Semilab Semiconductor
Physics Laboratory Co. Ltd.

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Powerful metrology use cases - Addressing compound material industry needs

Gábor Szendrei – Application Project Manager

4/20/2023

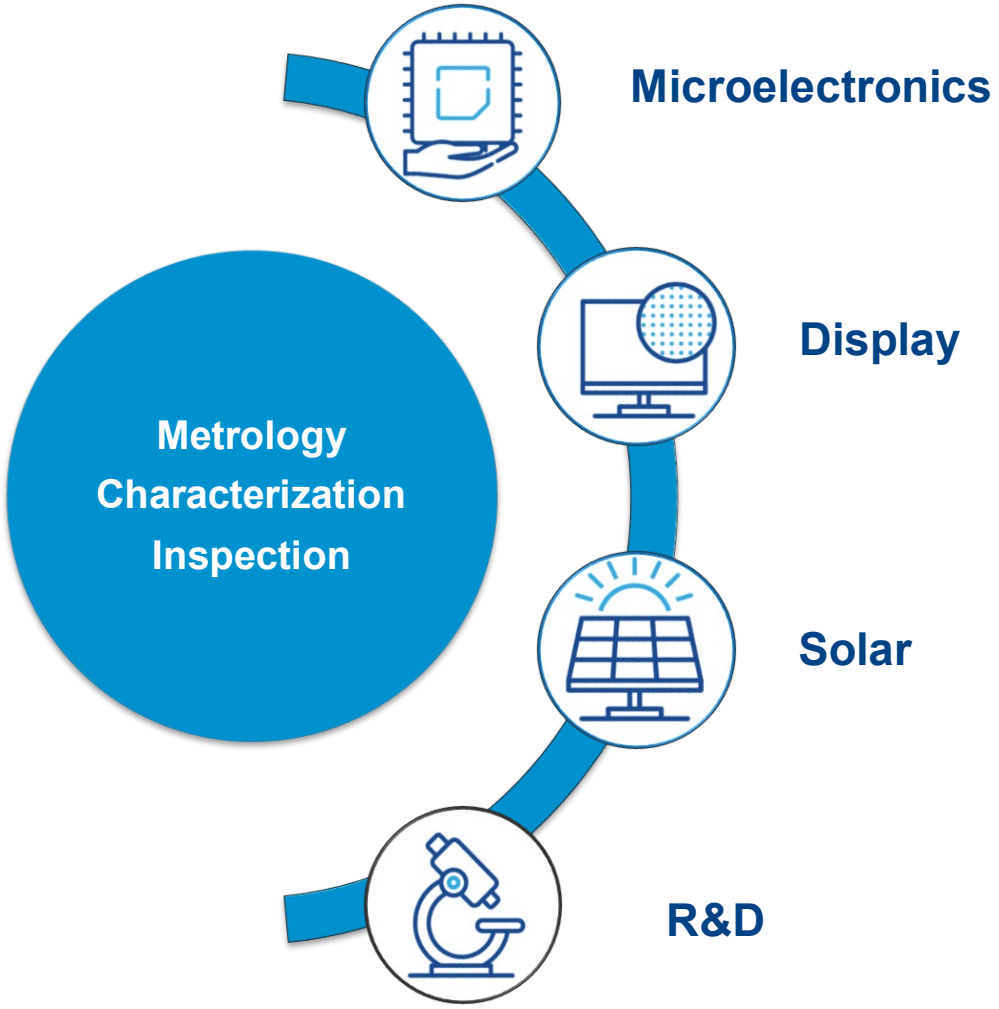
Outline

Semilab at glance

Use-cases on SiC & GaN structures

Summary & acknowledgements

About the Semilab group



No. of employees
1300+

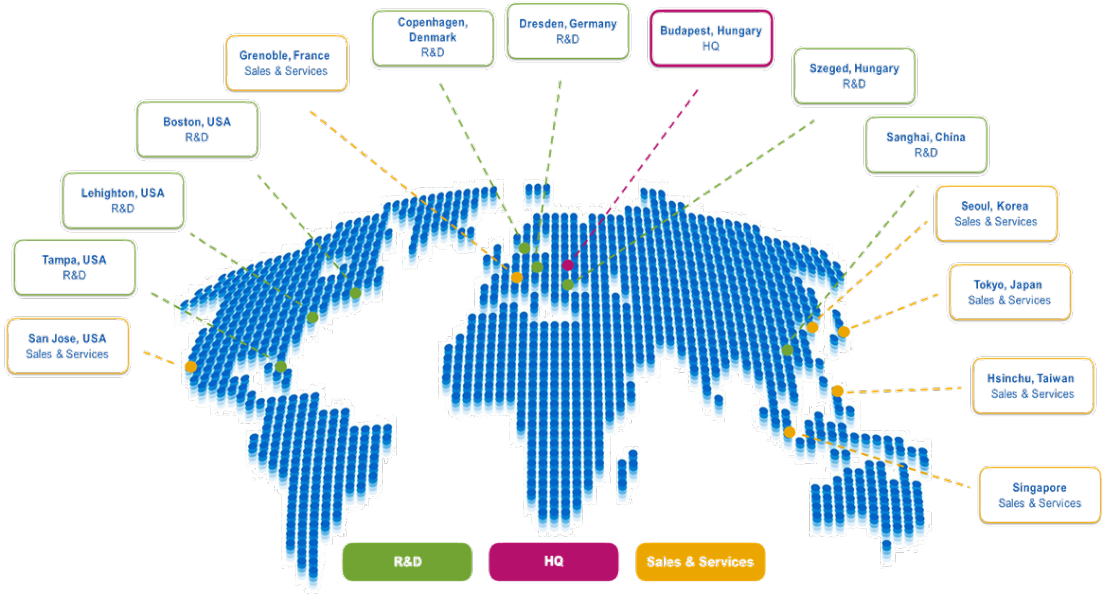
Technologists & engineers
650+

Patents
200+

10 countries

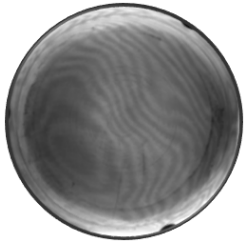
15 sites

Since
1989

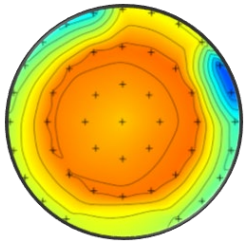


SiC & GaN in scope - Schematic structures

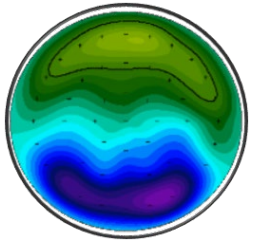
Manufacturing of compound semiconductor power devices require tight proccess control both at wafer & device level



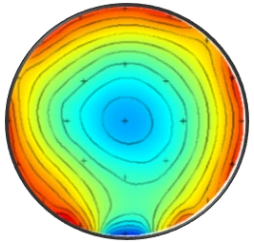
Stress field



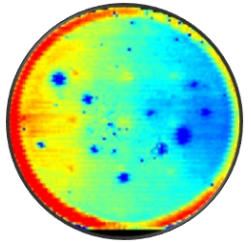
EPI thickness



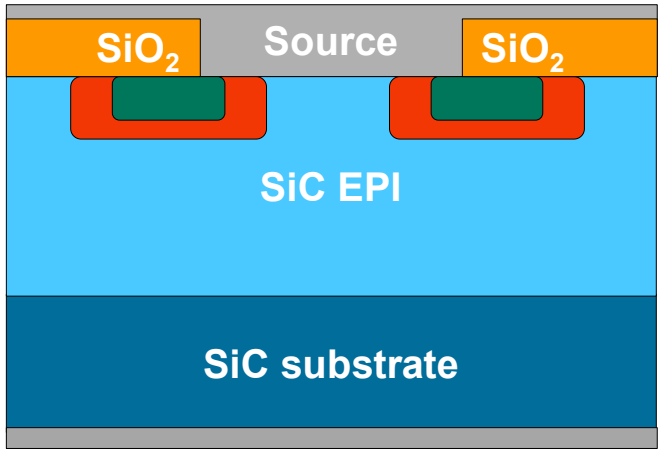
Surface voltage



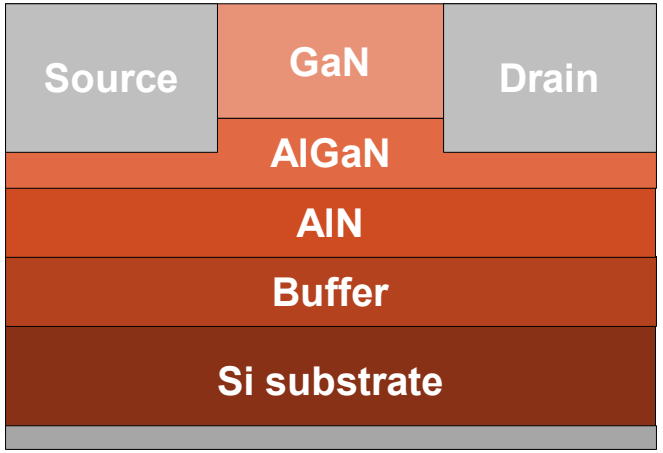
Thin film thickness



Defect & Al% monitoring



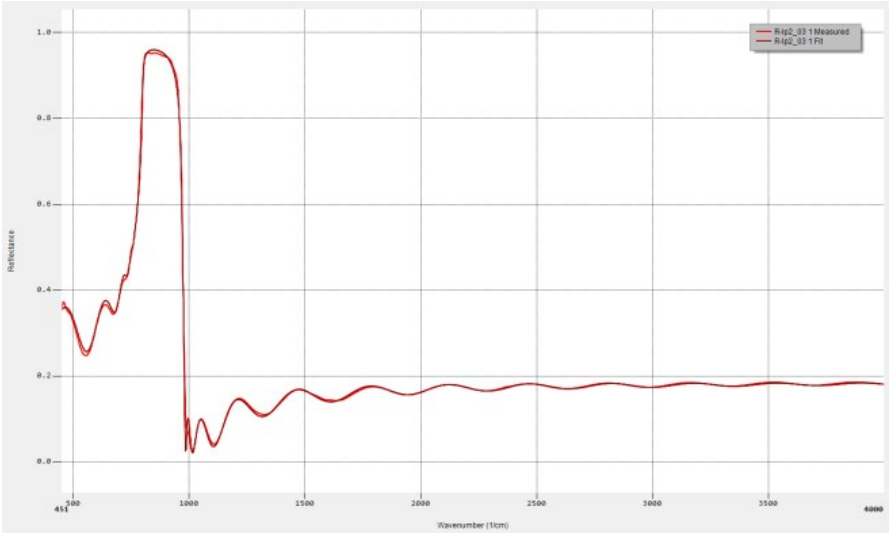
SiC MOSFET



d-GaN HEMT

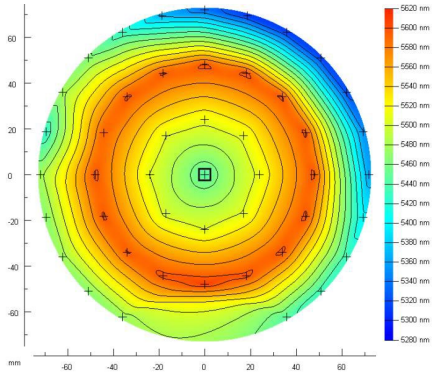
EPI thickness measurement

Reflectance spectra

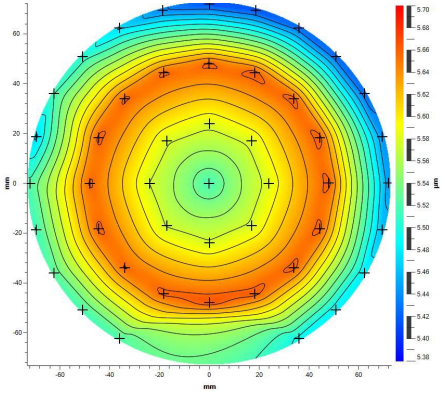


SiC EPI thickness maps

Optical modelling



FFT analysis



R^2 = **0.99999** for the two analyses

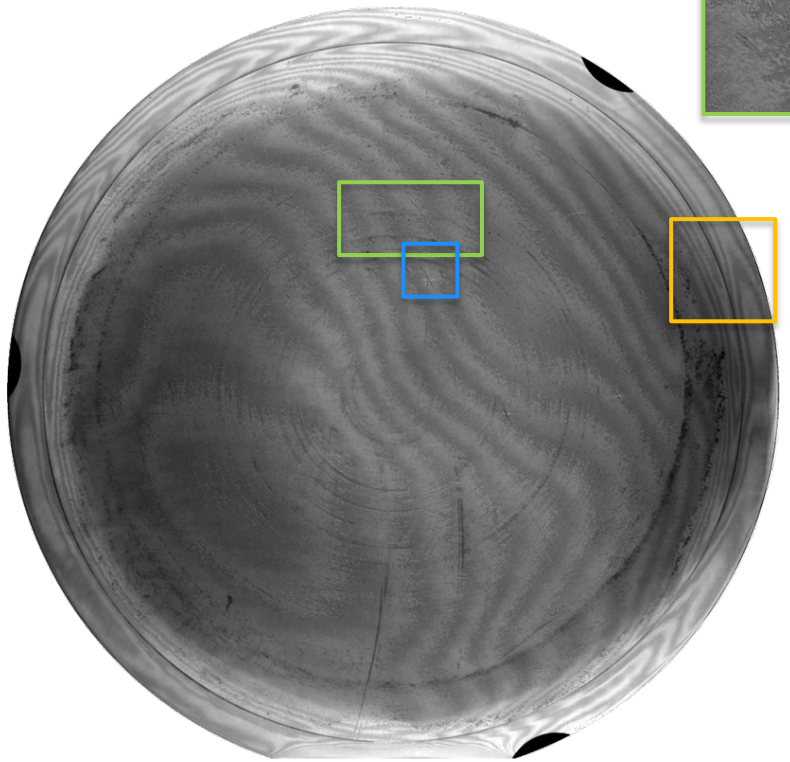
EIR-2201

Optical modelling and **FFT analysis** show well matching results for EPI layer thickness

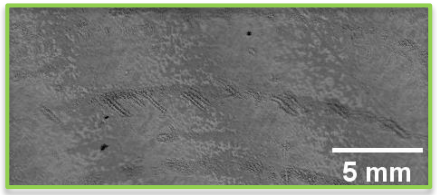
Stress field imaging

SiC EPI

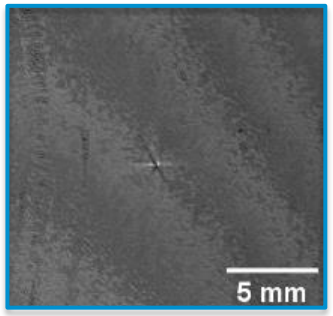
SiC substrate



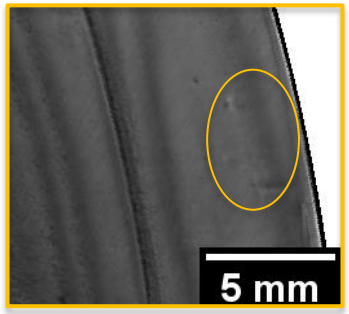
Surface contamination, scratches



Point defects

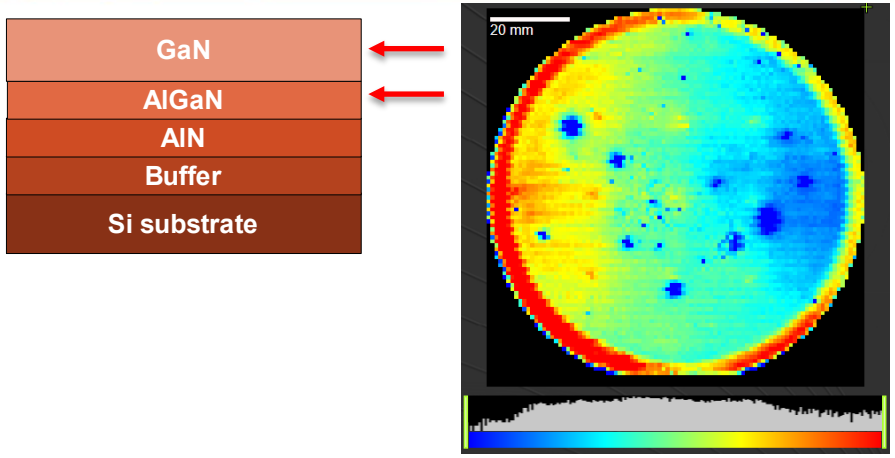


Stress field from unclear origin

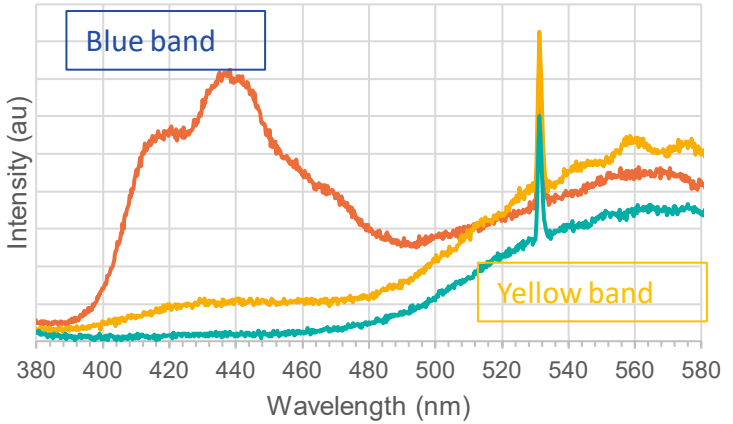


PSI-2200

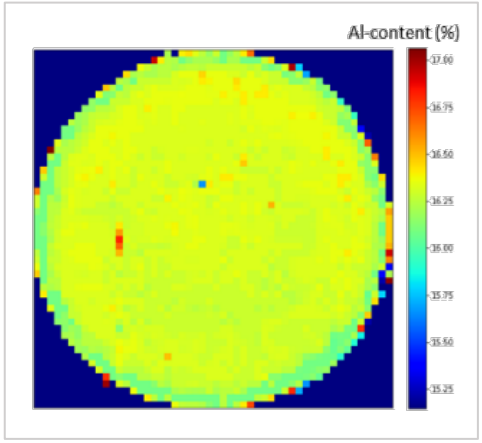
Defect finding algorithm reveals **defects**, **scratches** and **contamination**, while interference patterns indicate **surface inhomogenity**



Full wafer B2B transition intensity map of GaN cap



Characteristic PL spectra of GaN (defect related wavelength region)

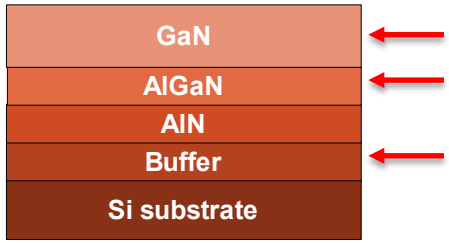


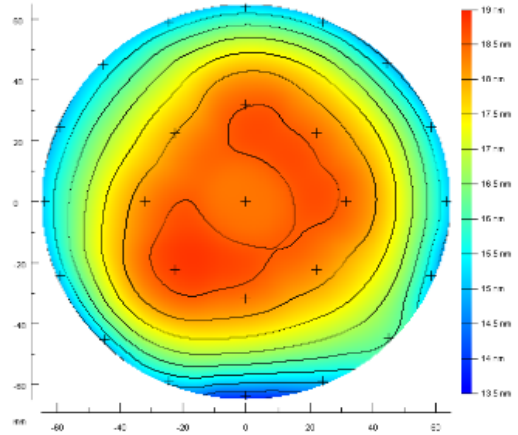
Al% content map of AlGaN layer (B2B peak position)

SPL-2200

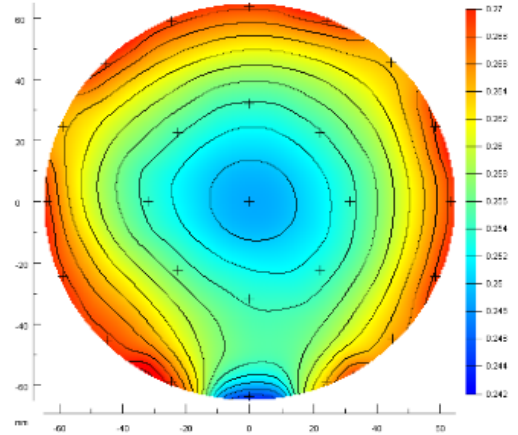
Defects, **impurities** & **vacancies** as well as **Al%** of AlGaN layer can be monitored on **300 mm GaN-on-Si wafers** by **SPL**

Thin film thickness measurement

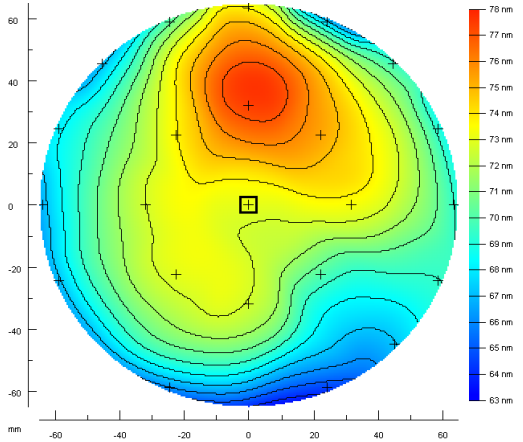




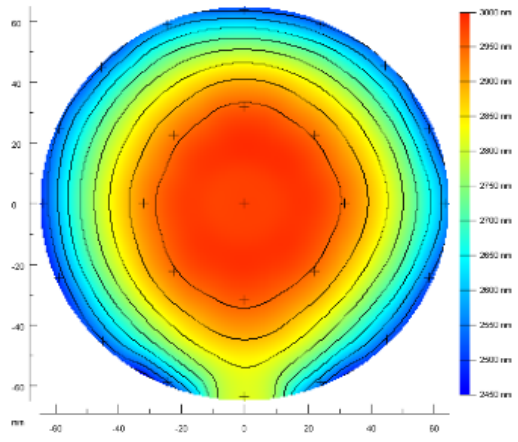
AlGaN thickness map



Al% content map



GaN-cap thickness map

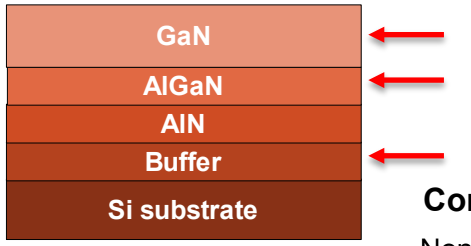


GaN thickness map

uSE-2500

uSE-2500 can monitor film **thickness homogeneity**, **Al%** of AlGaN and **bow/warp** of the entire structure

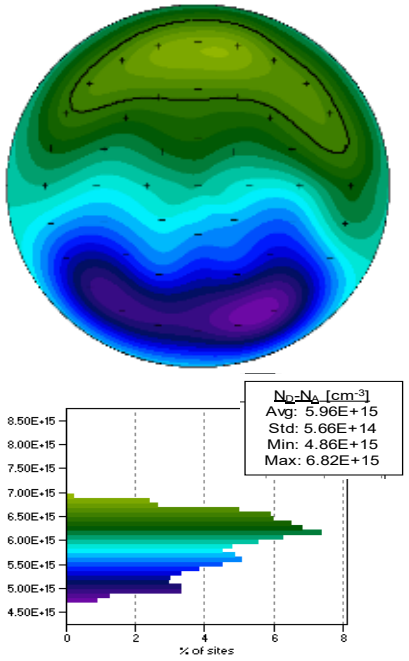
Corona non-contact CV measurement



Corona-Kelvin maps for dopant concentration

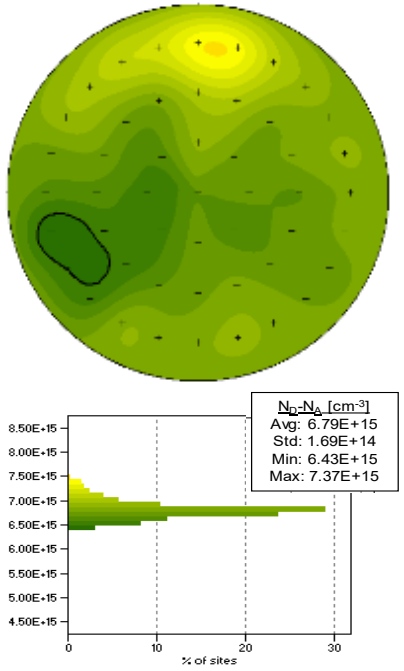
Non-uniform GaN

%Uniformity = 9.5%



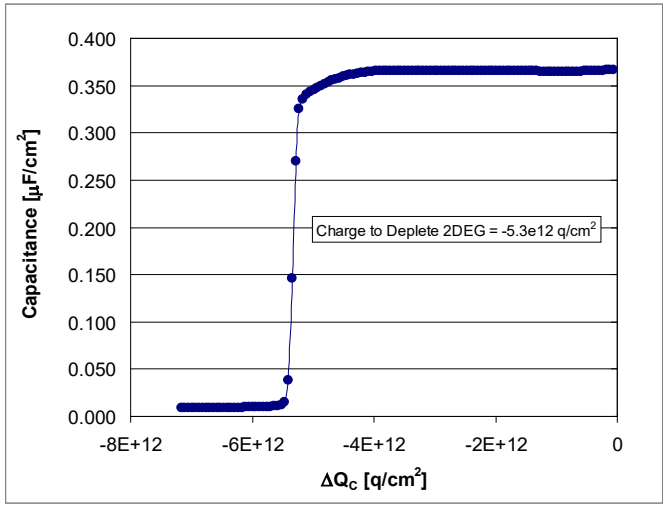
Improved Uniformity GaN

%Uniformity = 2.5%



Marshall Wilson *et al* 2017 *ECS J. Solid State Sci. Technol.* **6** S3129

Characterization of 2DEG sheet charge & pinch-off voltage



CnCV-230

CnCV provides information about **net dopant concentration, pinch-off voltage** and **2DEG sheet charge** as well

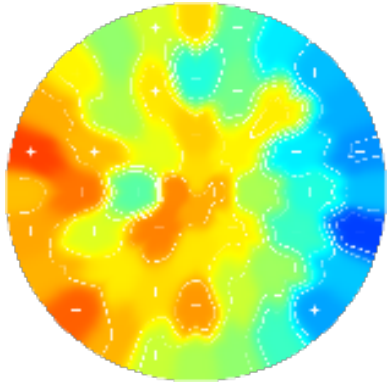
Use-case overview

Systems	Application (Both/SiC/GaN)	Technique	Material
EIR	EPI Thickness	IR Reflectometry	SiC
SPL	Composition / Defect monitoring / Thickness homogeneity	Photoluminescence defect monitoring	SiC, GaN
PSI	Stress induced defect monitoring	Stress field imaging	SiC, GaN
CnCV	Dopant depth profile / Dielectric characterization/ Defect mapping / Residual charge / Characterization of 2DEG in HEMT structures	Corona CV	SiC, GaN
uSE	Film thickness / Al content / Bow monitoring	Microspot Spectroscopic Ellipsometry	GaN

PMR-C for Compound based implant monitoring

The PMR-C uses the same metrology and platform as the PMR-S, but thanks to the optimalized metrology design, the device is now also suitable for monitoring (pre-annealed) SiC based implants.

Pre-Anneal Ion Implant monitoring



PMRC key facts

- **In-Line** measurement system
- **Pattern recognition**
- Monitoring of **product SiC** wafers

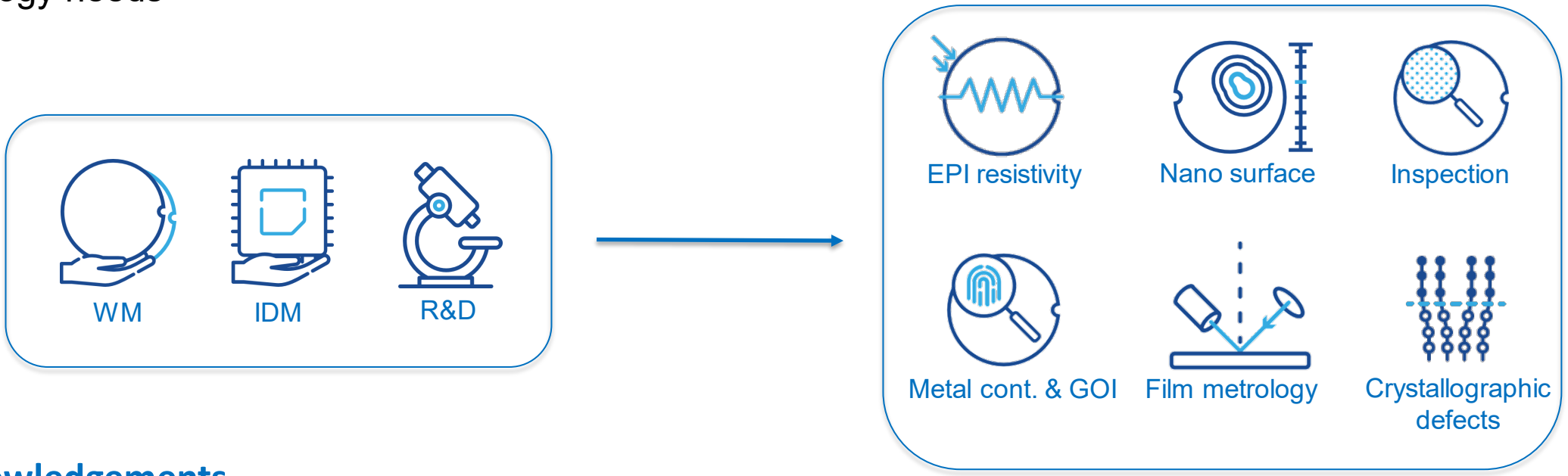
PMR key applications

- Dose monitoring
- Tilt angle
- Temperature

PMR-2200C

Wide portfolio of metrology solutions for compound semiconductors

Semilab continues product development in cooperation with **industrial** & **scientific key players** to address CS metrology needs



Acknowledgements

We would like to thank **Fraunhofer IISB** for their cooperation and provision of test SiC wafers for the comprehensive measurements.

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Thank you for your attention!

Power

Optoelectronics

RF