" by Michael J. Uren and Martin Kuball, Bristol University, UK

"Vertical GaN devices: process and reliability" by Shuzhen You, IMEC, BELGIUM

"Practical considerations for the reliability of fiber optic monitoring serving condition-based maintenance of aerospace-grade components" by Thomas Geernaert, VUB Vrije Universiteit Brussel, BELGIUM

"From semiconductor components to the LHC "system of systems": dealing with radiation effects in critical high-energy accelerator equipment" by Ruben Garcia Alia, CERN, SWITZERLAND

"Reliability of automotive and consumer MEMS sensors - an overview" by Martina Hommel, BOSCH, GERMANY

"Innovation and Novelty in Electrostatic Discharge (ESD) and Electrical Overstress from 1980 to 2020" by Dr. Steven H. Voldman, ESD Consulting LCC, USA

Exhibition with state-of-art equipment support the event while presenting their activity and know-how. Exhibitor flash presentations are scheduled each half-day to optimise interaction between attendees and exhibitors.

Finally, we should like to thank all our sponsors, who have allowed setting-up this high-quality programme :

- The members of the organising committee from IMS Laboratory, University of Bordeaux, LAAS-CNRS, University of Toulouse, CNES Toulouse,
- The ADERA Congrès organisation,
- ESREF 2021 exhibitors and sponsors.

All the members of the Programme and of the Technical Committees, all the reviewers and the Corresponding Members deserve our congratulations and our thanks for their involvement and their efforts to make ESREF meet the requirements of an international event dedicated to Quality and Reliability of Electron Devices.

We are looking forward to welcoming you in Bordeaux for a memorable experience !

Nathalie LABAT., *ESREF 2021 Chair*

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Tutorials

Tutorial 1: Machine learning based data and signal analysis methods for the application in failure analysis

Michael Kögel and Sebastian Brand, Fraunhofer IMWS, Germany

The tutorial aims at the introduction of the field of artificial intelligence, with focus on machine- and deep learning approaches, to the community of failure analysts. Starting with a brief excursion into the history available learning and analysis methods will be presented and introduced. In the main part of the tutorial the primary steps of a machine learning workflow will be presented, beginning with an overview of data sources and data handling. It will continue with the process of feature engineering for the extraction of features from the raw data, employing e.g. data mining techniques. Furthermore, an insight on how to select an appropriate learning algorithm will be given. The concepts and workflows of the different learning types and the corresponding models and systems will then be elucidated and criteria for model evaluation and optimization strategies will be addressed. The Tutorial will include several case studies and approaches to illustrate the potential in the field of failure analysis.

Michael Kögel graduated from the University of Applied Sciences in Leipzig in 2015 with a degree in Electrical Engineering and Information Technology. He wrote his Master thesis at Fraunhofer IMWS-CAM on methods and techniques for exploring spectral extraction of Rayleigh waves on solid interfaces with GHz-SAM. Since 2015, Michael Kögel works as an engineer for failure analysis of semiconductor components at IMWS-CAM and is member of the team for non-destructive defect localization in the field of failure analysis and metrology in microelectronics. His experience includes application and development for Scanning Acoustic Microscopy, Lock-In-Thermography and Magnetic Current Imaging

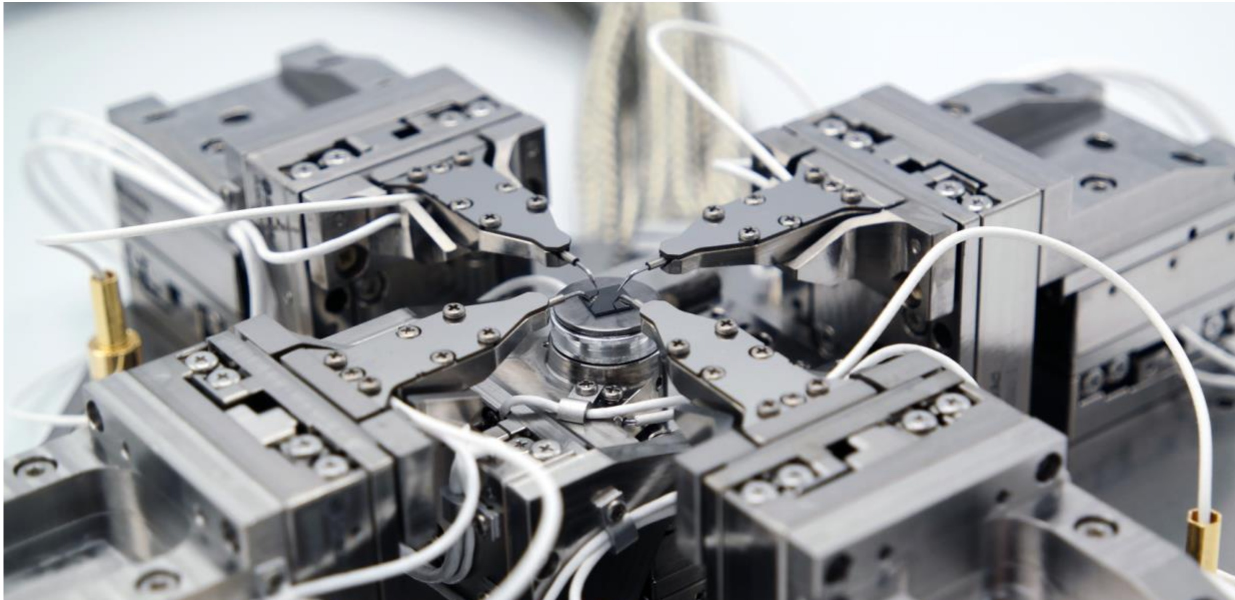
Sebastian Brand is a senior scientist at the Fraunhofer Institute for Microstructure of Materials and Systems in Halle, Germany where he leads a research-, development and application team for non-destructive defect localization in the field of failure analysis and metrology. Sebastian holds a Ph.D. in electrical engineering which he received in 2004 from the University of Magdeburg, Germany. In 2004 and 2005 he joined the University of Toronto and Ryerson University in Toronto, Canada as a post-doctoral fellow working in the field of cancer research. Sebastian has 18 years of experience in the field of acoustics in life- and material sciences and authored /coauthored more than 60 publications in this and adjacent research fields. His current research extends from acoustic methods over Lock-In-Thermography to magnetic imaging where he and his team undertake research and development for non-destructive defect localization and characterization to address challenges arising from novel technologies like 3D-Integration.
In the years 2009 – 2015 Sebastian and his team developed a novel Acoustic GHz-microscope in close collaboration with industry for the application in microelectronics failure analysis and metrology.

Tutorial 2: GaN power transistors: devices, technology and reliability

Matteo Meneghini, University of Padova, Italy

GaN has recently emerged as an excellent material for the fabrication of power semiconductor devices. Its wide bandgap, high breakdown field and high carrier mobility allow the fabrication of transistors with excellent breakdown performance and low on-resistance. This tutorial will introduce the operating principles and challenges of GaN-based transistors. Specific focus will be given to the processes that limit the stability of the main parameters (threshold voltage, on-resistance), and the long-term reliability, to provide a clear overview on the topic. Finally, future perspectives will be discussed.

Matteo Meneghini received his PhD in Electronic and Telecommunication Engineering (University of Padova), working on the optimization of GaN-based LED and laser structures. He is now associate professor at the Department of Information Engineering at the University of Padova. His main interest is the characterization, reliability and modeling of compound semiconductor devices (LEDs, laser diodes, HEMTs), and optoelectronic components, including solar cells. Within these activities, he has published more than 400 journal and conference proceedings papers.



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Keynotes

Nanoscale InGaAs Electronics: Lessons towards transistor innovation in new material systems.

Jesus del Alamo, MIT, USA

In the last few years, due to its extraordinary electron transport properties, there has been strong interest in the prospects of InGaAs for advanced electronics. Extremely scaled 3D transistors with high aspect-ratio FinFET and nanowire geometries have been demonstrated. Yet, their performance has been disappointing, well below what is to be expected from this material system. This talk will review recent research on nanoscale InGaAs MOSFETs. It will describe some of the technological advances that have been realized at MIT, such as thermal atomic-layer etching and alcohol-based digital etch. It will also describe some of the shortcomings that have been encountered and discuss possible solutions: OFF-state leakage current, mobility degradation in scaled structures and gate oxide trapping. The research holds valuable lessons for the development of advanced electronics on novel material systems.

Prof. del Alamo was an NSF Presidential Young Investigator. He is a member of the Royal Spanish Academy of Engineering and Fellow of the Institute of Electrical and Electronics Engineers, the American Physical Society and the Materials Research Society. He is the recipient of the Intel Outstanding Researcher Award in Emerging Research Devices, the Semiconductor Research Corporation Technical Excellence Award, the IEEE Electron Devices Society Education Award, the University Researcher Award by Semiconductor Industry Association and Semiconductor Research Corporation, the IPRM Award and the IEEE Cledo Brunetti Award. He currently serves as Editor-in-Chief of IEEE Electron Device Letters. He is the author of "Integrated Microelectronic Devices: Physics and Modeling" (Pearson 2017, 880 pages), a rigorous and up to date description of transistors and other contemporary microelectronic devices.

FD-SOI, the path to energy efficiency for 5G, AI and Automotive applications.

Philippe Flatresse, SOITEC, France

Fully depleted silicon-on-insulator devices built on an ultrathin SOI layer on a buried-oxide substrate feature unique performance capabilities and are suitable for full-range body biasing. FD-SOI technology has been adopted for multiple technology nodes and a wide range of current and upcoming microelectronic market segments, especially in the Internet of Things (IoT), artificial intelligence (AI), 5G and automotive applications, where ultralow power and reliability are required.

Philippe Flatresse received his PhD degree in Microlectronics in 1999 from the Institut National Polytechnique de Grenoble. During his thesis, he developed the LETISOI spice model dedicated to SOI technologies at CEA LETI. In year 2000, he joined STMicroelectronics Central R&D to deploy the SOI digital design activity. He has pioneered the partially and fully depleted SOI technologies and demonstrated their key advantages for low power high performance digital applications. As design architect, he contributed to the development of products targeting high-growth areas such as ADAS, MCU and IoT applications. He was in charge of exploring the energy efficiency limits on multi-cores systems for ultra-low power processing by combining FD-SOI technology with body biasing, advanced low power techniques. In 2017, he joined SOITEC as expert for digital applications to participate in the worldwide promotion of SOI technologies. He is currently Product Marketing Manager within the FD-SOI business unit.

Runtime Reliability Hardening for Edge AI and Automotive applications

Vincent Huard, DOLPHIN Design, France

The next decade will see the advent of the Artificial Intelligence both at the edge of the network and in automotive applications. The AI revolution is driven by the need to process the data locally near the sensors to avoid wasting 80% of the overall information available.

Such revolution will be enabled by more complex processing architectures located close to the sensors. The new processing architectures imply massively parallel processing which would require expensive margins and/or monitors to insure reliability at the cost of peak performance and energy efficiency. The location close to the sensors implies a greater sensitivity to Process Voltage Temperature (PVT) variations together with Aging variations The lecture will address what are the solutions foreseen to tackle together the reliability threads and the performance/energy efficiency challenges so to enable the Edge AI revolution. These solutions require to have a 360 degrees approach spanning from technology level (material) through various design stages up to software level.

Vincent Huard received the B.S. (1996) in physics and the M.S. (1997) in electrical engineering from INPG. He received his Ph.D. (2000) in physics from Grenoble university. In 2000, he was Visiting Scholar at UCSB. In 2002, he joined Philips Semiconductors. From 2007 to 2018, he was at STMicroelectronics as Design to Product Reliability manager and a Distinguished Member of Technical Staff. He is now the Chief Technology Officer at Dolphin Design and director of Audio & Processing Product Lines. His research interests cover design for excellence (test, reliability,..), new architectures and toolchains for energy efficient products especially for Edge AI/ML solutions, and new audio solutions. He authored 200+ papers, several invited papers, tutorials and keynotes, held 20+ patents and used to serve as IRPS Management Committee member and in technical committees of various conferences . He is the recipient of the IRPS 2017 and 2018 Best Paper award, the IRPS 2012, 2013, 2016 and 2017 Outstanding Paper awards, the DATE 2015 Best Paper award and the ITC-india 2017 Best Paper award.

Invited Papers

AI Techniques for Fault Analysis

Konstantin Schekotihin , AAU Klagenfurt Institute for Applied Informatics, Alpen-Adria-Universität Klagenfurt, Austria

Identification and localization of faults in semiconductors is a very knowledge-intensive task. The more information an engineer has about a sample at hand, the accurately and cost-effectively its analysis can be done. Often valuable information, such as method know-how, best practices, or reports of previous investigations, is available in different support systems, like file shares, wikis, or databases. However, all these systems are rarely connected since they store information in formats designed for human use only, like unstructured text. As a result, an expert must act as a mediator between such systems by transforming the output of one system into an input format of the other one. Such manual alignment of systems is time-consuming and causes engineers to rely on their own expertise. Modern Artificial Intelligence (AI) methods can help experts to access all required information in a single uniform interface by enabling automated interoperability between the available systems.

In this talk, we discuss logic-based and machine learning methods that can be used to solve the interoperability problem. The first group of methods focuses on applying ontologies to formalize knowledge in the fault analysis domain. The impact of such formalization is twofold. First, ontologies standardize notions used by experts and thus reduce the ambiguity of personal communication. Second, they provide other AI systems with sets of clearly defined concepts and relations between them that machines and experts interpret in the same way. Thus, one can use classes defined in the ontology, e.g., faults, tools, or locations, as labels for training data sets of machine learning methods, such as Natural Language Processing (NLP). The latter can be applied to train classification models that are able to process (un)structured documents from different information systems and align them based on the ontology concepts.

Dr. Konstantin Schekotihin is an associate professor of Intelligent Systems at the University Klagenfurt, Austria, where he leads research and teaching in applications of artificial intelligence methods. He received his MS degree in Informatics from NTU “Kharkow Polytechnic Institute”, Ukraine and his PhD from University Klagenfurt. Dr. Schekotihin research focus lies mainly on various aspects of semantic systems including knowledge representation and reasoning, machine learning for computer vision and natural language processing, knowledge acquisition and maintenance, logic programming and reasoning techniques. Research results were successfully applied in various industrial projects with companies like Infineon or Siemens, focused on topics such as configuration, planning and scheduling, recommendation, or interoperability of systems. He is an author of more than 70 paper in these fields that were published on such prestigious conferences, e.g., IJCAI, ECAI, AAAI, ISWC, or ICDM, and leading international journals as JAIR, IEEE TSE, JWS, or KBS. Dr. Schekotihin is a member of program committees and often acts as a reviewer in a number of international conferences and journals.

Buffer Trap-Induced Current Saturation and Current Collapse in GaN Devices

Michael J. Uren and Martin Kuball, Bristol University, UK

GaN-based HEMTs are now dominant in many high efficiency power amplifier applications, however surprisingly there are many aspects of the devices, especially related to their instabilities that are poorly understood. The semi-insulating buffer layer under the 2D electron gas channel acts to suppress off-state leakage, reduce output conductance and capacitance, but is also the source of multiple issues including current-collapse, dynamic Ron, and kink effect. These are usually discussed in terms of their trap energy levels, cross-sections, and densities. However, here we will show that these instabilities can often be better understood by considering Fermi-level pinning by background carbon acceptors, compensation ratio, and especially the transport to and from the traps dictated by the device electrostatics.

Michael Uren is Research Professor in the Centre for Device Thermography and Reliability at the University of Bristol, UK, and has now accumulated more than 40 years device physics experience. He did his MA and PhD in Physics at the University of Cambridge on electron transport in Si MOSFETs, followed by a postdoc at IBM, Yorktown Heights, USA. He worked at RSRE Malvern, UK (now QinetiQ) on SOI CMOS, random telegraph and 1/f noise, and interface trapping. Later he successfully implemented SiC RF power MESFET, GaN S-band and X-band MMIC processes. He moved to Bristol in 2011 where he leads the device electrical research on GaN, and Ga_2O_3 devices. His main current interest focuses on the understanding of the role of epitaxy on device performance

State of Health Estimation of Electronic Packages using Piezoresistive Stress sensor

Przemyslaw Gromala, BOSCH, Germany

To meet social expectancy, the electronics systems that are used in automotive industry become more complex. The electronic control units that will be used in highly automated and autonomous cars will typically be smart systems of 3rd generation, which will perform human like operations. The 3rd generation smart systems will act independently in respect to control and decision making. In addition, these systems will be capable to self-testing, self-calibration and self-healing. Furthermore, the Internet of Things concept will bring electronic components that are traditionally developed for consumer electronic market under the engine hood.

All of the aforementioned aspects will require new approaches to reliability and quality assurance. It is already observed that the lifetime requirements for embedded electronics used in automotive are increasing. At the same time the time of qualification and the cost of reliability tests are expected to be reduced. All these challenges and requirements can be realized by developing a new reliability concept that is strongly supported through numerical simulation and product optimization at a very early development stage. A possible solution is called prognostics and health managements. I will present an example of in-situ ASIC degradation monitoring of ASIC using a piezoresistive stress sensor. The data driven approach utilizes unique data sets from the stress cells and combines them with the state of health of the IC device. Machine learning techniques are used for fault detection and classification.

Mr Przemyslaw Gromala is a simulation senior expert at Robert Bosch GmbH, Automotive Electronics in Reutlingen. Currently leading an international simulation team and FEM validation and verification lab with the focus on implementation of simulation driven design for electronic control modules and multi-chip power packaging for hybrid drives. His technical expertise includes material characterization and modeling, multi-domain and multi-scale simulation incl. fracture mechanics, V&V techniques, and prognostics and health management for safety relevant electronic smart systems.
Prior joining Bosch Mr Gromala worked at Delphi development center in Krakow, as well as at Infineon research and development center in Dresden.
He is an active committee member of the IEEE conferences: ECTC, EuroSimE, iTherm; ASME: InterPACK. Active committee member of EPoSS – defining R&D and innovation needs as well as policy requirements related to Smart Systems Integration and integrated Micro- and Nanosystems.
He holds a PhD in mechanical engineering from Cracow University of Technology in Poland.

Vertical GaN devices: process and reliability

Shuzhen You, IMEC, Belgium

GaN-based power devices have been proven their competence in high power applications. GaN lateral devices are now commercially available rating voltages up to 900V. For higher voltage ratings, the area of lateral HEMTs increase significantly hence degraded cost effectiveness. Additionally, the difficulty in growth of thick buffer layer on Si and poor reliability hinders the development GaN lateral HEMTs. The vertical GaN power devices are promising candidates to realize breakdown voltages >1kV by using thick drift layer without enlarging the device footprint. Moving the peak electric field away from the surface into the bulk minimizes trapping effects and improves device stability and reliability. Vertical GaN diodes and transistors have already been demonstrated, with breakdown voltage up to 4kV. Most of them are

grown on free-standing GaN substrates, which is not cost effective for industrial production. Our approach of fabricating the vertical GaN technology on a 200mm CMOS compatible platform, can lead to significant cost savings. This work reviews the challenges related to the substrates, growth of GaN stacks, devices fabrication in 200mm CMOS platform and device performance and reliability.

Shuzhen You, R&D team leader for GaN devices development at imec. She received her master degree in 2003 from East China Normal University in China and her PhD degree in 2012 from KULeuven in Belgium. In 2012, she started her research of GaN power devices in imec. Her research interests include enhancement p-GaN lateral HEMTs and (semi-)vertical MOSFET in device physics, characterization, reliability study and compact modelling. She works on the p-GaN HEMTs devices and compact modelling both for discrete components and monolithically integrated circuits. Since 2019, She has been a work package leader for ECSEL JU project UltimateGaN, working on 200mm CMOS compatible processes for vertical GaN devices targeting a breakdown voltage of 1200V and beyond.

Practical considerations for the reliability of fiber optic monitoring serving condition-based maintenance of aerospace-grade components

Thomas Geernaert, VUB Vrije Universiteit Brussel, Belgium

Optical fibre sensors are increasingly used on aerospace-grade carbon fibre reinforced polymer (CFRP) components owing to their light weight, small diameter, multiplexing capabilities and immunity to electromagnetic interference. A permanently installed fiber optic monitoring network of fibre Bragg gratings (FBGs) would allow a transition from time-based maintenance to condition-based maintenance. The current state-of-the-art of BVID detection with OFS remains however at low technology readiness levels and the demonstrations found in literature are often not tested for their compatibility with aerospatial conditions. We therefore address practical considerations for the reliability of fiber optic monitoring: we deploy an in-flight compatible surface mounted OFS network, obtain detection thresholds for BVID detection in view of relevant on-ground conditions, and summarize the health of a component in one Global Damage Index number, based on the readings of the sensor network. We validate our findings on coupon, element and subcomponent level.

Thomas Geernaert is professor at the Faculty of Engineering of the Vrije Universiteit Brussel. He is member of the Applied Physics and Photonics Department and of the photonics research group B-PHOT (Brussels Photonics), which counts about 70 scientists, engineers, and administrative and technical staff. He graduated as an Electrotechnical Engineer with majors in Photonics in 2006 and received his PhD in Engineering in 2011, both at the VUB. Within B-PHOT, T. Geernaert is leading the research team on optical fiber technologies.

From semiconductor components to the LHC "system of systems": dealing with radiation effects in critical high-energy accelerator equipment

Ruben Garcia Alia, CERN, Switzerland

Successfully operating critical systems based on commercial electronics components in radiation environments poses unique challenges related to the design and qualification of such systems. In this presentation, we will cover the various steps of the Radiation Hardness Assurance (RHA) approach in the Accelerator and Technology Sector (ATS) at CERN, highlighting the key constraints and providing some examples of radiation tolerant developments for accelerators. Such RHA steps include radiation monitoring and calculations in order to specify the related requirements, designing custom systems based on commercial parts and with radiation effects mitigation in mind, as well as the actual radiation qualification of the related semiconductor components and systems.

Rubén García Alía is part of the “Radiation to Electronics” (R2E) project at CERN, which he leads since 2018. After having studied nuclear and high-energy physics in the Complutense University in Madrid (Spain), he started his career in radiation effects as a Young Graturate Trainee at the European Space Agency, in the Netherlands. From there, he moved to completing his PhD with CERN and the University of Montpellier, focusing on the effect of highly energetic particles on Single Event Effects in the LHC accelerator. During this period, he was recognized with the “Best Student Paper” award in RADECS 2012, and the Paul Phelps Award in 2015. Since then, he has kept a strong involvement in radiation effects research with, focusing on high-energy accelerator applications, and has co-authored more than 75 publications in peer reviewed journals. He has also co-authored a RADECS Short Course, has been session chair at NSREC and RADECS, and is currently technical chair for RADECS 2021. Recently he was elected Junior Member-at-Large of the Radiation Effects Steering Group (RESG).

Reliability of automotive and consumer MEMS sensors - an overview

Martina Hommel, BOSCH, Germany

In our daily life, sensors play more and more an important role. They take over many functions in the automotive world as well as in consumer products with an increasing dissemination of the internet of things. In addition, they offer a broad variety of new applications. Sensors are typically build up in a package including a sensing element (e.g. micromechanical structures in acceleration sensors or membranes in gas sensors, etc.) and a microelectronic chip to evaluate the sensor data. This article will give an overview, how the reliability of such a system is validated. The challenges for reliability in terms of requirements and qualification for automotive and consumer applications will be discussed. The complex structure of a sensor module in combination with a broad variety of materials implies many possible failure mechanisms, which have to be considered. Some relevant sensor failure mechanisms caused by mechanical shock, thermo-mechanical stress and the influence of humidity on sensor reliability will be shown. The challenges for describing the influence of humidity on the sensor lifetime by an acceleration model will be discussed in detail. Finally, the paper will give an outlook for the reliability challenges of future sensor applications.

Martina Hommel has more than 20 years' experience in the field of reliability and has worked on several topics including process reliability, power semiconductors and sensors. She has published several papers on reliability, one tutorial about stress migration and holds several patents in this field. She received her diploma in physics (M.S.) in 1996 and her doctoral thesis (Ph.D.) in 1999 on the mechanical properties and fatigue of thin metal films from University of Stuttgart and Max-Planck-Institute for Metals Research (Institute for Material Science), in Stuttgart. In 2000, she joined the Central Reliability Department of Infineon Technologies AG, Munich, where she worked on international technology transfers. The focus of her work was on the reliability of interconnects, inter-metal dielectrics and especially design-for-reliability. Since 2012, she was working for Robert Bosch GmbH, Reutlingen, where she was responsible for the reliability qualification of power semiconductors and power modules for automotive electronics. In 2018, she received as a member of the SiC-development team the Robert Bosch Automotive Electronics Innovation Award. Since 2019, she is working as a Senior Expert for the reliability of sensors, first at Bosch Sensortec GmbH, where she established reliability guidelines and -processes for sensor qualifications of consumer sensors. Now she is a Senior Expert in the sensor development department of automotive sensors.

Innovation and Novelty in Electrostatic Discharge (ESD) and Electrical Overstress from 1980 to 2020

Dr. Steven H. Voldman, ESD Consulting LCC, USA

In this lecture, an overview of the innovation and novelty of electrostatic discharge (ESD) and electrical overstress (EOS) protection from 1980 to 2020 will be discussed. The lecture will review the evolution of design practices, structures, chip architecture, technology, testing models, test equipment, standards, computer aided design (CAD) checking and verification in the ESD protection of semiconductors. The progression of ESD practices in semiconductors, and innovations will be shown. The focus will be on the steps taken to provide improved ESD protection in today's technologies.

Dr. Steven H. Voldman is the first IEEE Fellow in the field of electrostatic discharge (ESD) for "Contributions in ESD protection in CMOS, Silicon On Insulator and Silicon Germanium Technology."

Voldman was a member of the semiconductor development of IBM for 25 years. He initiated a lecture series that reached over 40 universities in the United States, Korea, Singapore, Taiwan, Malaysia, Philippines, Thailand, Senegal, Zimbabwe, and China. Dr. Voldman has teaches short courses and tutorials on ESD, latchup, patenting, and invention. He is a recipient of 264 issued US patents and has written over 150 technical papers in the area of ESD and CMOS latchup. Since 2007, he has served as an expert witness in patent litigation; and has also founded a limited liability corporation (LLC) consulting business supporting patents, patent writing and patent litigation

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Workshop

Assessment of long-term Reliability, Prognostic and Health Management (P&HM) and Predictive Maintenance of Aerospace and Wind Power structures: Attributes, Challenges, Pitfalls, Roles, Significance

Chair and co-chair: Marie-Anne De Smet (DFinder, France), Alain Bensoussan (Dfinder, France)

The industrial automation ecosphere is going through a major transformation towards the actual industrial revolution, or Industry 5.0. New and mature critical infrastructures such as Wind Power farms, Aeronautics transporters, Automotive, Nuclear Power stations, but also concrete bridges, high rise buildings, large dams, offshore platforms and steel pipelines are continuously experiencing environmental corrosion, material aging, fatigue, natural disasters and very complex operational loading.

Prognostics and Health Management (P&HM) is an enabling discipline consisting of technologies and methods to assess the reliability of a product in its actual life cycle conditions to determine the risk of failure and mitigate system operation. However, the deployment of PHM capabilities presents multiple challenges to the PHM practitioner charged with retrofitting such systems. Issues include a lack of specific instrumentation needed to capture the signals of interest; insufficient data and sampling rates required for fault detection and diagnosis, and for detection of failure/degradation indicators; and difficulties in the identification of a system's nominal behavior as a result of age induced degradation.

Advanced Diagnostics and Structure Health Management are applied separately or concurrently at device or component levels, as well as at subsystem, structure, system and/or total platform stages, sensor networks, protocols and agents, depend on the mission profiles stress conditions undergone by these vital systems. Checks and maintenance are periodically scheduled throughout their operational life.

Both PHM on systems and Structure Health Management on structures sustain operation cost and time reduction by optimizing maintenance planning when needed, manage equipment life time, impacting positively structural weight at design stage inducing energy savings.

The collateral Structural Health Monitoring (SHM) network, one element of the global Structure Health Management, provides important advantages in Safety by constant monitoring to apply the most appropriate procedure and protocols. This methodology aims to deliver the best operation survey and benefit from recorded in-situ data of any component ageing induced by operation.

Main topic of the Round Table is to focus on SHM fiber optical sensing solutions as technologies to ensure the integrity of parts, components, materials, and structures without damaging them. They are used to monitor and make diagnosis related to predict ageing behavior during operation. They help to anticipate any possible failure of the structure/component. Therefore, their reliability assessment during all life cycle is key

Panel list speakers from: PhotonFirst; Safran Tech; Vrije Universiteit Brussel; DFinder

Conference Program

Monday, October 4th

	Tutorial virtual Room 1
chairperson	H. FREMONT
8:50	Machine learning based data and signal analysis methods for the application in failure analysis M. Kögel, S. Brand Fraunhofer IMWS

10:30	Coffee Break

	Tutorial virtual Room 1
chairperson	N. NOLHIER
10:50	GaN power transistors: devices, technology and reliability M. Meneghini Univ. Padova

12:30	Lunch

14:00	Official opening of ESREF 2021 virtual Room 1

Session KN1	Keynote paper virtual Room 1
chairpersons	N. LABAT F. MARC
14:20	Invited paper FD-SOI, the path to energy efficiency for 5G, AI and Automotive applications. P. Flatresse SOITEC

Session KN2	Keynote paper virtual Room 1
chairpersons	N. LABAT F. MARC
15:00	Invited paper Runtime Reliability Hardening for Edge AI and Automotive applications V. Huard DOLPHIN Design

15:40	Coffee Break

Session D		Reliability of microwave devices and circuits virtual Room 1
chairpersons		J.G.TARTARIN M. DAMMANN
16:00		Invited paper Buffer Trap-Induced Current Saturation and Current Collapse in GaN Devices M. Uren, M. Kuball Bristol University
16:40	**D-1** **#61**	Reliability and failure analysis in power GaN-HEMTs during S-Band Pulsed-RF Operating

N. Moultif[1], S. Duguay[1], O. Latry[1], E. Joubert[1], M. Ndiaye[2]
[1]GPM, [2]CEVAA

17:00 **D-2 #147** Stability of the threshold voltage in fluorine-treated normally off AlN/GaN HEMTs co integrated with commercial normally on GaN HEMT technology
F. Albany[1], N. Labat[1], N. Malbert[1], F. Lecourt[2], E. Walasiak[2], N. Defrance[3], A. Curutchet[1], H. Maher[4], Y. Cordier[5]
[1]UMR 5218 - IMS - Laboratoire de l'Intégration du Matériau au Système, [2]OMMIC, [3]IEMN – CNRS UMR8520, [4]LN2 -Université de Sherbrooke, [5]CNRS-CRHEA

17:20 **D-3 #121** Charge trapping in 0.1 µm AlGaN/GaN RF HEMTs: dependence on barrier properties, voltage and temperature
F. Chiocchetta, C. De Santi, F. Rampazzo, M. Meneghini, G. Meneghesso, E. Zanoni
University of Padova

17:40 **D-4 #140** Impact of an AlGaN Spike in the Buffer in 0.15 µm AlGaN/GaN HEMTs during Step Stress
Z. Gao[1], F. Rampazzo[2], M. Meneghini[2], N. Modolo[2], C. De Santi[2], H. Blanck[3], H. Stieglauer[3], D. Sommer[3], J. Gruenenpuett[3], O. Kordina[4], J.-T. Chen[4], G. Meneghesso[2], E. Zanoni[2]
[1]DEI_UNIPD, [2]UNIPD, [3]UMS, [4]SweGaN

Session A1 Fault tolerant design improvement

virtual Room 2

chairpersons C. SALM
E. OLTHOF

16:40 **A1-1 #18** PReCEP: Automatic Insertion of Partial Redundancy based on Critical Error Probability
G. Luca Nazar[1], P. H. Capp Kopper[1], M. Tomazzoli Leipnitz[1], B. Juurlink[2]
[1]Universidade Federal do Rio Grande do Sul, [2]Technische Universität Berlin

17:00 **A1-2 #95** Similarity based Telemetry Data Recovery for Enhancing Operating Reliability of Satellite
Y. Wu, J. Liang, Y. Peng
Harbin Institute of Technology

17:20 **A1-3 #112** Improved Deep Learning based telemetry data anomaly detection to enhance spacecraft operation reliability
L. Yang[1], Y. Ma[1], F. Zeng[2], X. Peng[1], D. Liu[1]
[1]Harbin Institute of Technology, [2]Institute of Navigation Satellite Innovation Academy for Microsatellites of CAS Shanghai

Tuesday, October 5th

8:20		Exhibitors flash presentations virtual Room 1
		G. BASCOUL

Session E1		Assembly evolution during accelerating ageing virtual Room 1
chairpersons		R.RONGEN J. PERRAUD
8:30		Invited paper State of Health Estimation of Electronic Packages using Piezoresistive Stress sensor P. Gromala BOSCH
09:10	**E1-1 #68**	Different steps of failure mechanism in BGA SAC305 solder joints during thermal cycling E. Ben Romdhane[1], P. Roumanille[1], A. Guédon-Gracia[2], S. Pin[1], P. Nguyen[3], H. Frémont[2] [1]Institut de Recherche Technologique Saint-Exupéry, 31400 Toulouse, [2]Laboratoire de l'Intégration du Matériau au Système, IMS, UMR 5218, 33405 Talence, [3]Elemca, 31400 Toulouse
09:30	**E1-2 #67**	Evaluation of thermomechanical fatigue lifetime of BGA lead-free solder joints and impact of isothermal aging P. Roumanille[1], E. Ben Romdhane[1], S. Pin[1], P. Nguyen[2], J.-Y. Delétage[3], A. Guédon-Gracia[3], H. Frémont[3] [1]IRT Saint Exupery, [2]Elemca, [3]IMS Laboratory
09:50	**E1-3 #16**	Automated quantitative analysis of void morphology evolution in Ag-Ag direct bonding interface after accelerated aging Z. Yu, T. Xu, S. Letz, C. Bayer, A. Schletz, M. März Fraunhofer IISB

Session A2		Reliability in power systems virtual Room 2
chairpersons		C. SALM E. OLTHOF
9:10	**A2-1** **#64**	PV Mission Profile Simplification Method for Arid Climates M. B. Fogsgaard, A. S. Bahman, F. Iannuzzo, F. Blaabjerg Institute of Energy Technology at Aalborg University
09:30	**A2-2** **#124**	On-line temperature measurement during power cycle of PCB-embedded diode S. Bensebaa[1], M. Berkani[1], M. Petit[2], S. Lefebvre[2] [1]SATIE, [2]CNAM/SATIE
09:50	**A2-3** **#142**	Performance analysis of Indium Antimonide thermophotovoltaic system with varied material and geometrical properties J.S. Choong[1], M.S. Mohd Jasni[1], W.E.S. Wan Abd Rashid[2], Y. Abdul Wahab[3], S.F. Wan Muhamad Hatta[1] [1]Department of Electrical Engineering, Faculty of Engineering, University of Malaya, [2]Institute of Power Engineering (IPE), Universiti Tenaga Nasional, UNITEN, Kajang, Selangor, Malaysia, [3]Nanotechnology & Catalysis Research Centre, University of Malaya, Kuala Lumpur 50603, Malaysia

10:10	Coffee Break

Session A3		New reliability assessment methods virtual Room 2
chairpersons		C. SALM E. OLTHOF
10:30		Invited paper Reliability of automotive and consumer MEMS sensors - an overview M. Hommel BOSCH
11:10	**A3-1** **#114**	Reliability assessment of film capacitors oriented by dependent and nonlinear degradation considering three-source uncertainties X. Ye, Y. Hu, B. Zheng, C. Chen, R. Feng, S. Liu, G. Zhai School of Electrical Engineering and Automation, Harbin Institute of Technology
11:30	**A3-2** **#47**	Investigating Real-Time Control-Flow Error Detection in Hardware: how fast can we detect errors and take action?

A. Hoppe[1], F. Kastensmidt[2], J. Becker[3]
[1]Karlsruhe Institut of Technology (KIT), [2]Universidade Federal do Rio Grande do Sul - UFRGS, [3]Karlsruhe Institute of Technology (KIT)

Session E2		Environmental tests virtual Room 1
chairpersons		A. GUEDON-GRACIA R. RONGEN
11:10	**E2-1** **#86**	Generation and Characterization of Condensation Phenomena in Power Modules O. Schilling, S. Elhadri, S. Kremp, C. Puls Infineon AG
11:30	**E2-2** **#55**	Impact of temperature on the corrosion of lead-free solder alloy during salt spray test K. Akoda, A. Guédon-Gracia, J.-Y. Delétage, B. Plano, H. Frémont Université de Bordeaux/Laboratoire IMS

Session H		MEMS reliability virtual Room 2
chairpersons		G. PAPAIOANNOU C. POULAIN
11:50	**H-1** **#102**	A novel method for the assessment of surface charge density variance in capacitive RF-MEMS switches D. Birmpiliotis, M. Koutsoureli, G. Papaioannou University of Athens
12:10		Lunch

13:50	Exhibitors flash presentations virtual Room 1
	G. BASCOUL

Session KN3	Keynote paper virtual Room 1
chairpersons	N. LABAT F. MARC
14:00	Invited paper Nanoscale III-V Electronics: InGaAs FINFETs and Nanowire MOSFETs. J. Del Alamo MIT

Session F2-1		Wide bandgap degradation physics: GaN and SiC virtual Room 1
chairpersons		L.THEOLIER M. MENEGHINI
14:40	**F2-1-1** **#115**	Positive and negative charge trapping GaN HEMTs: interplay between thermal emission and transport-limited processes A. Nardo[1], C. De Santi[2], C. Koller[3], C. Ostermaier[3], I. Daumiller[3], G. Meneghesso[1], E. Zanoni[1], M. Meneghini[2] [1]Univeristà degli Studi di Padova, [2]University of Padova, [3]Infineon Technologies Austria
15:00	**F2-1-2** **#32**	Hot Electron Effects in AlGaN/GaN HEMTs During Hard-Switching Events A. Minetto[1], N. Modolo[2], M. Meneghini[2], E. Zanoni[2], L. Sayadi[1], S. Sicre[1], B. Deutschmann[3], O. Häberlen[1] [1]Infineon Technologies Austria AG, [2]Department of Information Engineering, University of Padua, [3]Graz University of Technology
15:20	**F2-1-3** **#104**	TCAD investigation of the transport of carriers deposited by alpha particles in Silicon Carbide power Schottky devices M. Pocaterra, M. Ciappa ETH Zurich
15:40	**F2-1-4** **#100**	Gate-oxide degradation characteristics of SiC MOSFETs under continuous switching conditions S.-I. Hayashi, K. Wada Tokyo Metropolitan University

Session B1	Reliability in MOS Technologies: from Low Voltage to High Power virtual Room 2

chairpersons		A. BRAVAIX E. LANGER
14:40	**B1-1** **#152**	Modeling HCD interaction between On and Off modes for 28nm FDSOI used AC RF applications M. T. Garba Seybou[1], X. Federspiel[1], A. Bravaix[2], F. Cacho[1] [1]STMicroelectronics, [2]ISEN-REER, IM2NP UMR
15:00	**B1-2** **#90**	Impact of Single-Defects on the Variability of CMOS Inverter Circuits M. Waltl[1], D. Waldhoer[1], K. Tselios[1], B. Stampfer[1], C. Schleich[1], G. Rzepa[2], H. Enichlmair[3], E. G. Ioannidis[3], R. Minixhofer[3], T. Grasser[1] [1]TU Wien/Institute for Microelectronics, [2]Global TCAD Solutions, [3]ams AG
15:20	**B1-3** **#120**	Radiation and Annealing Related Effects in NBT Stressed P-Channel Power VDMOSFETs D. Danković[1], V. Davidović[1], S. Golubović[1], S. Veljković[1], N. Mitrović[1], S. Djorić-Veljković[2] [1]Faculty of Electronic Engineering, University of Niš, Serbia, [2]Faculty of Civil Engineering and Architecture, University of Niš, Serbia
15:40	**B1-4** **#53**	Local capacitance-voltage profiling and high voltage stress effect study of SiO2/SiC structures by time-resolved scanning nonlinear dielectric microscopy K. Yamasue, K. Suzuki, Y. Cho Tohoku University

16:00	Coffee Break

Session F2-2	Wide bandgap failure analysis virtual Room 1

chairpersons		L.THEOLIER M. MENEGHINI
16:20		Invited paper Vertical GaN devices: process and reliability S. You IMEC
17:00	**F2-2-1** **#82**	Influence of different test strategies on the power cycling test results of 6.5 kV SiC MOSFETs M. Gerlach[1], R. Boldyrjew-Mast[1], F. Bruchhold[1], J. Lutz[1], T. Basler[1], H. Schwarzmann[2] [1]Chemnitz University of Technology, [2]SEMIKRON Elektronik GmbH & Co. KG

17:20	**F2-2-2** **#33**	Towards a safe failure mode under short-circuit operation of power SiC MOSFET using optimal gate source voltage depolarization W. Jouha[1], F. Richardeau[1], S. Azzopardi[2] [1]Laplace -INP Toulouse, [2]SAFRAN TECH
17:40	**F2-2-3** **#12**	Investigations on Acceptable Breakdown Voltage Variation of Parallel-Connected SiC MOSFETs Applied in Solid-State Circuit Breakers Z. Lou[1], K. Wada[2], W. Saito[1], S.-I. Nishizawa[1] [1]Kyushu University, [2]Tokyo Metropolitan University
18:00	**F2-2-4** **#103**	Avalanche Current Balancing Using Parallel Connection of SiC-JFETs with Cascode Connection M. Sagara[1], K. Wada[1], S.-I. Nishizawa[2], W. Saito[2] [1]Tokyo Metropolitan University, [2]Kyushu University

Session B2 — Reliability of Advanced Memories

virtual Room 2

chairpersons		A. BRAVAIX E. LANGER
17:00	**B2-1** **#71**	Carbon Ion Implantation as Healing Strategy for Improved Reliability in Phase Change Memory Arrays G. Bourgeois, G. Navarro CEA, LETI, Univ. Grenoble Alpes, 38000 Grenoble, France.
17:20	**B2-2** **#26**	Improving Failure Rates in Two-pulse SOT-MRAM Switching by Reinforcement Learning J. Ender[1], R. Lacerda De Orio[2], S. Fiorentini[1], S. Selberherr[2], W. Goes[3], V. Sverdlov[1] [1]Christian Doppler Laboratory for Nonvolatile Magnetoresistive Memory and Logic, Institute for Microelectronics, TU Wien, [2]Institute for Microelectronics, TU Wien, [3]Silvaco Europe Ltd.
17:40	**B2-3** **#91**	Morphology and reliability aspects of 40nm eSTM architecture F. Melul[1], V. Della Marca[2], M. Bocquet[2], M. Akbal[3], P. Laine[2], F. Trenteseaux[4], M. Mantelli[3], M. Hesse[3], A. Regnier[3], S. Niel[4], F. La Rosa[3] [1]Aix-Marseille University, CNRS, IM2NP UMR 7334 / STMicroelectronics Rousset, [2]Aix-Marseille University, CNRS, IM2NP UMR 7334, [3]STMicroelectronics Rousset, [4]STMicroelectronics Crolles
18:00	**B2-4** **#132**	Hot-carrier evaluation of a zero-cost transistor developed via process optimization in an embedded non-volatile memory CMOS technology P. Devoge[1], H. Aziza[2], P. Lorenzini[3], A. Marzaki[1], A. Malherbe[1], M. Mantelli[1], A. Regnier[1], F. Julien[1] [1]STMicroelectronics, [2]Aix-Marseille University, [3]University of Côte d'Azur
18:20	**B2-5** **#5**	Search for copper diffusion at hybrid bonding interface through chemical and electrical characterisations J. Jourdon[1], S. Lhostis[1], S. Moreau[2], P. Lamontagne[1], H. Fremont[3] [1]STMicroelectronics, Crolles, [2]CEA LETI, [3]IMS-Bordeaux

Wednesday, October 6th

8:20	Exhibitors flash presentations virtual Room 1
	G. BASCOUL

Session I3-1		Radiation impact on circuits and systems reliability virtual Room 1
chairpersons		M.MAZUREK S. UZNANSKI
8:30		Invited paper From semiconductor components to the LHC "system of systems": dealing with radiation effects in critical high-energy accelerator equipment R. Garcia Alia CERN
09:10	**I3-1-1** **#76**	Evaluating Softcore GPU in SRAM-Based FPGA under Radiation-Induced Effects M. M. Goncalves[1], F. Benevenuti[1], G. Braga[1], H. Hernandez[2], M. Hubner[2], M. Brandalero[2], F. Kastensmidt[1], J. R. Azambuja[1] [1]Universidade Federal do Rio Grande do Sul, [2]Brandenbug University of Technology - Cottbus Senftenberg
09:30	**I3-1-2** **#109**	Basic single-event mechanisms in Ge-based nanoelectronics subjected to terrestrial atmospheric neutrons D. Munteanu[1], J.-L. Autran[2] [1]CNRS-IM2NP, [2]Aix-Marseille University
09:50	**I3-1-3** **#89**	On the evaluation of FPGA radiation benchmarks G. Bricas[1], G. Tsiligiannis[1], A. Touboul[1], J. Boch[1], M. Kastriotou[2], C. Cazzaniga[2], C. Frost[2] [1]IES - Institut d'Electronique est des Systèmes, [2]STFC

Session E3	Silver sintering for power modules virtual Room 2

chairpersons — A. GUEDON-GRACIA, J. PERRAUD

9:10 **E3-1** **#154**
Constitutive equations for strain rate and temperature dependent mechanical behaviour of porous Ag-sintered joints in electronic packages
M. Lederer, Z. Gökdeniz, G. Khatibi, J. Nicolics
TU Wien

09:30 **E3-2** **#77**
Thermal aging of power module assemblies based on ceramic heat sink and multilayers pressureless silver sintering
N. Botter[1], R. Khazaka[2], Y. Avenas[1], J.-M. Missiaen[1], D. Bouvard[1], S. Azzopardi[2]
[1]Université Grenoble Alpes, [2]SAFRAN Tech

09:50 **E3-3** **#51**
Nano Ag sintering on Cu substrate assisted by self-assembled monolayers for high-temperature electronics packaging
C. Liu[1], L. Zhang[1], Y. Su[2], Z. Zhou[1], C. Liu[1]
[1]Loughborough University, [2]Beihang University

10:10	Coffee Break

Session I3-2	Radiation impact on circuits and systems reliability virtual Room 1

chairpersons — M.MAZUREK, S. UZNANSKI

10:30 **I3-2-1** **#143**
Modelling of Charge Injection by Multi-Photon Absorption in GaN-on-Si HEMTs for SEE Testing
C. Ngom[1], V. Pouget[2], M. Zerarka[3], F. Coccetti[3], O. Crepel[4], A. Touboul[2], M. Matmat[3]
[1]IRT Saint Exupery Toulouse, [2]IES, Université de Montpellier, [3]IRT Saint-Exupery Toulouse, [4]Airbus Toulouse

10:50 **I3-2-2** **#59**
Recharging Process of Commercial Floating-Gate MOS Transistor in Dosimetry Application
S. D. Ilić[1], M. S. Andjelković[2], R. Duane[3], A. J. Palma[4], M. Sarajlić[1], S. Stanković[5], G. S. Ristić[6]
[1]Center of Microelectronic Technologies, Institute for Chemistry, Technology and Metallurgy, University of Belgrade, [2]System Architectures Department, IHP - Leibniz Institut für innovative Mikroelektronik, [3]Centre for Micro and Nano Systems, Tyndall

National Institute, University College Cork, Dyke Parade, Cork, Ireland, [4]Department of Electronics and Computer Technology, University of Granada, Granada, [5]Department of Radiation and Environmental Protection, "Vinča" Institute of Nuclear Sciences, University of Belgrade, [6]Applied Physics Laboratory, Faculty of Electronic Engineering, University of Niš

11:10 **I3-2-3 #79**
Impact of Radiation-Induced Soft Error on Embedded Cryptography Algorithms
V. Bandeira[1], J. Sampford[2], M. Garay Trindade[3], R. Garibotti[4], R. Possamai Bastos[3], R. Reis[1], L. Ost[5]
[1]UFRGS, [2]Phixos, [3]Université Grenoble Alpes, [4]PUCRS, [5]Loughborough University

11:30 **I3-2-4 #122**
Evaluating reliability through soft error triggered exceptions at ARM Cortex-A9 microprocessor
P. M. Aviles, A. Lindoso, J. A. Belloch, L. Entrena
University Carlos III de Madrid

11:50 **I3-2-5 #146**
Analysis of Radiation-induced Transient Errors on 7nm FinFET Technology
S. Azimi, C. De Sio, L. Sterpone
Politecnico di Torino

Session F3 — Power Electronics Systems: Reliability and Failure Analysis

virtual Room 2

chairpersons: F.IANNUZZO, O. CREPEL

10:30 **F3-1 #34**
Fast cut-off, low I2T and high temperature monolithic on-chip fuse on silicon substrate for new fail-safe embedded power switch
A. Oumaziz[1], F. Richardeau[2], A. Bourennane[3], V. Bley[4], C. Combettes[4], A. Ghannam[5], E. Sarraute[2]
[1]LAPLACE & LAAS-CNRS Toulouse, [2]LAPLACE, Toulouse, [3]LAAS-CNRS, Toulouse, [4]LAPLACE, Université Paul Sabatier, Toulouse, [5]3DiS technologies

10:50 **F3-2 #113**
Thermal monitoring of the stator winding insulating part by a reliable thermal model for failure mitigation
T. Guenenna, K. Ben Smida, A. Khedher
ENISo

11:10 **F3-3 #138**
FEM analysis of a HF coreless transformer for automotive applications
S. Daniele[1], D. Spaggiari[2], D. Santoro[2], P. Cova[2], N. Delmonte[2]
[1]Federal-Mogul Italy s.r.l., [2]University of Parma

11:30 **F3-4 #17**
Behavioral modeling of PROFET^TM devices for system-level simulation of mission profiles in automotive environment applications
M. Simonazzi[1], D. Santoro[1], M. Bernardoni[2], N. Delmonte[1], P. Cova[1], R. Menozzi[3]
[1]University of Parma, [2]Infineon Technologies, [3]Università di Parma

11:50 **F3-5 #137**
Recurrent Neural Networks Based Model for Reliability of Power Electronic Systems in PMSG
S. Liu, D. Zhou, C. Wu, F. Blaabjerg
Aalborg University

12:10		Lunch

13:50		Exhibitors flash presentations virtual Room 1
		G. BASCOUL
Session I1-I2		ESD-EOS, Latchup,EMC-EMI virtual Room 1
chairpersons		P. GALY F. CAIGNET, T. DUBOIS
14:00		Invited paper Innovation and novelty in electrostatic discharge (ESD) and electrical overstress from 1980 to 2020 S. H. Voldman ESD Consulting LCC
14:40	**I1-I2-1 #88**	Intrinsic ESD robustness on new high voltage N/PMOS devices in 28nm FDSOI CMOS technology through TLP/VFTLP characterizations P. Galy[1], B. Jacquier[2], S. Haendler[3] [1]STMicroelectronics, [2]Stmicroelectronics, [3]STmicroelectronics
15:00	**I1-I2-2 #15**	Study on the high-temperature triggering and holding characteristics of PDSOI SCR devices W. Jiaxin, L. Xiaojing, Z. Chuanbin Institute of Microelectronics, Chinese Academy of Sciences
15:20	**I1-I2-3 #41**	Impact of Place and Route Strategy on FPGA Electromagnetic Emission E. Lara[1], A. Constante[1], J. Benfica[1], F. Vargas[1], A. Boyer[2], S. Ben Dhia[2], A. Gleinser[3], G. Winkler[3], B. Deutschmann[3] [1]Catholic University - PUCRS, [2]LAAS-CNRS, [3]Graz University of Technology - TU Graz
15:40	**I1-I2-4 #96**	Temperature effects on the conducted emission of a high-side switch N. Baptistat[1], T. Dubois[2], K. Abouda[1], G. Duchamp[2] [1]NXP, [2]IMS Laboratory/Univ. Bordeaux
16:00	**I1-I2-5 #127**	Conducted EMI Susceptibility Analysis of a COTS Processor as Function of Thermal Cycling and Overvoltage Stresses M. Fay Soares, F. Vargas, J. D'ornelas Benfica Catholic University - PUCRS

Session F1	IGBT reliability
	virtual Room 2

chairpersons L. THEOLIER

14:40 **F1-1** **#133**
Application of artificial neural networks to the identification of weak electrical regions in large area MIM structures
J. Muñoz-Gorriz[1], S. Monaghan[2], K. Cherkaoui[2], J. Suñe[1], P. Hurley[2], E. Miranda[1]
[1]Universitat Autonoma de Barcelona, [2]Tyndall National Institute

15:00 **F1-2** **#131**
Long-Term Electrical Stability of Next Generation LV Trench IGBT at Hitachi ABB Power Grids
N. Schneider[1], E. Buitrago[1], W. A. Vitale[2], L. De-Michielis[2]
[1]Hitachi ABB Powergrids, [2]Hitachi ABB Power Grids

15:20 **F1-3** **#123**
Improved HV-H³TRB robustness of a 1700 V IGBT chip set in standard power modules
J.-H. Peters[1], M. Hanf[1], S. Clausner[1], C. Zorn[2], N. Kaminski[1]
[1]Institute for Electrical Drives, Power Electronics, and Devices, University of Bremen, [2]ForWind - Center for Wind Energy Research, University of Bremen

15:40 **F1-4** **#151**
Comparisons of the instability in device characteristics for thin-film SOI power n- and p-MOSFETs at high temperature under AC stress
R. Yamanishi, S. Matsumoto
Kyushu Institute of Technology

16:00 **F1-5** **#107**
A testing method for evaluating shoot-through immunity of IGBTs in an inverter
K. Hasegawa[1], S. Abe[2], M. Tsukuda[3], I. Omura[2], T. Ninomiya[3]
[1]Kyushu Istitute of Technology, [2]Kyushu Institute of Technology, [3]Green Electronics Research Institute, Kitakyushu

16:20	Coffee Break

	Poster session I
16:40	virtual Room 1

chairpersons T. DUBOIS
P. GALY

16:40 **IP-1** **#9**
Analyzing the Impact of Guard-ring on Different Dual-direction SCR by Device Simulation and TLP Measurement
Y. Wang, J. Li, D. Jia, W. Wei
Xiangtan University

16:45	**IP-8** **#87**	Stability of Wireless Power Transfer using Gamma-ray Irradiated GaN Power HEMTs S.-W. Tang[1], P.-Y. Yao[2], D.-S. Chao[3], T.-L. Wu[1], H.-M. Hsu[2] [1]National Yang Ming Chiao Tung University, [2]National Chung Hsing University, [3]National Tsing Hua University
16:50	**IP-2** **#49**	Layout-based mitigation of single-event transient for monolithic 3D CMOS integrated circuits J. Zhang[1], F. Liu[2], B. Li[2], Y. Huang[2], C. Yang[2], G. Wang[2], J. Luo[2] [1]Institute of Microelectronics, Chinese Academy of Sciences; University of Chinese Academy of Sciences, [2]Institute of Microelectronics, Chinese Academy of Sciences
16:55	**IP-3** **#54**	Error sensitivity study of FFT architectures implemented in FPGA L. ÁN. García-Astudillo[1], A. Lindoso[2], L. Entrena[2], H. Martín[2], M. García-Valderas[2] [1]Universidad Carlos III de Madrid, [2]University Carlos III Madrid
17:00	**IP-4** **#57**	Evaluating the soft-error sensitivity of LU decomposition on low-power and high-end GPUs G. León[1], J. M. Badía[1], J. A. Belloch[2], A. Lindoso[2], L. Entrena[2] [1]Universitat Jaume I de Castellón, [2]Universidad Carlos III de Madrid
17:05	**IP-5** **#63**	Impacts of Carbon Ions on SEU in SOI SRAM J. Gao[1], Q. Zhang[2], K. Xi[3], B. Li[4], B. Li[5], P. Lu[4], C. Wang[6], K. Wang[4], G. Zhang[4], F. Zhao[4], J. Li[5], H. Liu[6], L. Wang[4], J. Luo[7], Z. Han[7], J. Liu[8], G. Guo[9] [1]University of Chinese Academy of Sciences； Institute of Microelectronics, Chinese Academy of Sciences, [2]Beijing Institute of Spacecraft System Engineering ， China Academy of Space Technology, [3]Institute of Microelectronics Chinese Academy of Sciences, [4]Institute of Microelectronics, Chinese Academy of Sciences, [5]IMECAS, [6]Key Laboratory of Silicon Device Technology ,Institute of Microelectronics, Chinese Academy of Sciences, [7]Institute of Microelectronics of the Chinese Academy of Sciences, [8]Materials Research Centre, Institute of Modern Physics, Chinese Academy of Sciences, [9]China Institute of Atomic Energy, Beijing
17:10	**IP-6** **#65**	A New Mixed Hardening Methodology applied to a 32-bit DSP 28nm FDSOI Subjected to Gamma Radiation A. Urena Acuna[1], J.-M. Armani[1], M. Slimani[1], I. Miro Panades[1], P. Dollfus[2] [1]Commissariat à l'Énergie Atomique et aux Énergies Alternatives (CEA), [2]Centre for nanoscience and nanotechnology (C2N), CNRS
17:15	**IP-7** **#84**	Design and Verification of Multiple SEU Mitigated Circuits on SRAM-based FPGA System J. Yu[1], C. Cai[2], B. Ning[3], T. Liu[4], L. Xu[5], M. Shen[3] [1]Fudan University, [2]Chinese Academy of Sciences, [3]Shanghai Fudan Microelectronics Group, [4]Institute of Modern Physics, Chinese Academy of Sciences, [5]State Key Laboratory of ASIC and System, Fudan University
17:20	**IP-9** **#94**	Research on Single Event Effect Test of a RRAM Memory and Space Flight Demonstration H. Lyu China Aerospace Components Engineering Center
17:25	**IP-10** **#99**	Degradation of AIIIBV/Ge triple junction solar cells irradiated by gamma-rays, electrons and neutrons

M. Ryabtseva[1], A. Petrov[2], G. Voevodkin[1], K. Tapero[2], N. Vagapova[1], M. Bankovsky[2]
[1]Join Stock Company “Scientific and Production Enterprise “Kvant”, [2]Research Institute of Scientific Instruments (RISI)

17:30	**IP-11 #108**	Electronics reliability assessment of future power fusion machines: neutron interaction analysis in bulk silicon J.-L. Autran[1], M. Daniela[2] [1]Aix-Marseille University, [2]CNRS
17:35	**IP-12 #130**	Influence of ionizing radiation on the conducted electromagnetic emission of integrated circuits N. Czepl, B. Deutschmann, A. Michalowska-Forsyth Institute of Electronics

Poster session F1, F2, F3

16:40 virtual Room 2

chairpersons F. COCCETTI, M. MENEGHINI

16:40	**F1P-1 #70**	Impact of Cooling Conditions on Power Cycling Lifetime of IGBT Module L. Ding[1], J. Cai[1], J. Wang[1], N. Jiang[2] [1]Hefei University of Technology, [2]Institute of Semiconductor, Guangdong Academy of Sciences
16:45	**F1P-2 #98**	Practical challenges of high-power IGBT’s I-V curve measurement and its importance in reliability analysis O. Alavi, L. Van Cappellen, W. De Ceuninck, M. Daenen Hasselt University
16:50	**F2P-1 #21**	Influence of Phosphorus Diffusion on the SiO2/4H-SiC (0001) Interface during Poly Gate Formation Process C. Wan[1], Y. Zhang[2], H. Xu[1] [1]Institute of Microelectronics, Chinese Academy of Sciences, [2]Huawei Technologies Co., Ltd.
16:55	**F2P-2 #46**	A Novel Double-Sided Cooling Packaging Structure of Sic-Based Half Bridge Module Integrating the Laminated Busbar J. Wang[1], Y. Liu[2], S. Yu[2], C. Wang[2], L. Ding[2], N. Jiang[3] [1]Hefei University of Technology；Institute of Energy, Hefei Comprehensive National Science Center, [2]Hefei University of Technology, [3]Institute of Energy, Hefei Comprehensive National Science Center
17:00	**F2P-3 #62**	Repetitive short circuit capability of SiC MOSFET at specific low gate-source voltage bias for more robust extreme operation W. Jouha[1], F. Richardeau[1], S. Azzopardi[2] [1]LAPLACE, University of Toulouse,CNRS, INPT, UPS, [2]Safran

17:05 **F2P-4** **#83**
Analysis of the Subthreshold Characteristics in AlGaN/GaN HEMTs with a p-GaN Gate
S.-W. Tang, T.-L. Wu
National Yang Ming Chiao Tung University

17:10 **F2P-5** **#125**
Measurement and Simulation of Short Circuit Current Sharing under Parallel Connection: SiC MOSFETs and SiC Cascode JFETs
R. Wu[1], S. N. Agbo[2], S. Mendy[1], E. Bashar[1], S. Jahdi[3], J. Ortiz Gonzalez[2], O. Alatise[1]
[1]University of Warwick, [2]The University of Warwick, [3]University of Bristol

17:15 **F3P-1** **#10**
Fault Location Method of IGBT Short-Circuit for a Grid-Tied Netural-Point-Clamped Inverter System
M. Ma, X. Meng, N. Xiang, H. Wang, X. Zhang
Hefei University of Technology

17:20 **F3P-2** **#22**
Online Monitoring of IGBT Modules Based on Creating the Non-interventional Monitoring Environment
M. Ma, N. Meng, H. Wang, Z. Chen
Hefei University of Technology

17:25 **F3P-3** **#36**
A method to improve the accuracy and efficiency for metallized-film capacitor's reliability assessment using joint simulation
J. Yin, Y. Zhang, C. Lv
Xi'an Jiaotong University

17:30 **F3P-4** **#39**
DC-Side faults mechanism analysis and causes location for Two-Stage Photovoltaic Grid Connected Inverters
M. Ma, P. Xiong, N. Xiang
Hefei University of Technology

17:35 **F3P-5** **#43**
Diagnosis of Open-Phase Fault of Five-Phase Permanent Magnet Synchronous Motor by Harmonic Current Analysis
T. Li[1], R. Ma[1], Z. Zhang[2]
[1]Northwestern Polytechnical University, [2]CHANG'AN UNIVERSITY

17:40 **F3P-6** **#56**
Robustness study of a fast protection method based on the gate-charge dedicated for SiC MOSFETs power device
Y. Barazi, F. Richardeau, N. Rouger, J.-M. Blaquiere
Lab. LAPLACE - CNRS - Université Toulouse INP

17:45 **F3P-7** **#66**
Calendar degradation of Li-ion batteries under high storage temperature based on electrochemical impedance spectroscopy
Y. Sun, S. Zhang, J. Qi, Z. Su
Harbin University of Science and Technology

Thursday, October 7th

8:20	Exhibitors flash presentations virtual Room 1
	G. BASCOUL
Session G	Photonic reliability virtual Room 1
chairpersons	M. VANZI, A. BENSOUSSAN Y. DESHAYES

8:30		Invited paper Practical considerations for the reliability of fiber optic monitoring serving condition-based maintenance of aerospace-grade components T. Geernaert VUB Vrije Universiteit Brussel
09:10	**G-1** **#13**	Fault diagnosis of PID in crystalline silicon photovoltaic modules through I-V curve M. Ma[1], H. Wang[1], N. Xiang[1], P. Yun[2], H. Wang[1] [1]Hefei University of Technology, [2]Sungrow Power Supply
09:30	**G-2** **#97**	Electrical, optical characterization and degradation of Cu(InGa)Se2 devices with fluorine-doped tin oxide back contact M. Bertoncello[1], M. Barbato[1], A. Caria[1], M. Buffolo[1], C. De Santi[1], S. Rampino[2], G. Meneghesso[1], M. Meneghini[1] [1]Università degli studi di Padova, [2]CRN-IMEM
09:50	**G-3** **#117**	Degradation mechanisms of 1.3 µm C-doped quantum dot lasers grown on native substrate M. Zenari[1], M. Buffolo[1], C. De Santi[1], J. Norman[2], R. Herrick[3], G. Meneghesso[1], E. Zanoni[1], J. Bowers[2], M. Meneghini[1] [1]Università degli studi di Padova, [2]University of California, Santa Barbara, [3]Intel Corporation, Santa Clara
10:10	**G-4** **#126**	Effect of indium content and carrier distribution on the efficiency and reliability of InGaN/GaN-based multi quantum well light emitting diode C. Casu, M. Buffolo, A. Caria, C. De Santi, M. Meneghini, E. Zanoni, G. Meneghesso Università degli studi di Padova
10:30	**G-5** **#148**	Optical characterizations of “P-down” bonded InP pump laser S. Gerard[1], C. Starck[1], F. Laruelle[1], M. Bettiati[1], J.-P. Landesman[2] [1]3SP Technologies, [2]Institut Foton INSA Rennes

10:50		Coffee Break
		Poster session G, B, C
11:10		virtual Room 1

chairpersons G. BASCOUL
Y. DESHAYES

11:10	**GP-1 #45**	Improved Reliability PERC PV modules with Moth-eye Nanostructured Optical films using Nano Imprint Lithography K.-S. Oh[1], S.-H. Cho[1], J.-Y. Choi[2], K.-J. Lee[3], S.-I. Chan[1] [1]Korea Electronics Technology Institute, [2]Nanomecca, [3]Government Complex-Sejong
11:15	**BP-1 #11**	On the stochastic nature of conductive points formation and their effects on reliability of MoS2 RRAM: experimental characterization and Monte Carlo simulation Y. Huang, X. Wu, Y. Gu, R. Ge, D. Akinwande, J. Lee University of Texas at Austin
11:20	**BP-2 #50**	Nanoscale capacitance-voltage profiling of DC bias induced stress on a high-κ/SiO2/Si gate stack K. Suzuki, K. Yamasue, Y. Cho Tohoku University
11:25	**BP-3 #135**	Gate stress reliability of a novel trench-based Triple Gate Transistor R. Gay[1], V. Della Marca[2], H. Aziza[2], P. Laine[2], A. Regnier[1], S. Niel[1], A. Marzaki[1] [1]STMicroelectronics, [2]Aix-Marseille Universty, IM2NP
11:30	**CP-1 #20**	Soft sensor design for estimation of thermal behavior of encapsulating materials in power electronic module B. Trajin, I. Sakhraoui, F. Rotella LGP-ENIT
11:35	**CP-2 #25**	Analysis of the impact of power loss by degradation of the snail trails in 95kWp photovoltaic power system W. Oh[1], H. Choi[1], D. Kim[2] [1]STECO corporation, [2]Korea university

		Poster session A, E
11:10		virtual Room 2

chairpersons A. GUEDON-GRACIA
E. OLTHOF

11:10	**AP-1 #7**	Optimal design of cyclic-stress accelerated life tests for lognormal lifetime distribution under type I censoring S.-H. Kim[1], S.-I. Sung[2] [1]Samsung Electronics, [2]Kyonggi University
11:15	**AP-2 #106**	Statistical analysis method for accelerated life testing with incomplete data and competing failure modes G. Pan, X. Li, Y. Li, D. Li, C. Wang China Electronic Product Reliability and Environmental Testing Research Institute
11:20	**AP-3 #156**	Lifetime and degradation analysis of AgPt alloy thick film/AlN heater for semiconductor wafer annealing J.-S. Jeong Korea Electron Technology Institute (KETI)
11:25	**EP-1 #24**	Research on Sintering Process and Thermal Conductivity of Hybrid Nanosilver Solder Paste Based on Molecular Dynamics Simulation Z. Zhang, G. Fu, B. Wan School of Reliablility and Systems Engineering,Beihang University
11:30	**EP-2 #52**	Relative importance of solder and wirebond defects on the maximum junction temperature of IGBT devices P.-Y. Pichon, J. Brandelero Mitsubishi Electric R&D Centre Europe - France
11:35	**EP-3 #72**	Impact of Heat Treatment on the Lifetime of the Wire-Bonded Power Modules J. Brandelero, P.-Y. Pichon Mitsubishi Electric R&D Centre Europe
11:40	**EP-4 #149**	Fatigue crack evolution and effects analysis of Ag sintering die-attachment in SiC power devices under power cycling based on phase-field simulation Y. Su[1], G. Fu[1], C. Liu[2], C. Liu[2], X. Long[3] [1]Beihang University, [2]Loughborough University, [3]Northwestern Polytechnical University

12:10	Lunch

13:50	Exhibitors flash presentations virtual Room 1
	G. BASCOUL
Session C	Progress in Failure Analysis

		virtual Room 1
chairpersons		G. MURA F. ALTMANN
14:00		Invited paper AI Techniques for Fault Analysis K. Schekotihin AAU Klagenfurt Institute for Applied Informatics,
14:40	**C-1** **#93**	Local metal segregation as root cause for electrical shorts in highly doped pressure sensor devices M. Simon-Najasek[1], P. Diehle[1], C. Große[2], S. Huebner[1], G. Brokmann[3], B. Sprenger[3], F. Altmann[1] [1]Fraunhofer, [2]Fraunhofer IMWS, [3]CiS Forschungsinstitut für Mikrosensorik GmbH
15:00	**C-2** **#136**	Use of passive, quantitative EBIC to characterize device turn-on in 7 nm technology G. M. Johnson[1], A. Rummel[2] [1]Zeiss Microscopy, [2]Kleindiek Nanotechnik
15:20	**C-3** **#37**	Simulation Based Dynamic Laser Stimulation for Failure analysis of Analog and Mixed-signal Circuits T. Melis[1], E. Simeu[2], L. Saury[3], E. Auvray[3] [1]Univ. Grenoble Alpes, CNRS, Grenoble INP, TIMA, [2]TIMA Laboratory, [3]STMicroelectronics
15:40	**C-4** **#110**	Failure case studies of Fast Ionization Dynistors X. Huang[1], L. Liang[1], G. Wang[2] [1]Huazhong University of Science and Technology, [2]China Academy of Engineering Physics
16:00	**C-5** **#141**	A novel material detection method using femtosecond laser and confocal imaging enabling fast inspection of microelectronics A. Phoulady[1], N. May[2], H. Choi[1], S. Shahbazmohamadi[1], P. Tavousi[1] [1]UCONN, [2]university of connecticut

	Photonic Workshop
14:40	virtual Room 2
moderator	A. BENSOUSSAN

16:20	Coffee Break

17:00	Announcement of ESREF 2022, Best Paper Awards, Conference closing virtual Room 1

N. LABAT
O. WITLER

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ESREF 2021 Program at a glance

Monday 4 October

- 8:50–10:30 **Tutorial 1 — Failure analysis** — Michael Kögel, Sebastian Brand, Fraunhofer IMWS
- 10:30–10:50 Coffee break
- 10:50–12:30 **Tutorial 2 — GaN power transistors,** Matteo Meneghini, University of Padova
- 12:30–14:00 Lunch
- 14:00–14:20 **Conference Opening session**
- 14:20–15:00 **Invited Key Note** — Philippe Latresse
- 15:00–15:40 **Invited Key Note** — Vincent Huard
- 15:40–16:00 Coffee break
- 16:00–16:40 **Invited D** — M. Uren
- 16:40–18:00 **Session D** — Reliability of microwave devices and circuits — 61, 147, 121, 140
- **Session A1** — Fault tolerant design improvement — 18, 95, 112

Tuesday 5 October

- 8:20–8:30 Exhibitor Flash Presentation
- 8:30–9:10 **Invited E** — Przemyslaw Jakub Gromala
- 9:10–10:10 **Session E1** — Assembly evolution during accelerating ageing 68, 6,16
- 9:10–10:10 **Session A2** — Reliability in power systems — 64, 124, 142
- 10:10–10:30 Coffee break
- 10:30–11:10 **Invited A** — Martina Hommel
- 11:10–11:50 **Session E2** — Environmental tests — 86, 55
- 11:10–12:10 **Session A3 & H** — Reliab. assess. methods — 114, 47, 102
- 12:10–13:50 Lunch
- 13:50–14:00 Exhibitor Flash Presentation
- 14:00–14:40 **Invited Key Note** — Jesus Del Alamo
- 14:40–16:00 **Session F2-1** — Wide bandgap degradation physics — 115, 32, 104, 100
- 14:40–16:00 **Session B1** — Reliability in MOS Techno: Low Voltage to High Power — 152, 90, 120, 53
- 16:00–16:20 Coffee break
- 16:20–17:00 **Invited F2** — Shuzhen You
- 17:00–18:20 **Session F2-2** — Wide bandgap failure analysis — 82, 33, 12, 103
- 17:00–18:40 **Session B2** — Reliability of Advanced Memories — 71, 26, 91, 132, 5

Wednesday 6 October

- 8:20–8:30 Exhibitor Flash Presentation
- 8:30–9:10 **Invited I3** — Ruben Garcia Alia
- 9:10–10:10 **Session I3-1** — Radiation impact on reliability 76,109, 89
- 9:10–10:10 **Session E3** — Silver sintering for power modules — 154, 77, 51
- 10:10–10:30 Coffee break
- 10:30–12:10 **Session I3-2** — Radiation impact on reliability — 143, 59, 79, 122, 146
- 10:30–12:10 **Session F3** — Power Electronics Systems: Reliability and Failure Analysis — 34, 113, 138, 17, 137
- 12:10–13:50 Lunch
- 13:50–14:00 Exhibitor Flash Presentation
- 14:00–14:40 **Invited I1- I2** — Steven Voldman
- 14:40–16:20 **Session I1- I2** — ESD-EOS, Latchup, EMC-EMI — 88, 15, 41, 96, 127
- 14:40–16:20 **Session F1** — IGBT reliability — 133, 131, 123, 151, 107
- 16:20–16:40 Coffee break
- 16:40–18:20 **Poster session I** — 9, 49, 54, 57, 63, 65, 84, 87, 94, 99, 108, 130
- 16:40–18:20 **Poster session F1, F2, F3** — 70, 98, 21, 46, 62, 83, 125, 10, 22, 36, 39, 43, 56, 66

Thursday 7 October

- 8:20–8:30 Exhibitor Flash Presentation
- 8:30–9:10 **Invited G** — Thomas Geernaert
- 9:10–10:50 **Session G** — Photonic reliability — 13, 97, 117, 126, 148
- 10:50–11:10 Coffee break
- 11:10–12:10 **Poster session G, B, C** — 45, 11, 50, 135, 20, 25
- 11:10–12:10 **Poster session A, E** — 7, 106, 156, 24, 52, 72, 149
- 12:10–13:50 Lunch
- 13:50–14:00 Exhibitor Flash Presentation
- 14:00–14:40 **Invited C** — Konstantin Schektihin
- 14:40–16:20 **Session C** — Progress in failure analysis — 93, 136, 37, 110, 141
- 16:20–17:00 Coffee break
- 14:40–17:00 Photonic Workshop
- 17:00–17:40 **BPA Announcement and Closing**