Physical Modeling, Numerical Simulation and Characterization of Advanced Semiconductor Devices: the ARCES perspective

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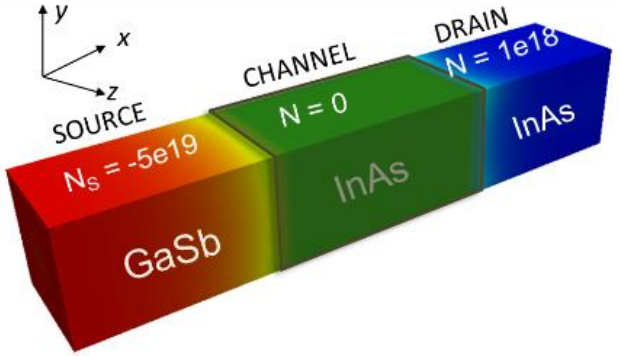
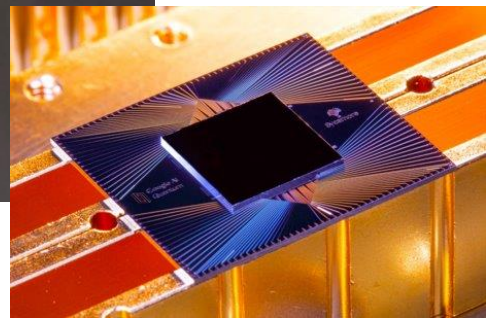
Nanoelectronics

- ❑ Simulation of nanoelectronic devices using in-house developed tools
- ❑ Development of new simulation approaches for Quantum Computing

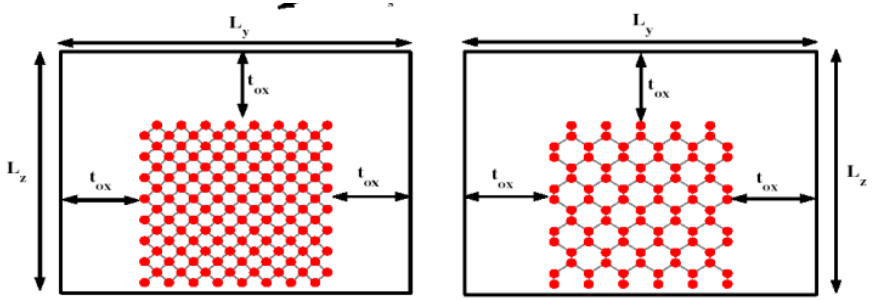




New physical effects

Material engineering

Device engineering



2.1 nm x 2.1 nm x 32 nm ≈ 7000 atoms
20 orbitals for each atom

Disruptive innovation in future electronics:

- **Ultra-low power devices for HPC**
- **Analog in-memory computing for AI**
- **More-than-Moore nanosensors for IoT**

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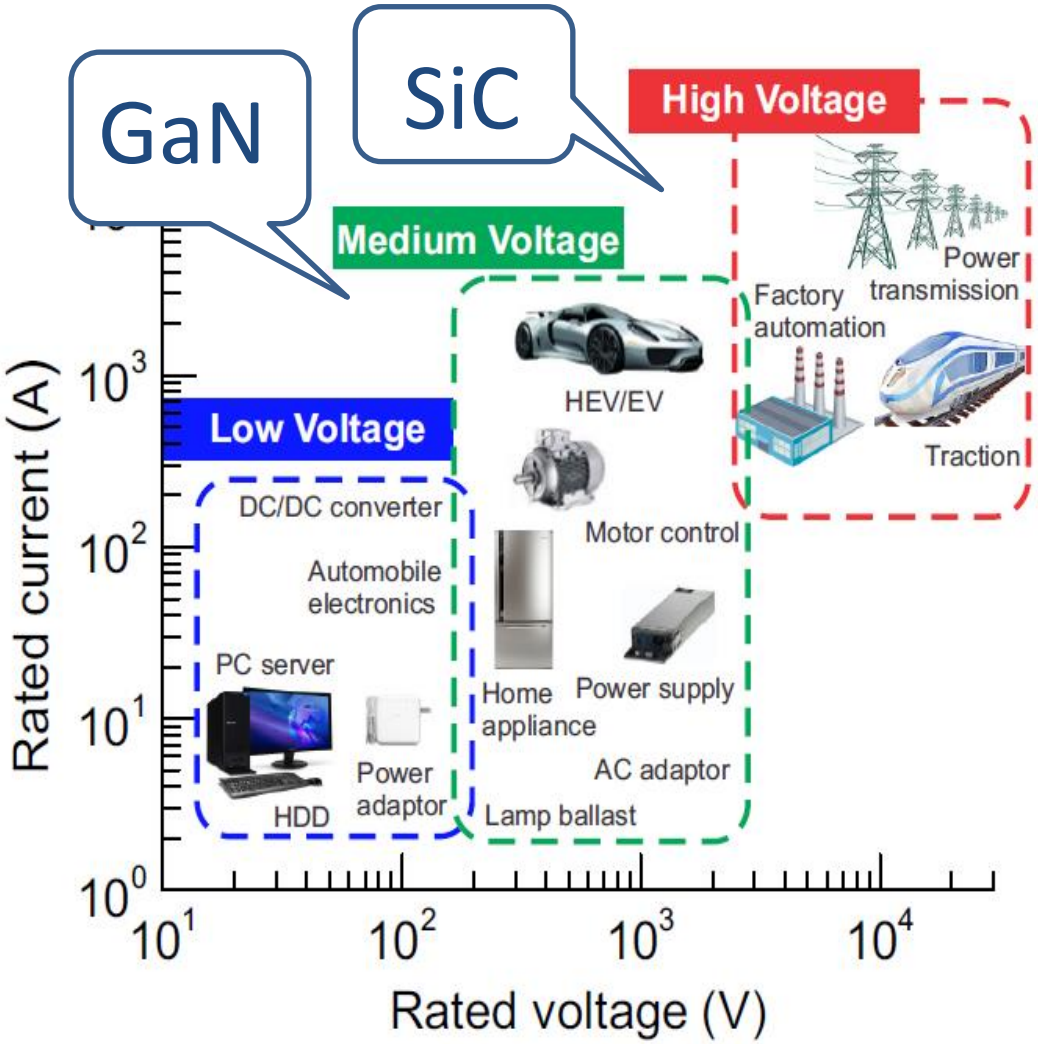
SiC & GaN Power Devices: the reliability challenges!

- ❑ High-Voltage on-wafer and in-package characterization
- ❑ TCAD simulations



Degradation issues in GaN-Based Power HEMTs

In collaboration with: ***imec*, Belgium.**

Bias Temperature Instabilities in SiC MOSFETs

Investigation of new barrier materials for GaN-based HEMTs

Large Energy Savings Potential

Globally **nearly 100TWh/year**:

- Data centers
- Electric vehicles
- Laptops & mobile phones
- Renewable energy generation

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ARCES on-going activities in European and National Projects

R3-PowerUP: 300mm Pilot Line for Smart Power and Power Discretes (H2020, JTI-ECSEL)

iREL 4.0 : Intelligent Reliability 4.0 (H2020, JTI-ECSEL)

REACTION: first and euRopEAn siC eigTh Inches pilOt liNe. (H2020, JTI-ECSEL)

Five2D "Five challenges towards electronics based on 2D materials" **(PRIN2017)**

GaN4AP: GaN for Advanced Power Applications (H2020, JTI-ECSEL)

TRANSFORM: Trusted European SiC Value Chain for a greener Economy (H2020, JTI-ECSEL)

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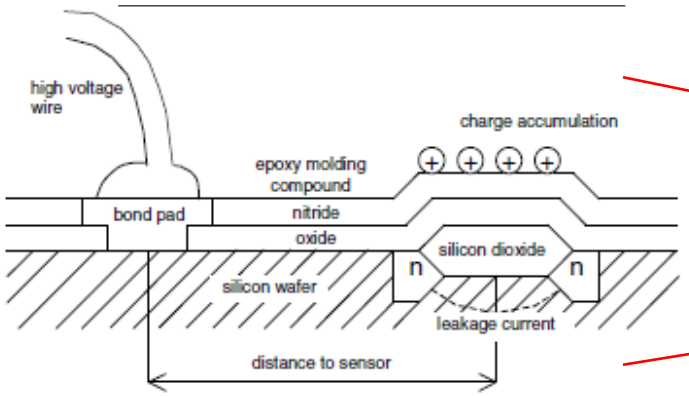
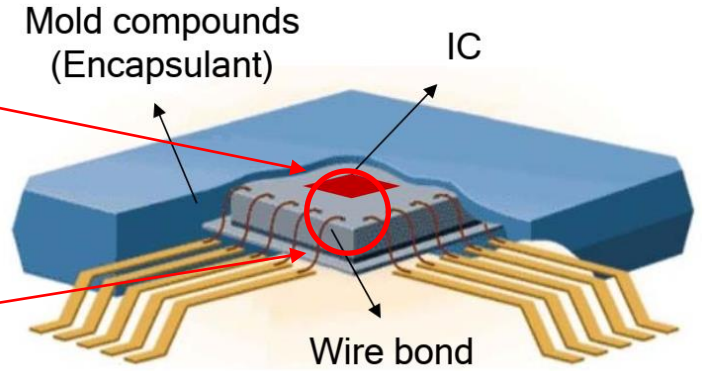
Industrial Partnerships

Conductivity in the molding compound: characterization and modeling of charge spreading

Texas Instruments Dallas, Texas

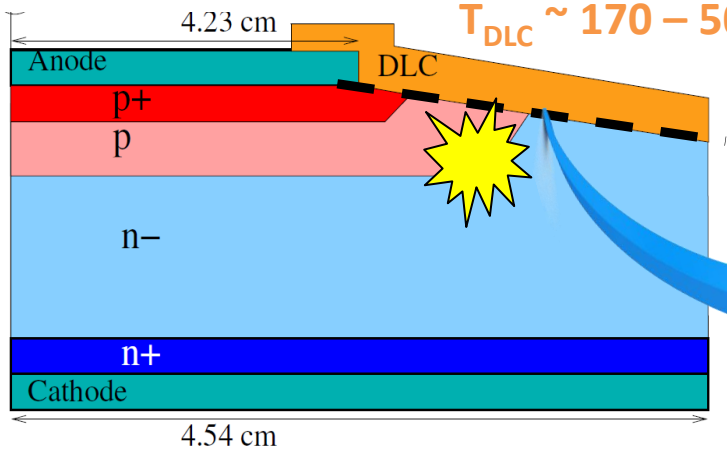




TCAD-based investigation on transport properties of Diamond-like Carbon coatings for HV-ICs

ABB Semiconductors, Switzerland

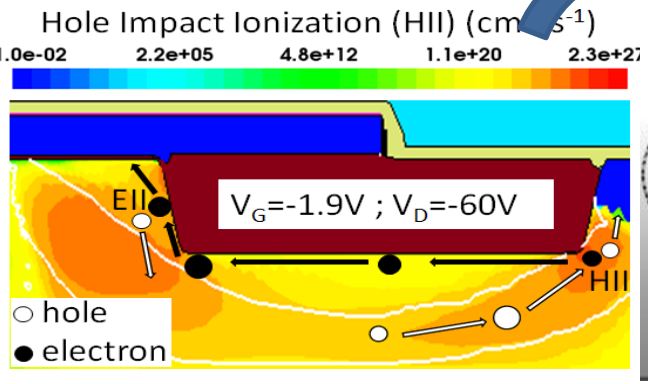
4- 10 kV Discrete Diodes

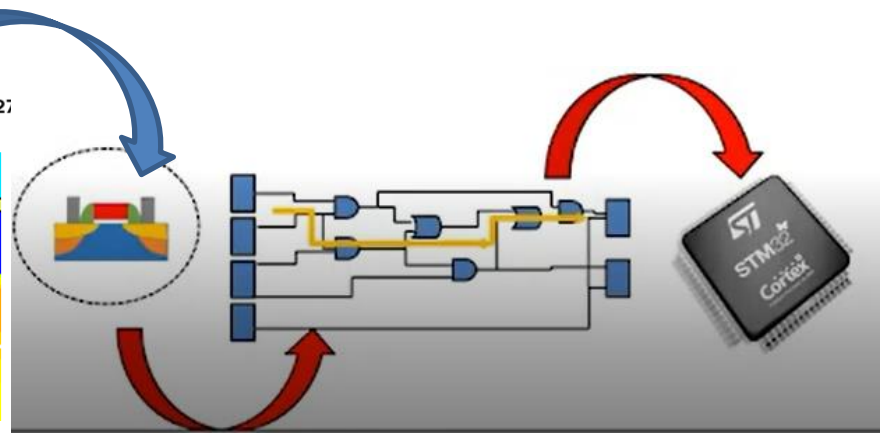


T_{DLC} ~ 170 – 500 nm

Understanding of hot-carrier stress degradation and gate leakage current in LDMOS devices

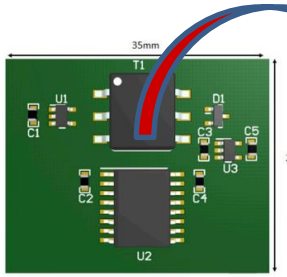
ARCES-STMicroelectronics Lab



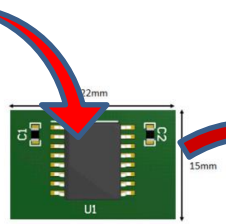


Next steps: Integrated Galvanic Isolation

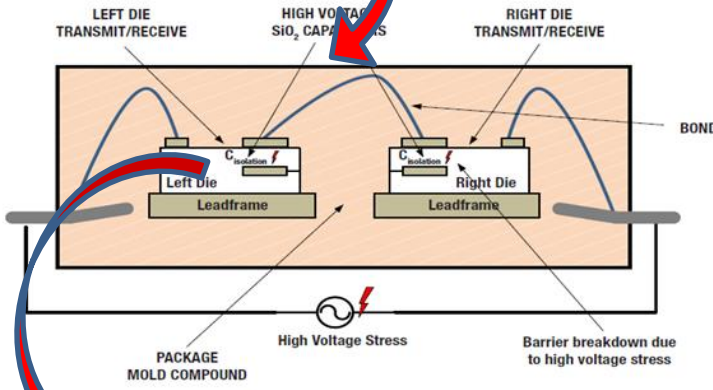
ARCES-STMicroelectronics Joint Lab

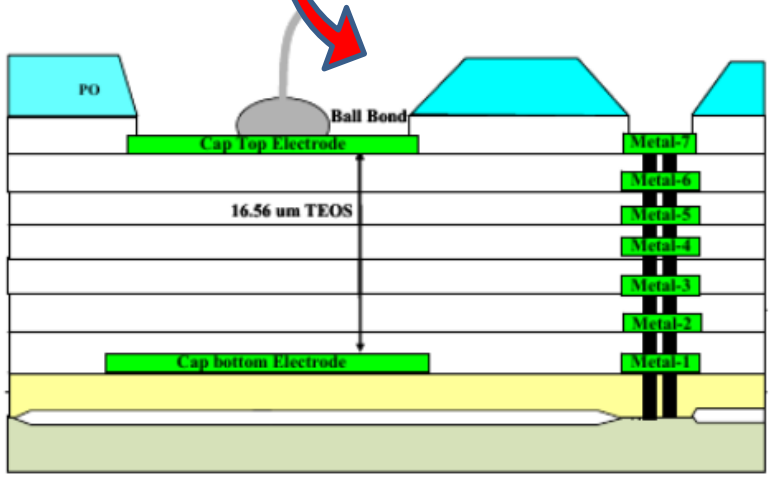


Digital isolator, transformer driver IC, transformer, LDO and other discrete components



Integrated signal and power isolation





Automotive
Electric vehicles
Motor control
DC-DC converter

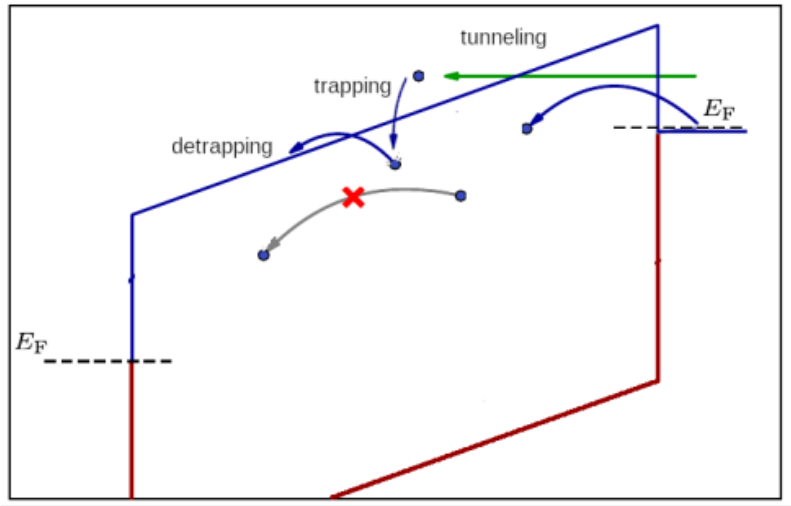
Industrial
Inverters
Automation
Welding

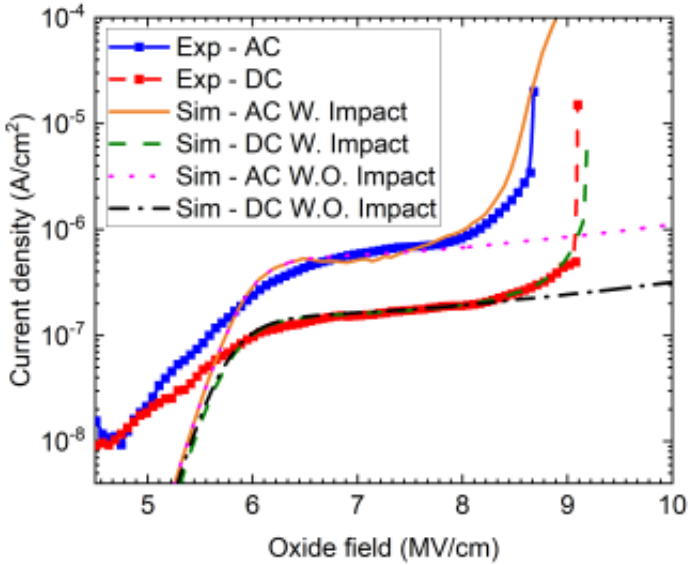
Consumer
Induction cooking
HID ballasts
Home appliance

Medical
Microwave therapy
Electrocardiographs
Defibrillators

Power conversion
Solar inverter
UPS system

Communication
Sensor
Local network

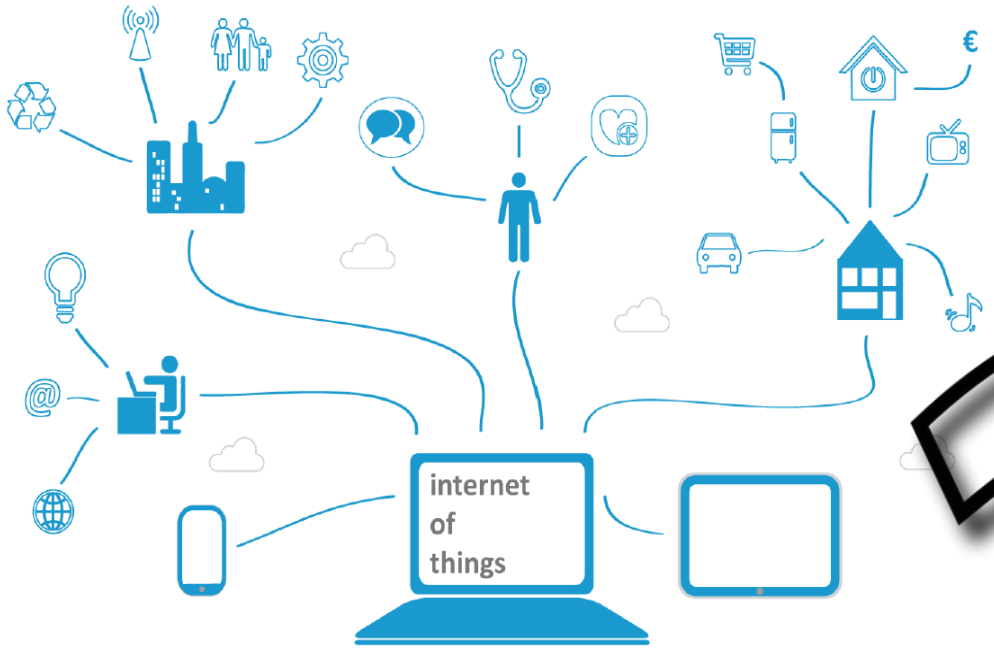


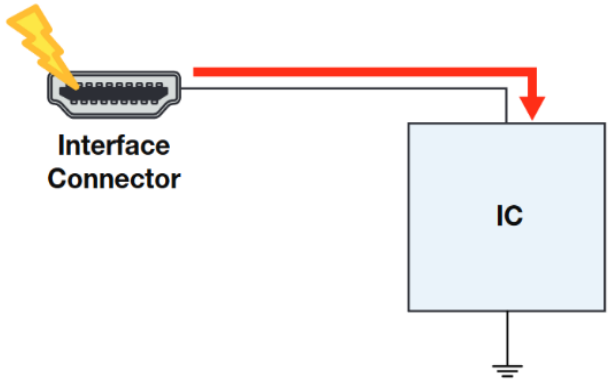


… and Integrated Electrostatic-Discharge (ESD) Protection

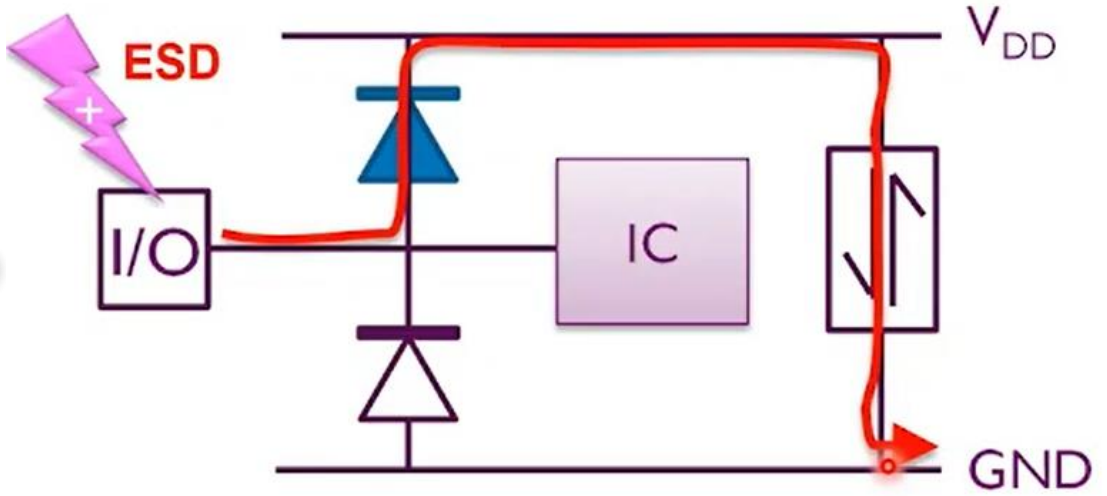
Texas Instruments Dallas, Texas

- 50 billion devices connected to internet
- Endless possibilities in combining

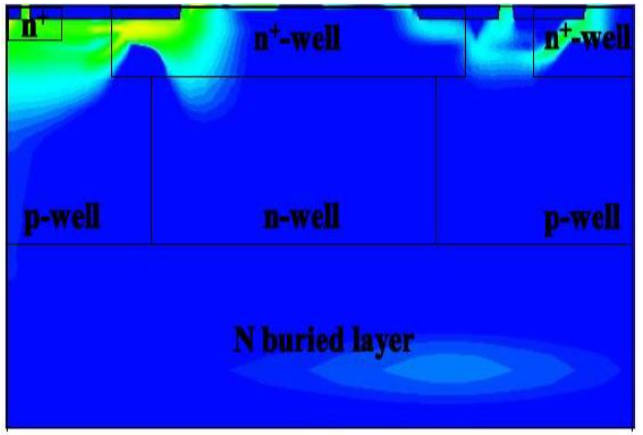


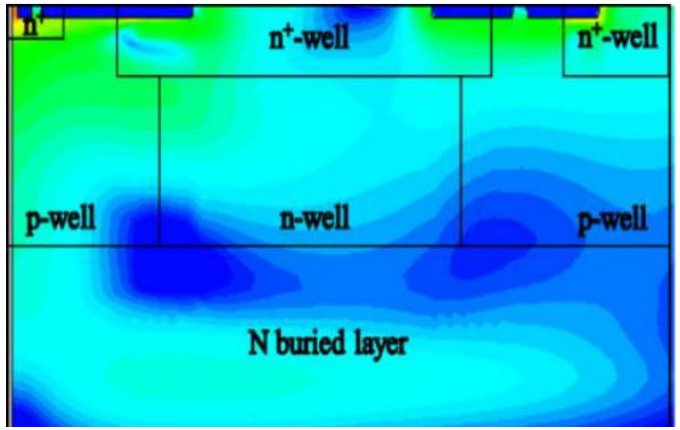


non-standard on-chip protection clamps → ESD reliability challenges



Physiscal insight into complex ESD events via TCAD simulations





Technical Committees

MILAN 2022
ESSDERC
ESSCIRC

IRPS
International Reliability Physics Symposium

ESREF 2022

IEDM 68th International Electron Devices Meeting

EurSOI

IIRW INTERNATIONAL INTEGRATED RELIABILITY WORKSHOP
IEEE

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