incize

A DECADE OF TRUST & INNOVATION

2011 2012 2013 **2014** 2015 2016 2017 2018 **2019** 2020 2021 2022 2023 **2024**

Milestone

2011: UCLouvain — Spin-off; 1st customer (substrate)

2013: 1st US Customer

2014: incize — Private company; 1st foundry & 1st MEMS

2015: Skywin Aerospace cluster of Wallonia — Space; 1st Korean Customer; Modelling for RF SOI

2016: PDK services for RF SOI; GaN RF

2017: SOI industry consortium — Full support for RF SOI adoption by foundries; 5G Sub-6 GHz; Quartz

2018: 1st Chinese Customer

2019: GLOBALFOUNDRIES RFwave™ — 5-Year Milestone; Porous Si; POI; 1st UK Customer

2020: Medical application; 1st fabless

2021: Industrial Alliance for Processors and Semiconductor Technologies — 1st Japanese Customer

2022: RF substrate benchmarking; 1st IDM

2023: 10-Year Milestone; Disrupting the RF FEM market!!

Team

1 1 1 1 3 3 5 4 8 11 11 12 14 14
















Customers

0 1 3 5 8 12 14 16 20 24 33 41 47 53

Incize at a glance

Custom & innovative semiconductor technology enablement services for advancing current and future technologies.

Expertise

- **RF**
- **Materials**
- **Devices**
- **Characterization**
- **Modeling**
- **Simulation**

Clients

- **Fabless**
- **Foundries**
- **Substrate manufacturers**

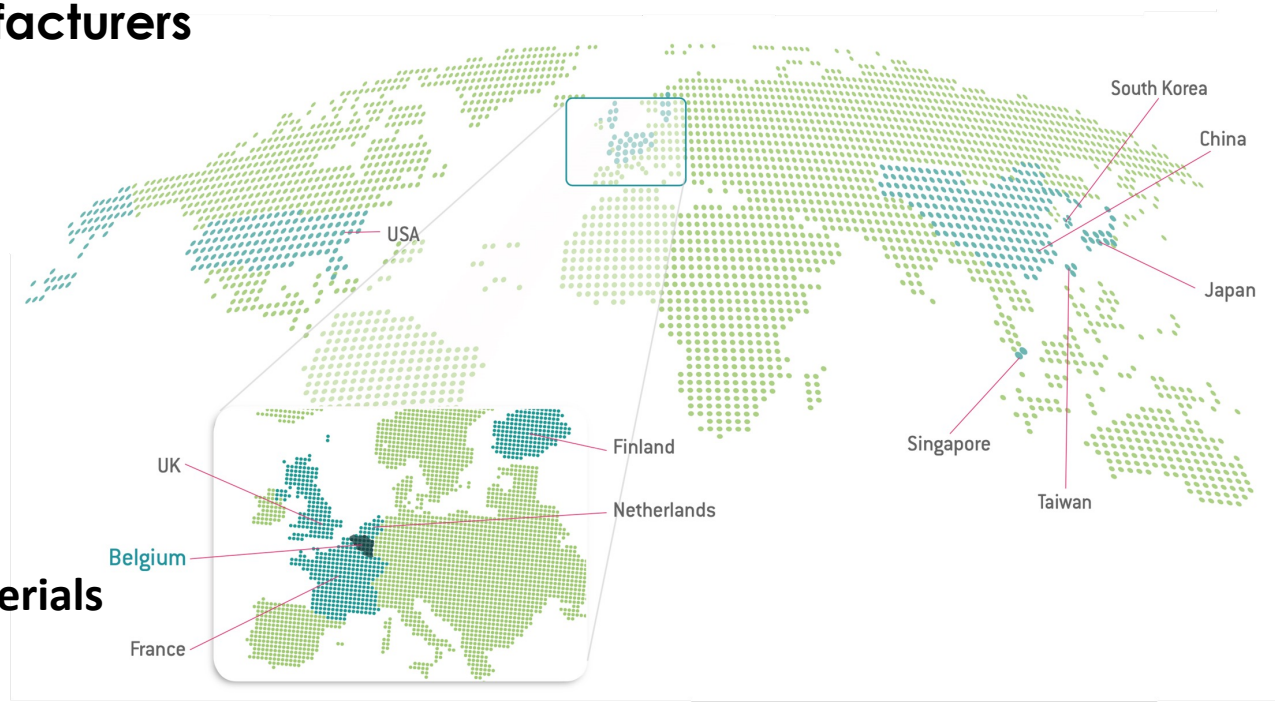
14 talents

53 clients

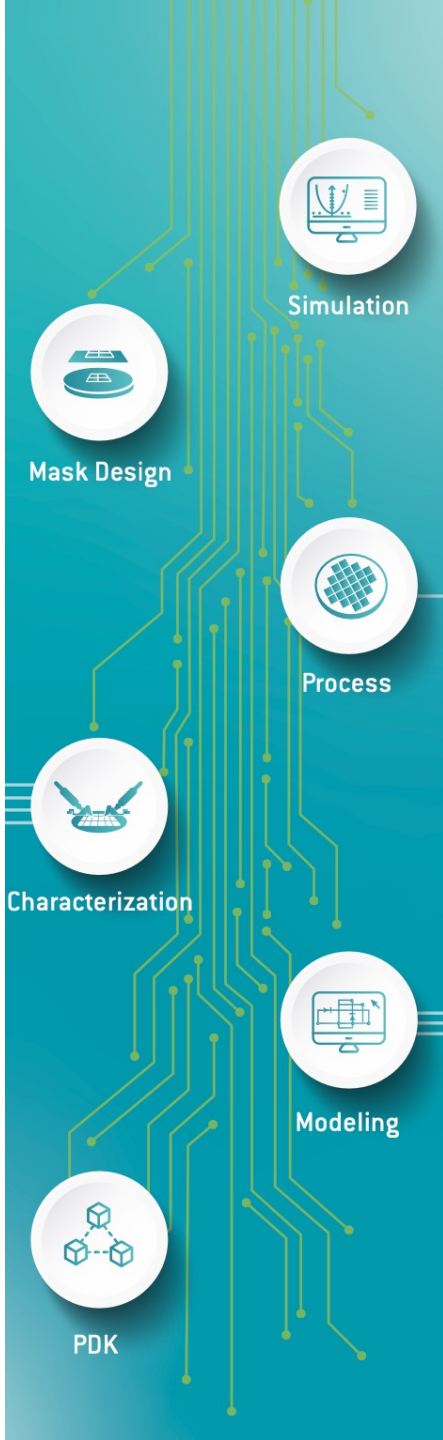
14% R&D

Technologies

- **Silicon**
- **III-V**
- **Dielectric**
- **Piezo**
- **2D**
- **Phase-changing materials**
- **MEMS**



A DECADE OF TRUST & INNOVATION

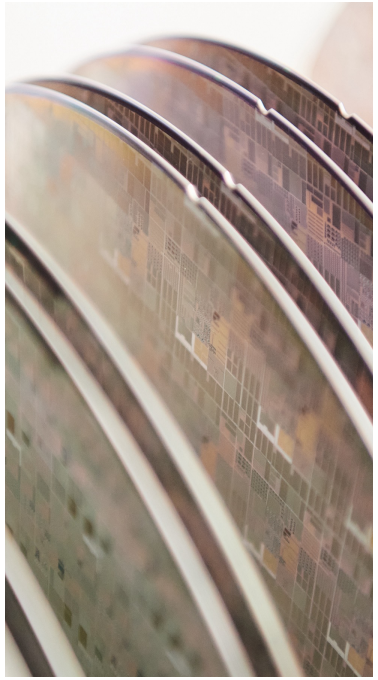


Customers Geographical Distribution

Foundries
Fabless
Wafer suppliers

53 Customers – 13 Countries

Incize is active in the following industries...

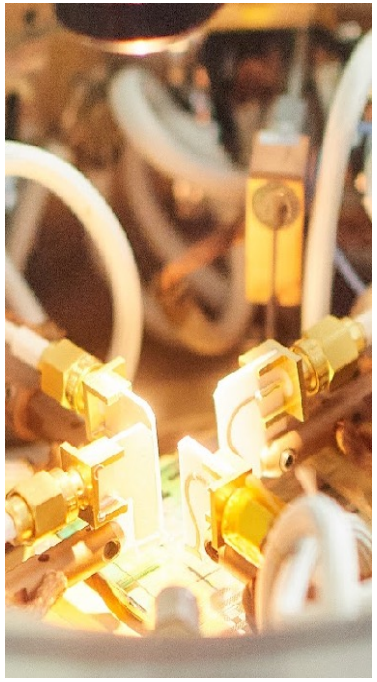


SEMICONDUCTOR

> Characterization
> Modelling
> Simulations
> Fab Process

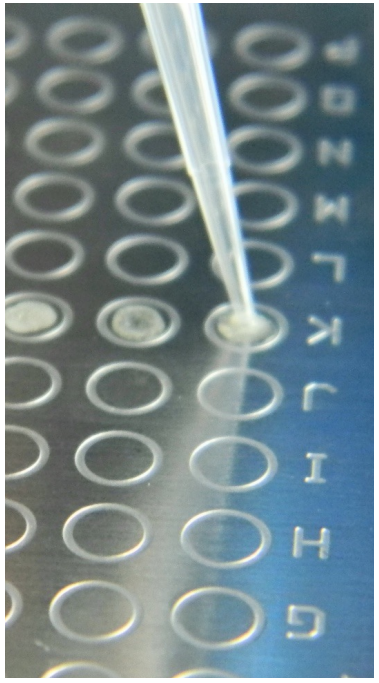
SPACE

Radiation
> Heavy ions
> Proton beam
> Gamma irradiation



QUANTUM COMPUTING

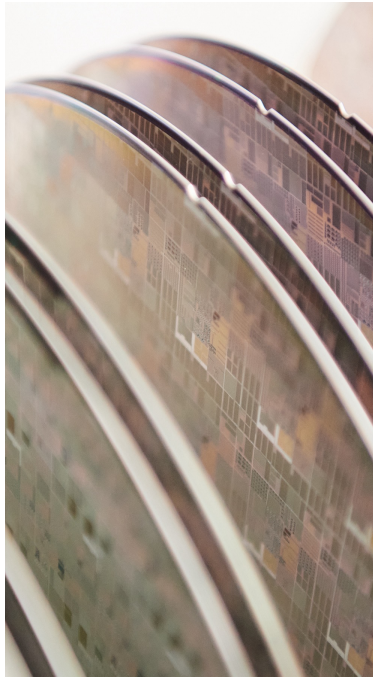
> Cryogenic
from -270°C (4 K)



BIOTECH

> Structures
for enhanced
pathogen analysis

Incize is active in the following industries...



SEMICONDUCTOR

> Characterization
> Modelling
> Simulations
> Fab Process

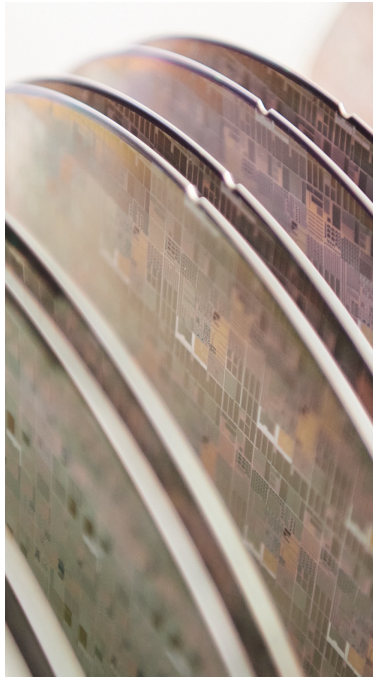
Materials

Silicon	Bulk, SOI, Trap-Rich, Porous, SiC, SiGe
III-V	GaN, GaAs, InP
Dielectric	Quartz, Fused Silica
Piezo	$LiTaO_3$, $LiNbO_3$, ZnO
2D	Graphene, hBN
Phase-changing	VO_2, GeTe
Metals	Al, Ag, Au, Ti, Ni, Cr, Pd
MEMS	

Samples

Silicon	Single die … 300 mm
Shape	Piece of wafer or whole wafer
Devices	Active & passive
	On-wafer & packaged
	Supported devices include BJTs, FETs, diodes, resistors and circuits (op-amps, comparators, etc.)

Incize is active in the following industries...



SEMICONDUCTOR

> Characterization
> Modelling
> Simulations
> Fab Process

Bulk Si

SOI

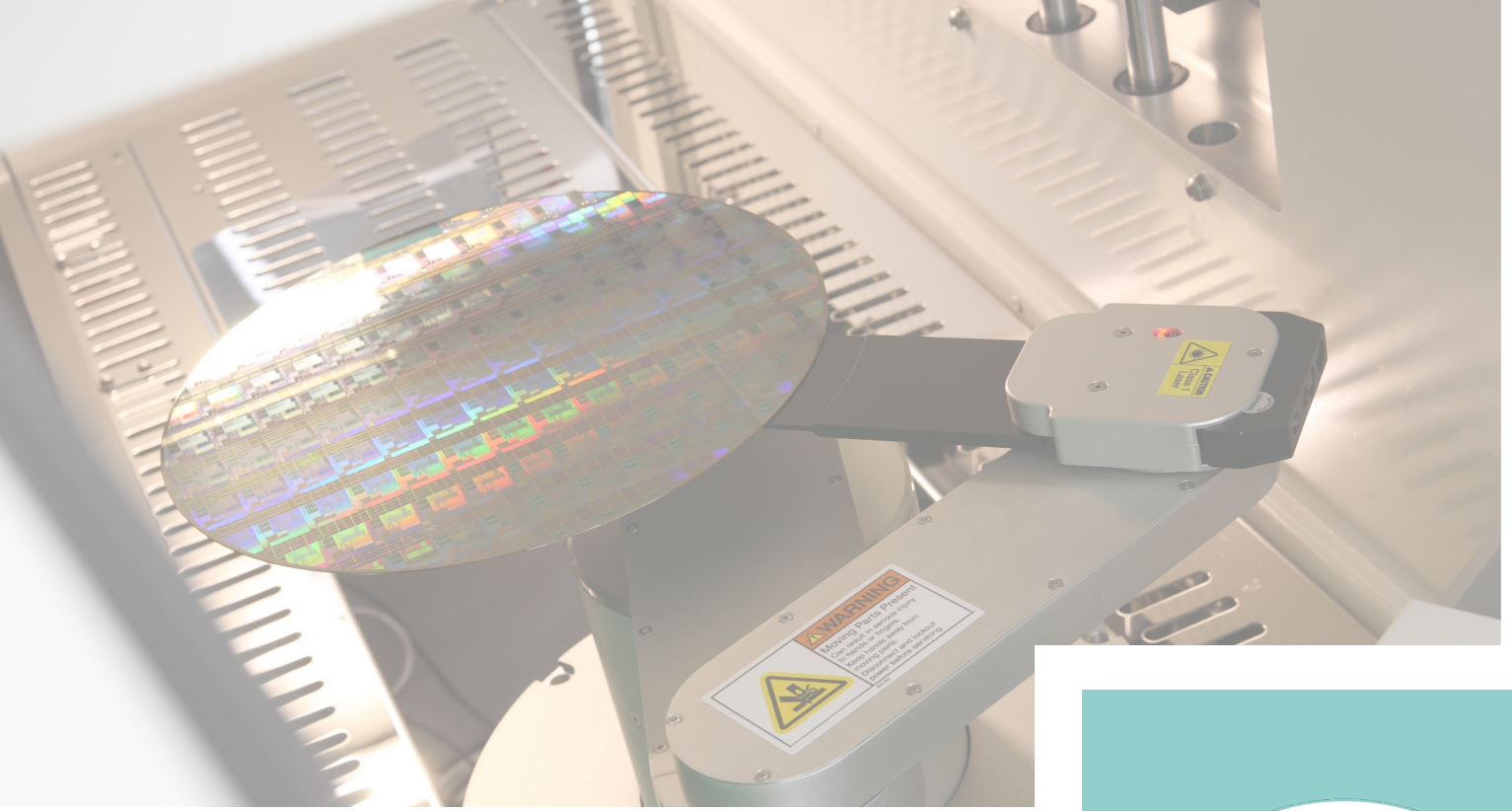
GaN-on-Si

Piezo and POI

For RF Applications

Technology Enablement and Optimization

- Simulation
- Mask design
- Process
- Radiation
- Characterization
- Modelling
- PDK



Cleanroom process

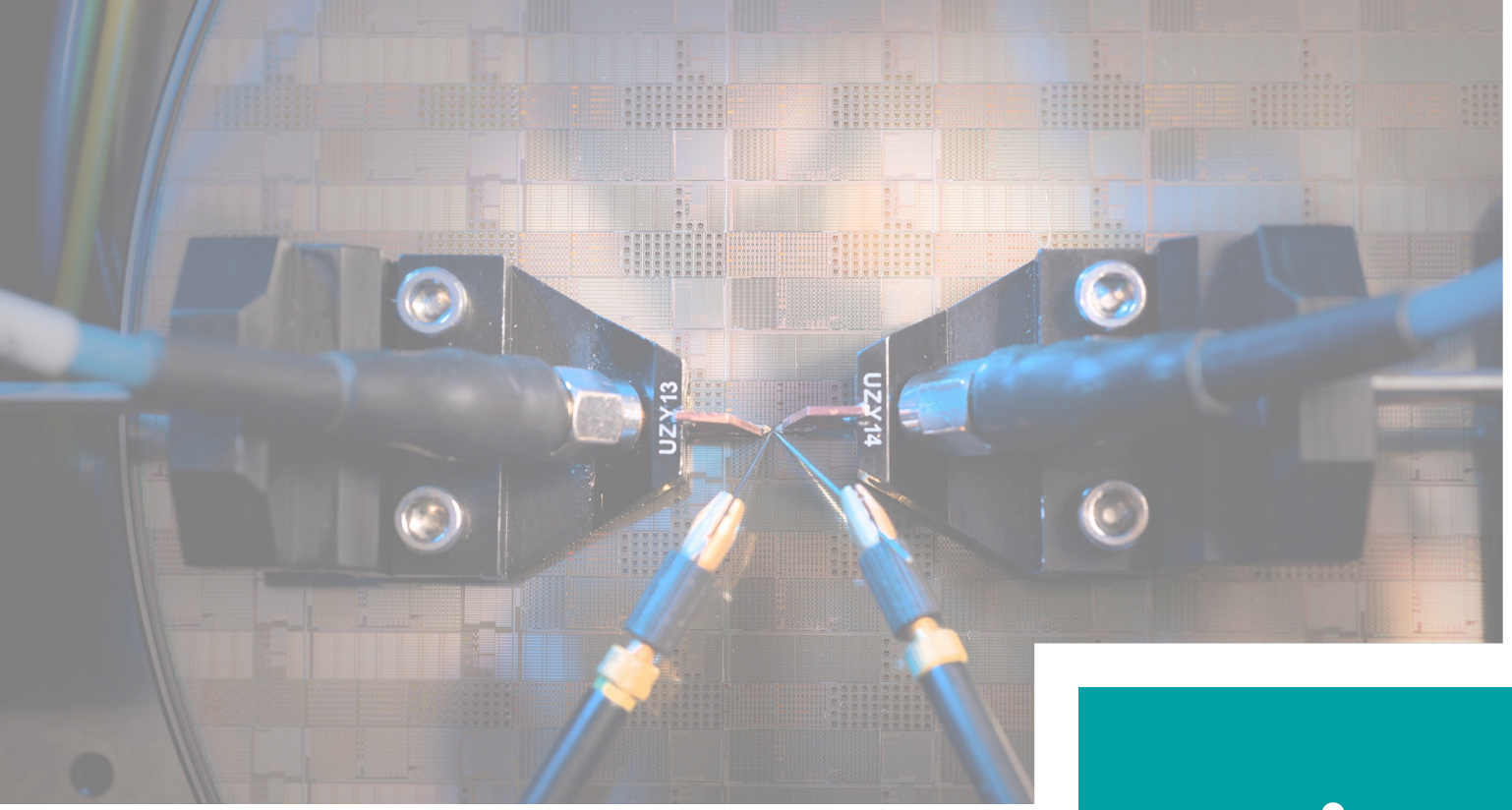
Microfabrication

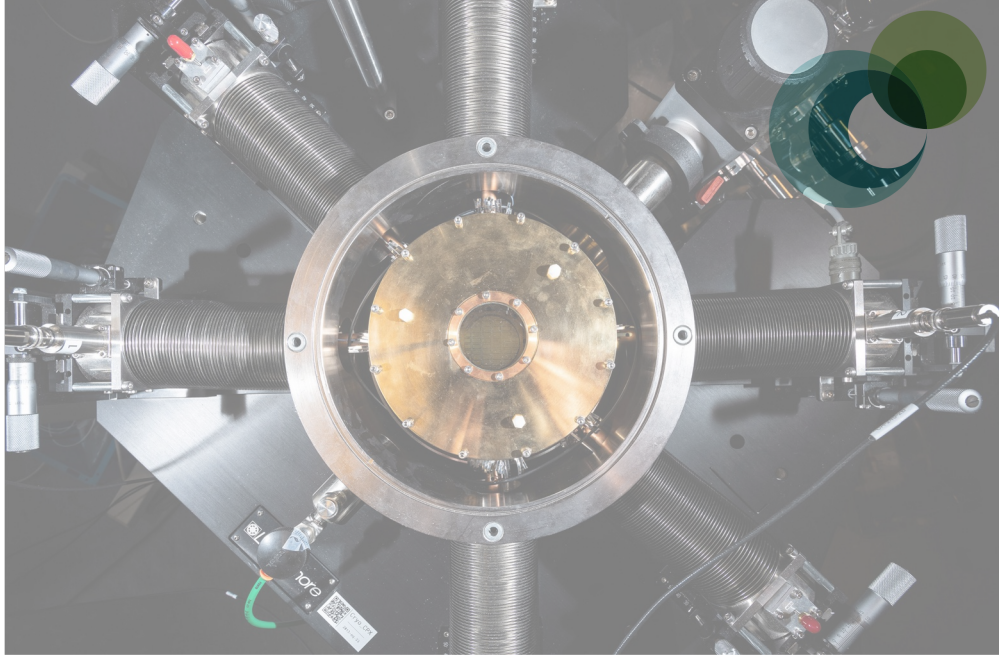
The microtechnology platform of UCLouvain

winfab

UCLouvain

Area	1000 m^2
Class	< 10 particles of100 nm/$feet^3$ of air
Equipment	50 state-of-the-art
Tools for	Surface-patterning, Thin films deposition and etching & Back-end processes
Activities	SOI-CMOS, Thin film characterization, co-integration, Photovoltaic, MEMS-NEMS, Sensors, Bio-technologies, Porous Si, Organic electronics & Nano-electronics





Electrical characterization

Testing Capabilities

Large & Small Signal

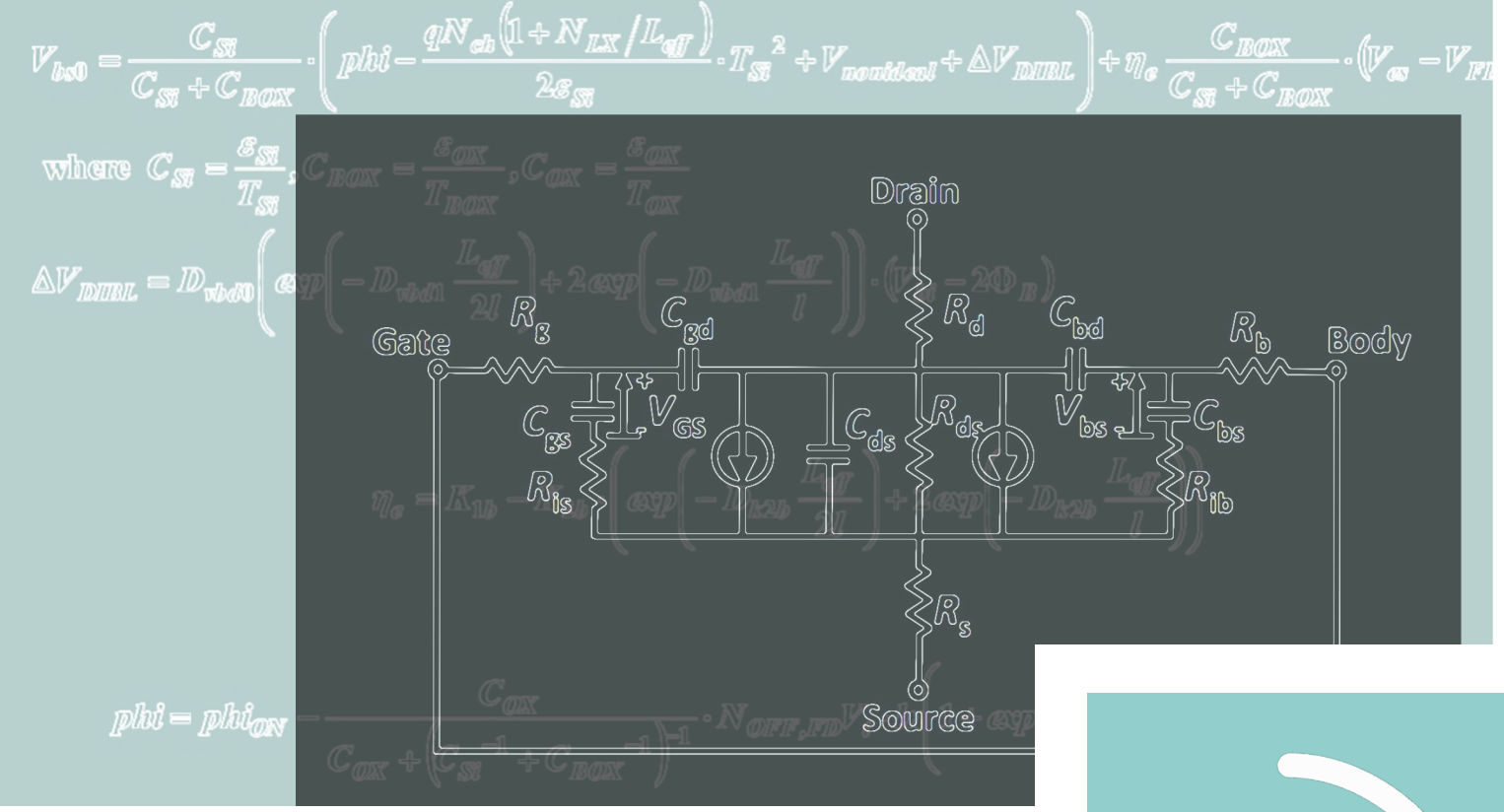
DC/CV/RF	Semi-automatic prober up to 300 mm wafer size
Pulsed IV	Down to 100 ns pulse width
Small Signal	• S-parameters up to 170 GHz • Low frequency from 5 Hz • RF figures of merit
Frequency	DC – 170 GHz
Large Signal	Harmonics (single tone), intermodulation (dual tone) and power handling
RF P_{in} with noise floor	-25 to 49 dBm -170 dBm
Load-pull	0.8 – 110 GHz
High voltage	On-wafer: up to 500 V Packaged: up to 1100 V
Temperature	• on-wafer: 4 to 600 K • packaged devices: -60 to 180 C

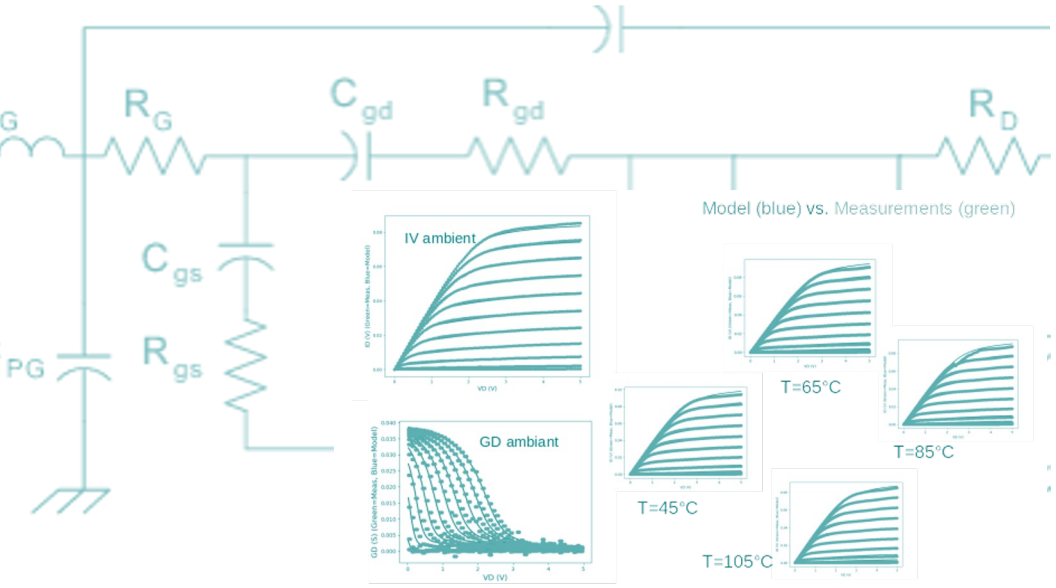
Noise

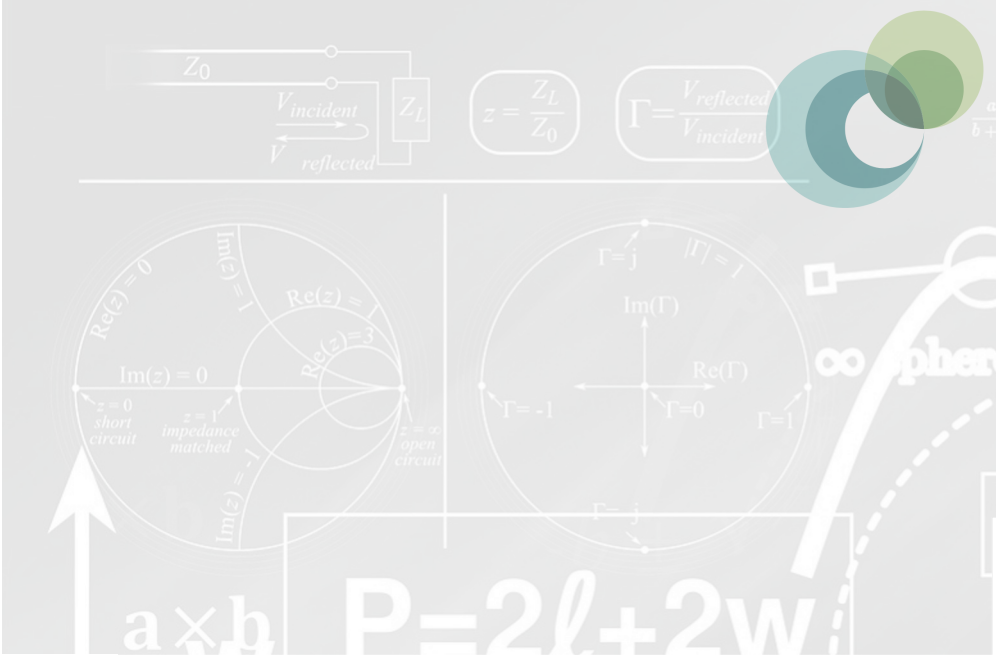
RF thermal noise	• 1 – 110 GHz • Down to 0.2 dB of NF_{min} • Programmable microwave tuners • Measurement of NF_{min}, R_n, Y_{opt} and NF50
1/f flicker noise	• Frequency range 0.03 – 40 MHz • Noise measurement down to 0.67 nV/sqr(Hz) @ 10 kHz • 25 impedance values ranging 0 – 100 MΩ • Current/voltage/power range up to 0.1 A/200 V/10 W, respectively
Random telegraph signal noise (RTS, RTN)	• Time domain representation • Current & voltage histograms • 2.5 ns minimum time step • Sampling size up to 16 million

Raman

- four laser wavelengths: 458, 488, 514 and 633 nm
- motorized x-y-z stage for 2D and 3D micro-Raman imaging
- Raman-thermal analysis: -196 to 600 C

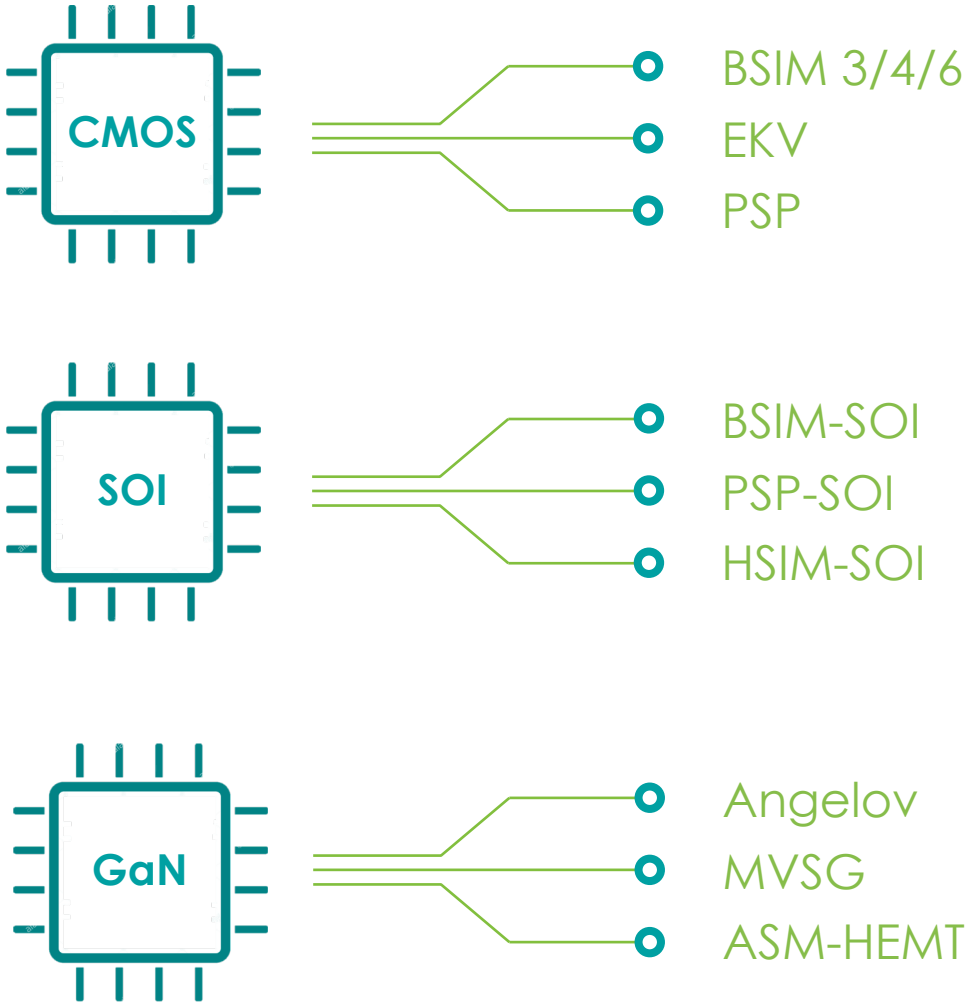

Drain
Gate
Body
Source
R_g
C_{gd}
R_d
C_{bd}
R_b
C_{gs}
V_{GS}
C_{ds}
R_{ds}
V_{bs}
C_{bs}
R_{is}
R_{ib}
R_s


R_G
C_{gd}
R_{gd}
R_D
C_{gs}
R_{gs}
PG
Model (blue) vs. Measurements (green)
IV ambient
GD ambiant
T=65°C
T=85°C
T=45°C
T=105°C


Z_0
$V_{incident}$
$V_{reflected}$
Z_L
$z = \frac{Z_L}{Z_0}$
$\Gamma = \frac{V_{reflected}}{V_{incident}}$
Re(z) = 0
Im(z) = 1
Re(z) = 1
Re(z) = 3
Im(z) = 0
short circuit
impedance matched
open circuit
Im(Γ)
Re(Γ)
Γ=-1
Γ=0
Γ=1
Γ=j
Γ=-j
a×b
P=2l+2W

Modeling

Modeling services



We support all EDA tools

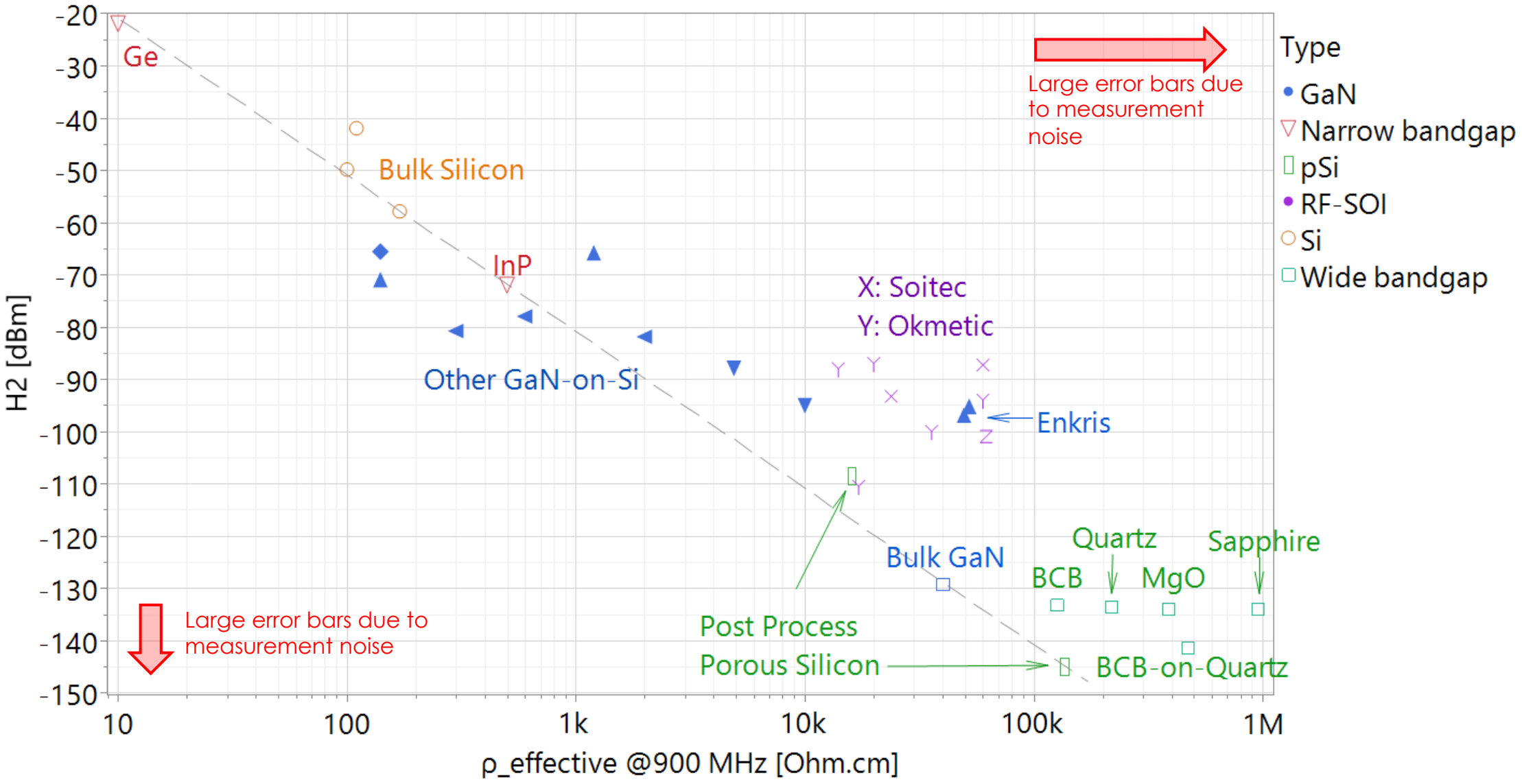
Service includes
> Model validation
> Design of test structures

Models include
> DC, AC, RF
> Flicker noise, thermal noise
> Corners
> Substrate
> Linear and nonlinear

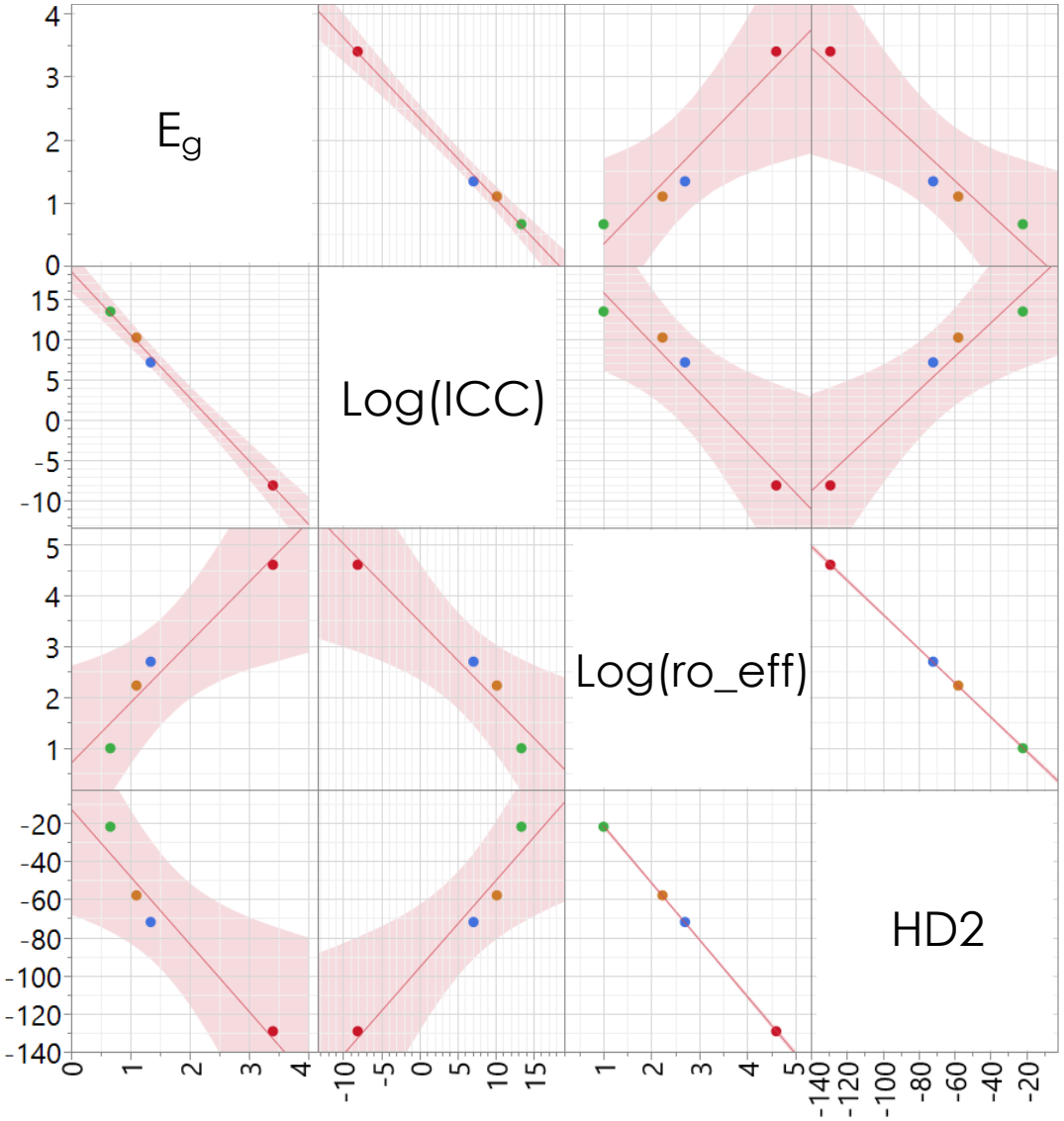
We use our own tools for model extraction

RF Substrates
Benchmarking

Benchmark


Ge
Bulk Silicon
InP
Other GaN-on-Si
X: Soitec
Y: Okmetic
Enkris
Bulk GaN
Post Process
Porous Silicon
Quartz
Sapphire
BCB
MgO
BCB-on-Quartz
Large error bars due to measurement noise
Large error bars due to measurement noise
Type
GaN
Narrow bandgap
pSi
RF-SOI
Si
Wide bandgap
H2 [dBm]
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
10
100
1k
10k
100k
1M
ρ_effective @900 MHz [Ohm.cm]

Correlations for bulk materials



Bulk Materials

- Ge
- Si
- InP
- GaN

Parameters

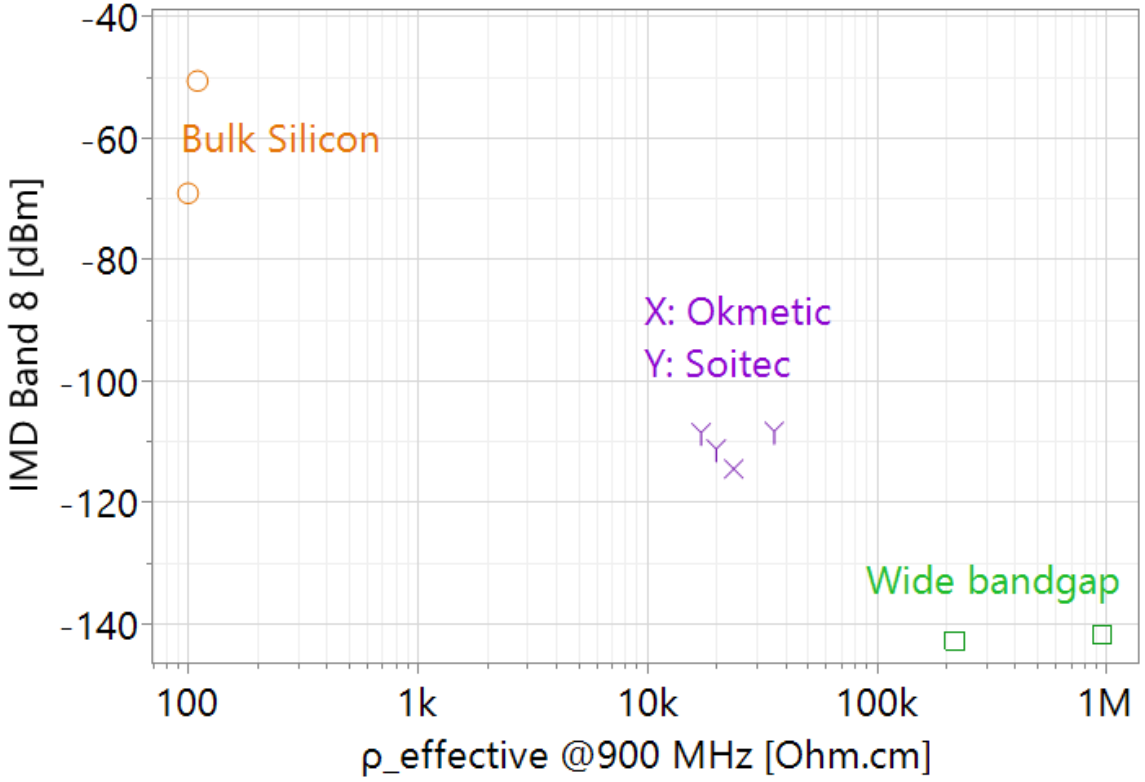
- Bandgap energy
- HD2
- effective resistivity (log)
- intrinsic carrier concentration (log)

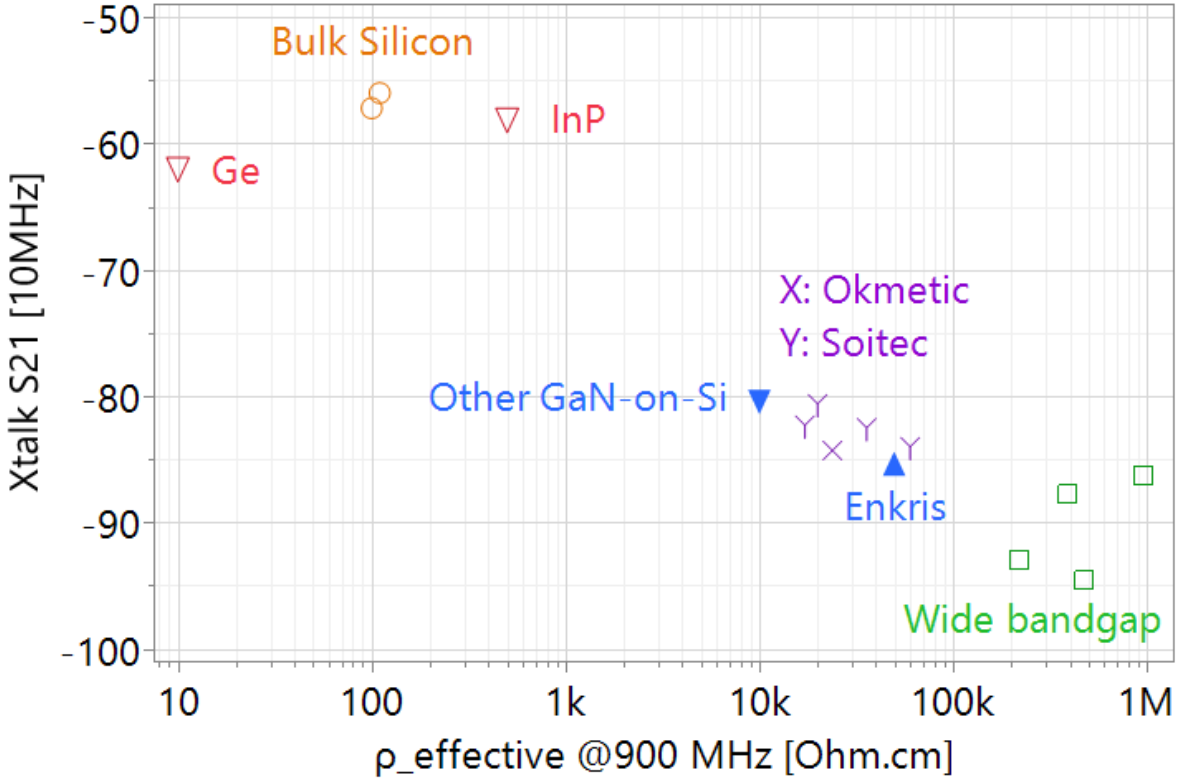
Strong correlations exist between

- bandgap energy and log(intrinsic carrier conc.)
- log(effective resistivity) and HD2

For HR substrates: effective resistivity is limited by ICC

Investigation of other RF characteristics (work in progress)





- Cross-talk (S21 at 10MHz)
- Intermodulation in band 8

→ IMD and Xtalk show similar trends as HD2

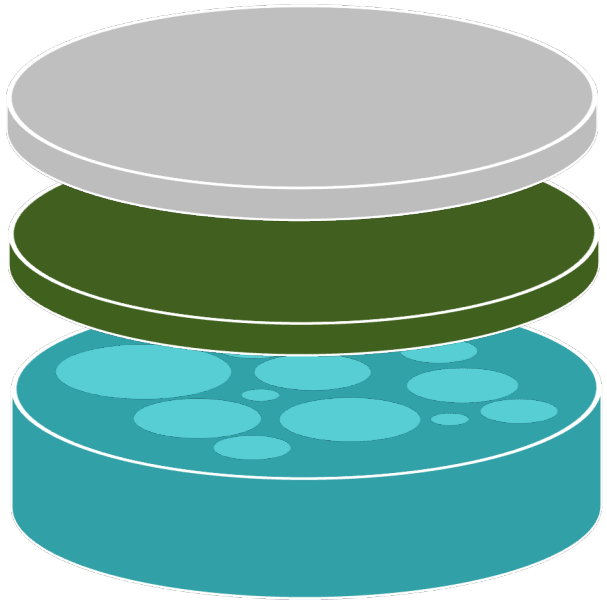
What is NEXT?

Disrupt **THE RF MARKET**

Once

and forever

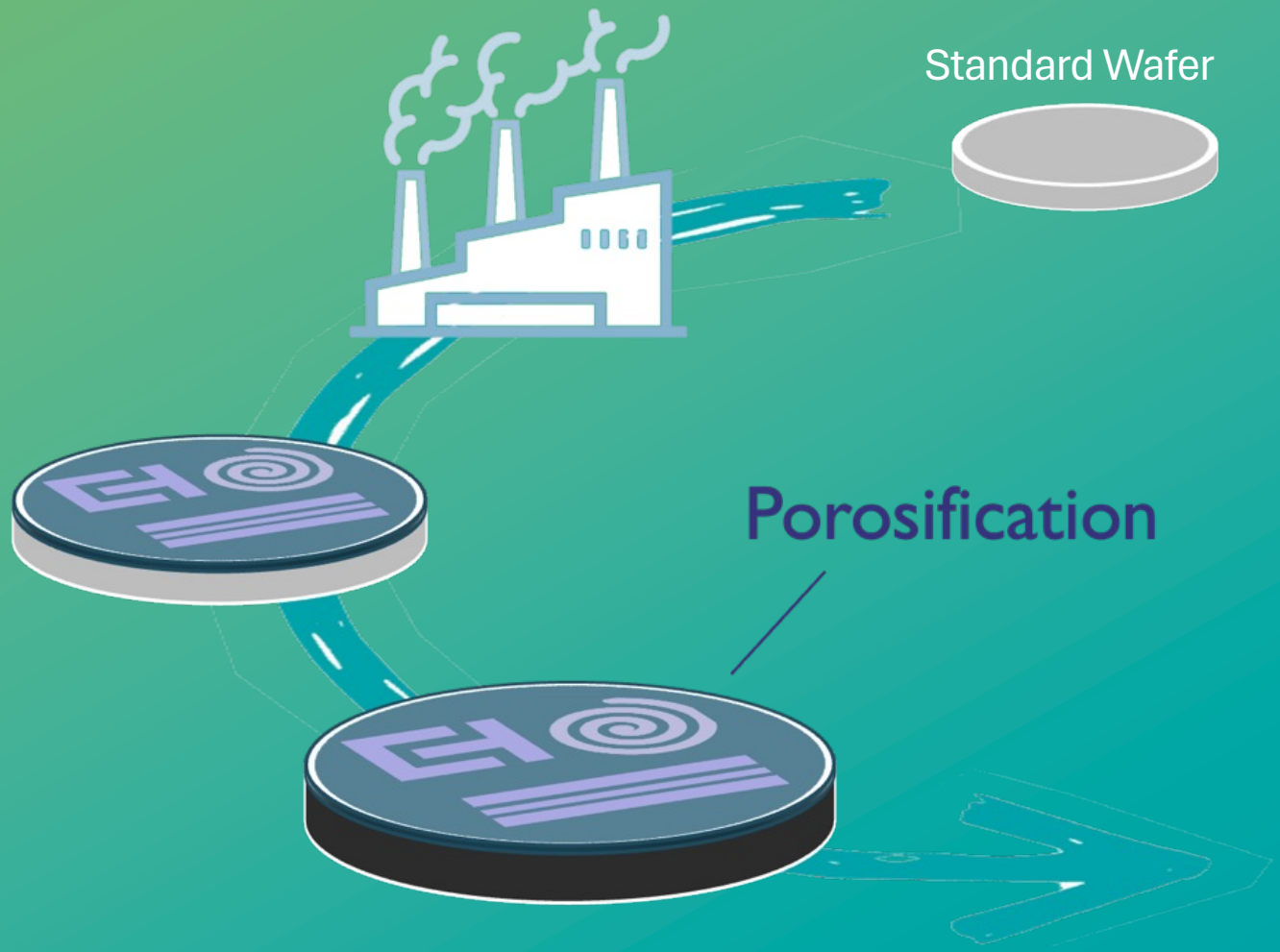
Anything-on-Porous Silicon



- *Top-layer: Si, GaN, piezo…*
- *Intermediate layer*
- ***Porous silicon***

Post Process

Porosification



Questions

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