
# Emerging Growth Opportunities for MBE in GaN

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CS INTERNATIONAL CONFERENCE
ANGELTECH

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RIBER

# III-N Applications & Market

RIBER 60 YEARS OF PERFORMANCE

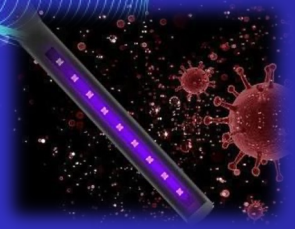
## Power & RF applications







## Optoelectronic applications / UVC-hygiene, AR/VR, wearables, displays



**RIBER** addresses the **unique features required for MBE of GaN** through a **nitride specific product range** of MBE systems and components. **Customer's data in some emerging markets that could feature MBE** are shown and we look ahead **towards new concepts**.

# RIBER : a brief history

RIBER 60 YEARS OF PERFORMANCE

**Molecular Beam Epitaxy solutions**

**More than 920 Riber/VG MBE SYSTEMS**

**MBE Cells**

**More than 12000 effusion sources**

MBE experts

Paris, France

Since 1964

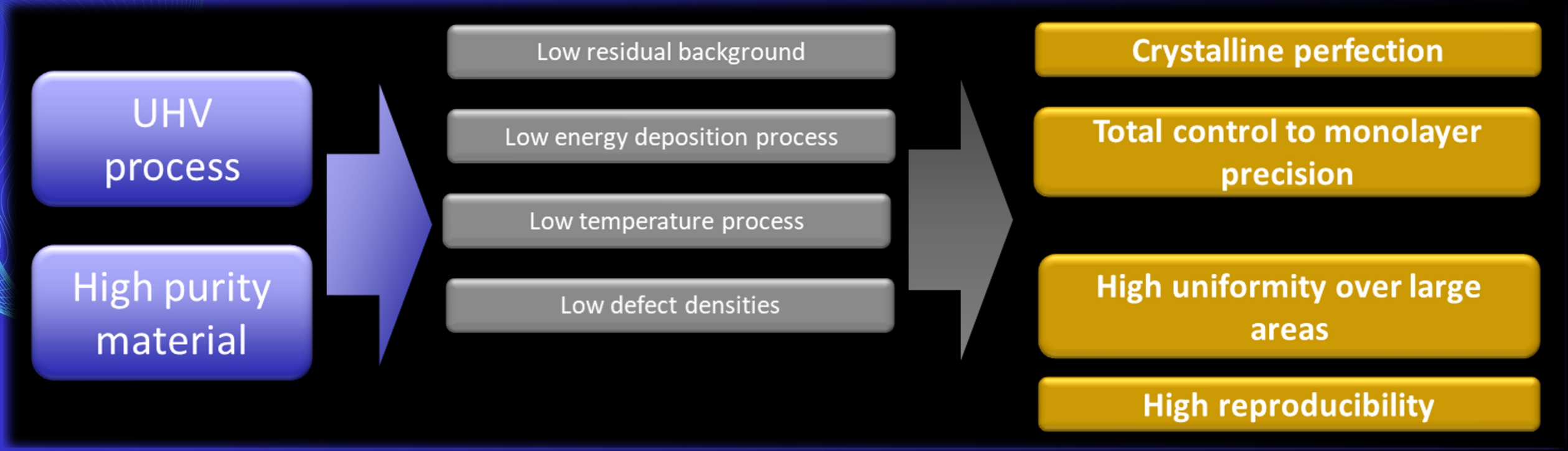
1978 : 1st commercial MBE system

120 employees

afaq ISO 9001 Qualité

ISO 9001

# Riber and Nitrides – Why MBE ?




**low growth temperature**:

→ Impact on epilayer quality & device performance

**Highly doped n-type GaN:Si possible**

**High Al content readily achieved**

**Precise Tunnel Junction doping**

# Riber and Nitrides – the story so far

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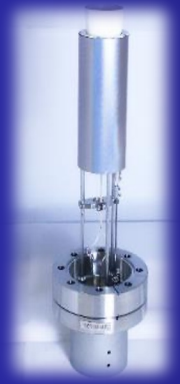
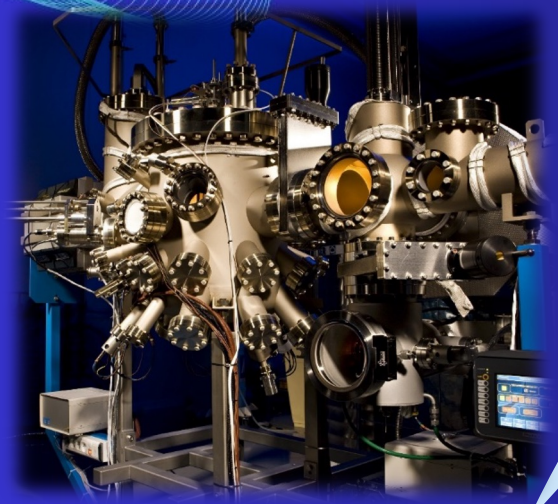
Ammonia injector



Aluminum effusion cell

Nitrogen RF plasma cell

Magnesium valved cracker cell- VCOR



1997
First Ammonia-GaN dedicated system

Aluminum dedicated effusion cell

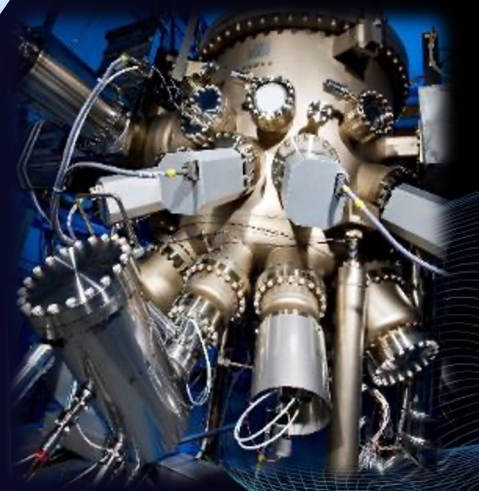
RF plasma source

Mg Valved source

Multi 4'' NH3 production system

High capacity effusion cell

**2020**
**Multi 4''/ Single 8''**
**NH3 + PAMBE production system**



4x4'' MBE 49

CRHEA GaNeX NANOGANUV UCSB easygan the shortcut to GaN-on-Si technology

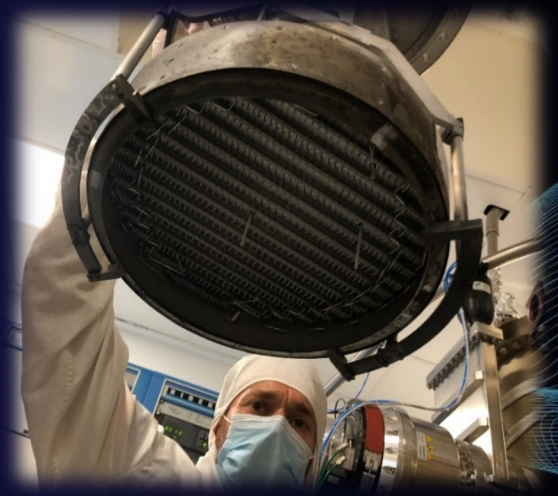
# Nitride specific MBE reactors – R&D to Production

RIBER 60 YEARS OF PERFORMANCE

## Fully automated GaN system RIBER MBE 49

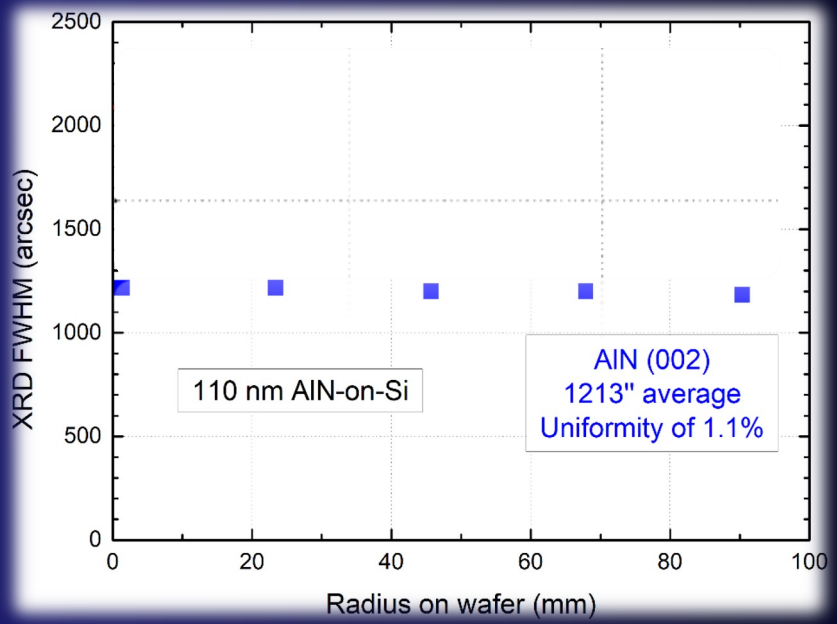
**Process transfer to 200 mm (Si)**

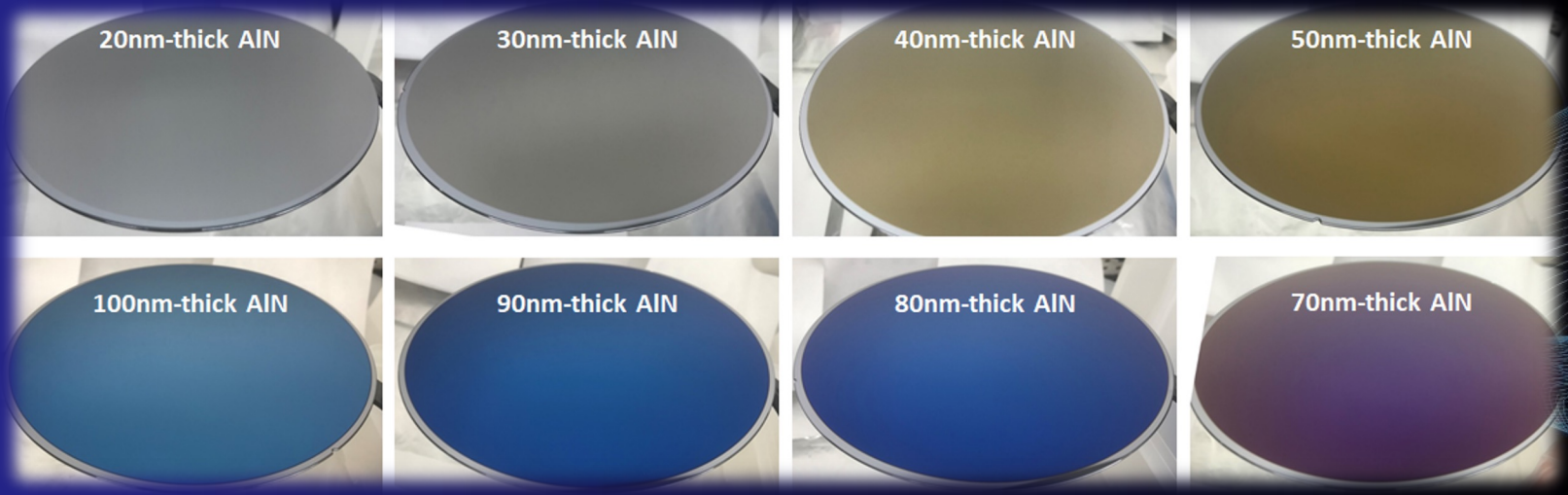
- 0.2 to 2000 sccm $NH_3$ injection
- Automated $NH_3$ regeneration
- 15 platen capacity / 1x 200 mm / 3x 100 mm / 5x 75 mm
- 10 cell ports : Ga, Al, In, Si, Mg, N*, NH3
- RHEED, wafer curvature (RIBER EZ-Curve)

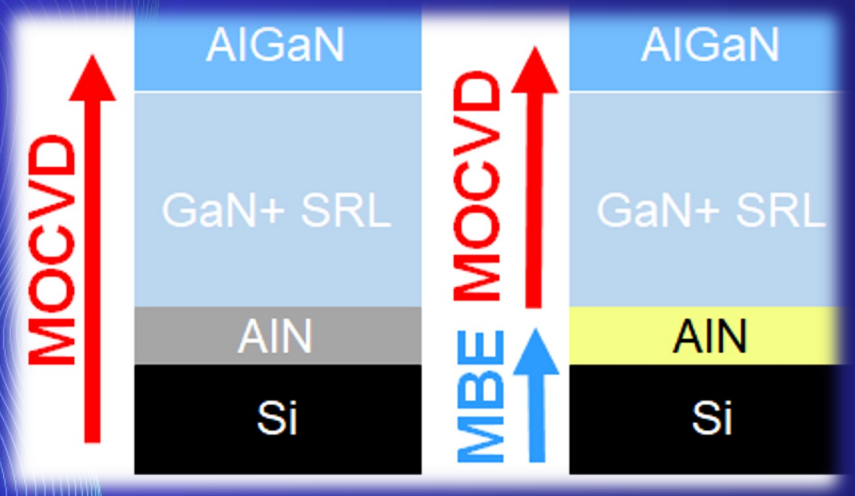
# Emerging markets – AlN-on-Si 200 mm templates

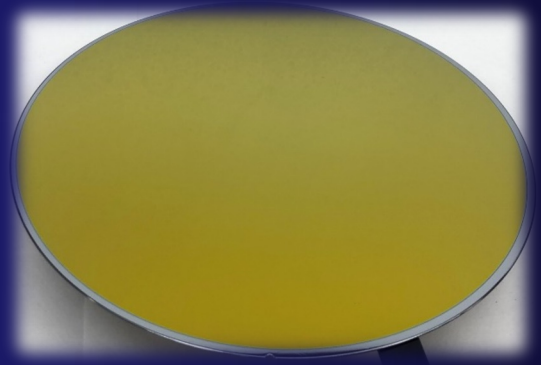
- Temperature uniformity: 3 °C
- **No slip lines**
- State-of-the-art crystal quality
- Real-time curvature monitoring (RIBER EZ-Curve)
- **High reproducibility**



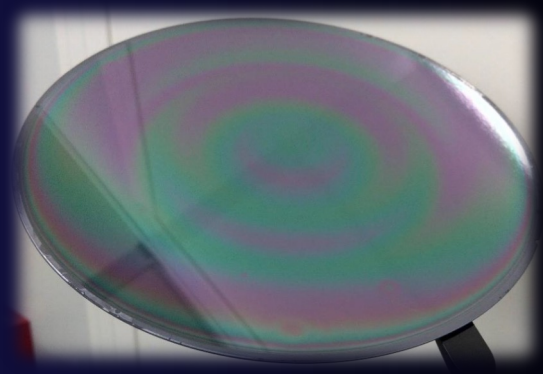



# Emerging markets – AlN-on-Si 200 mm templates



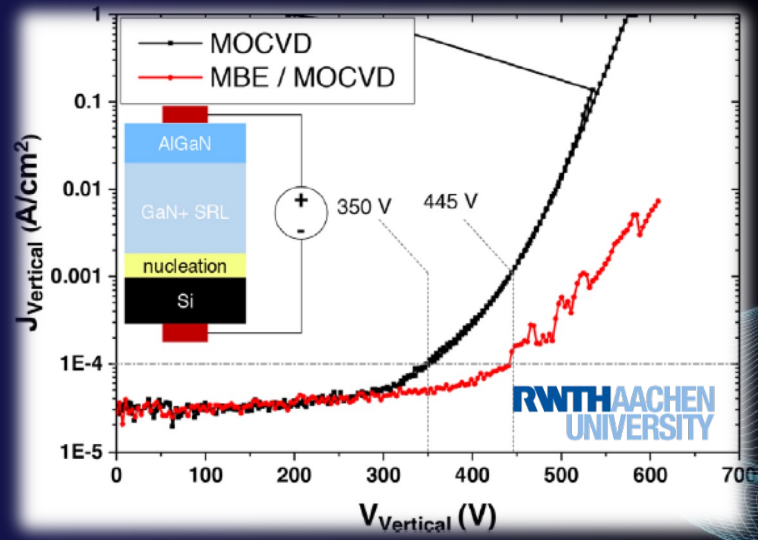



AlN-on-Si 8" Template



Hybrid GaN-on-Si 8"

- **MOCVD re-growth validated** (Aixtron and Veeco) – no impact from MBE template air exposure or substrate holder exclusion zone
- **Reduced Substrate Bow due to thin AlN MBE template layers**
- **Gain in device blocking capability - Sharp, clean AlN/Si interface, suppresses parasitics**

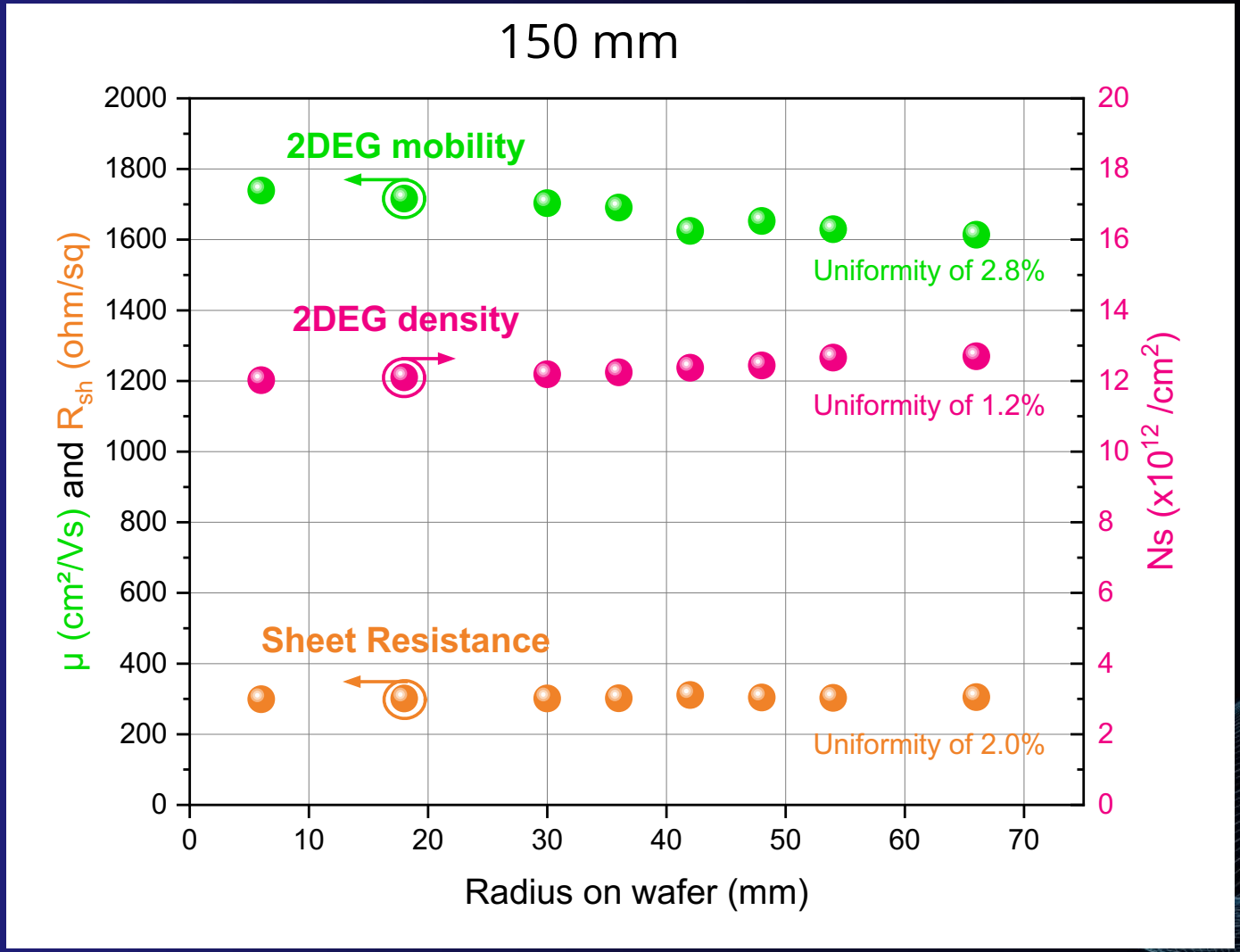



*H. Yacoub et al., Phys. Status Solidi (2018)*

# Beyond templates – MBE HEMT

RF applications

Simplified structure
< 800 nm total thickness


**Excellent 2 DEG uniformity**

# UVC Light Source Market set for Rapid Growth

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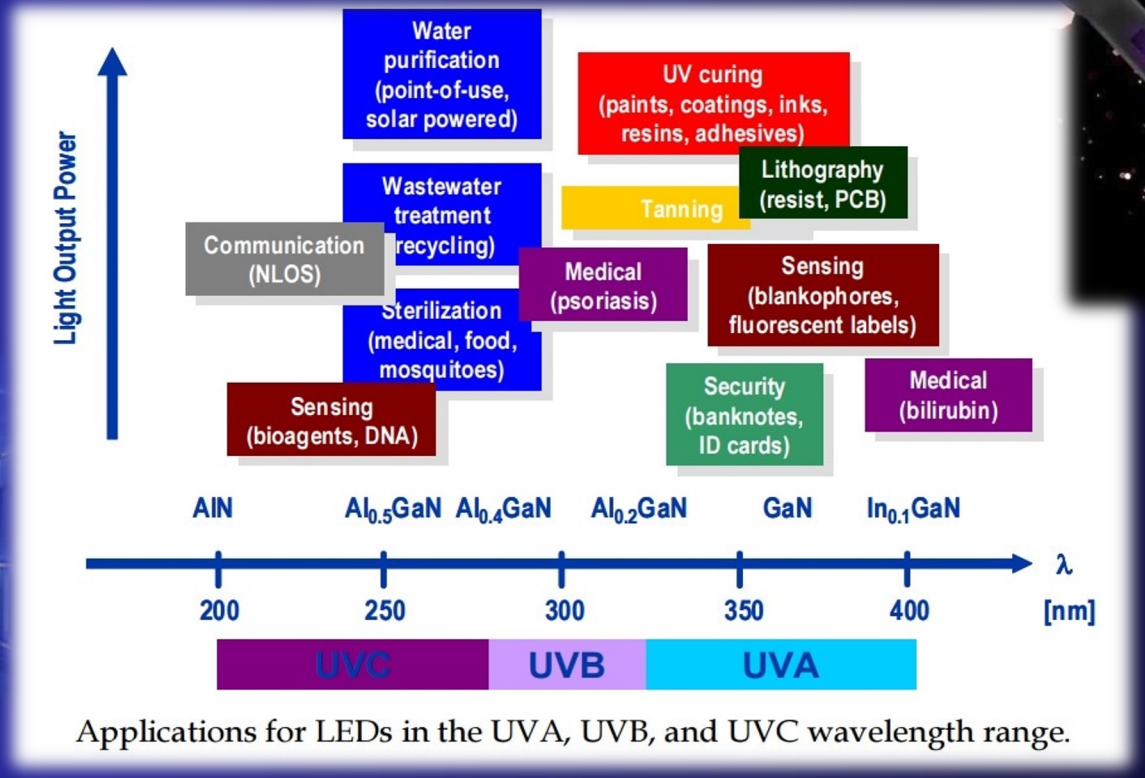
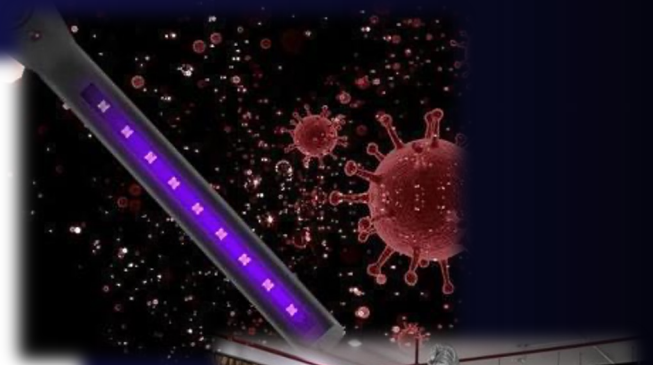


Applications for LEDs in the UVA, UVB, and UVC wavelength range.



- Deep ultraviolet light is widely used in air sterilization, surface sanitation, medical equipment, water purification, industrial curing and other fields
- According to market segmentation analysis, sterilization is the largest sector, accounting for 54% of the total.

# Typical UVC LED Structure Grown by MBE

Sophisticated structure **with high Al content**

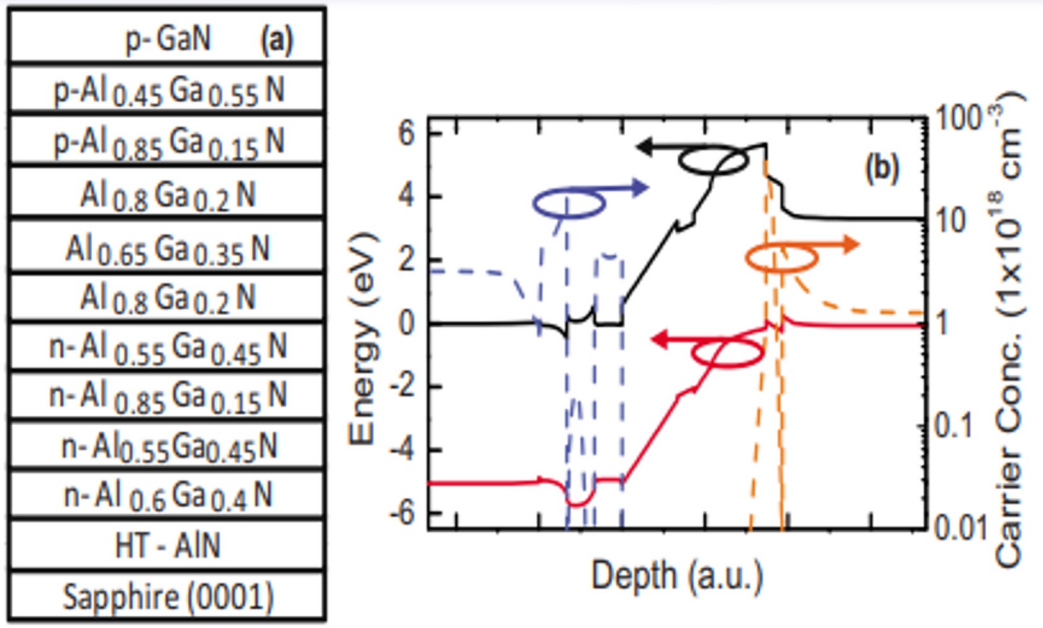
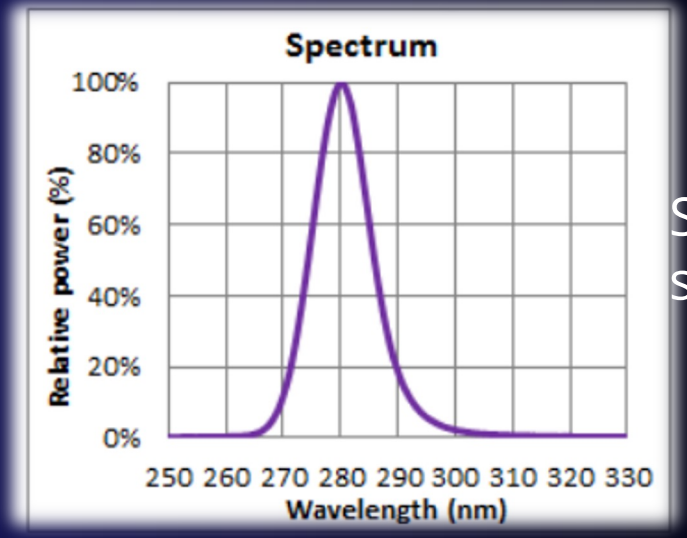
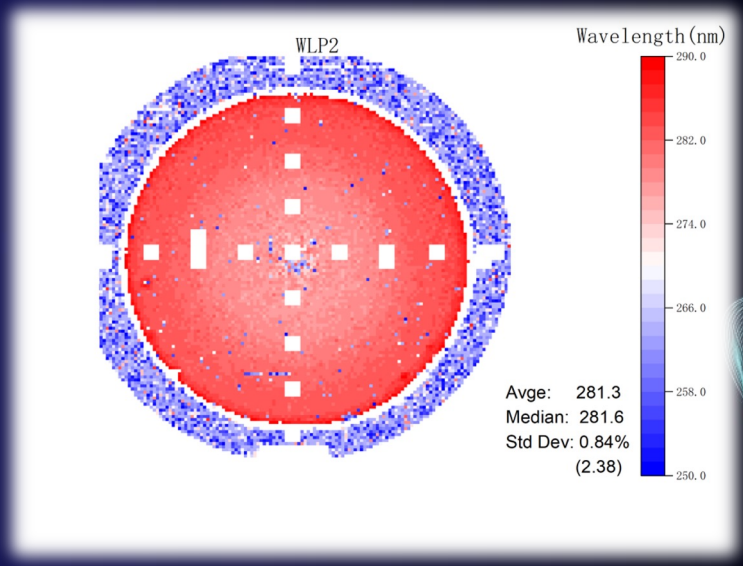



FIG. 3. (Color online) (a) Schematic of the investigated deep UV LED structure; (b) thermal equilibrium band diagram and carrier densities of the structure shown in Fig. 3(a).

https://doi.org/10.1063/1.3559842




Spectral selectivity

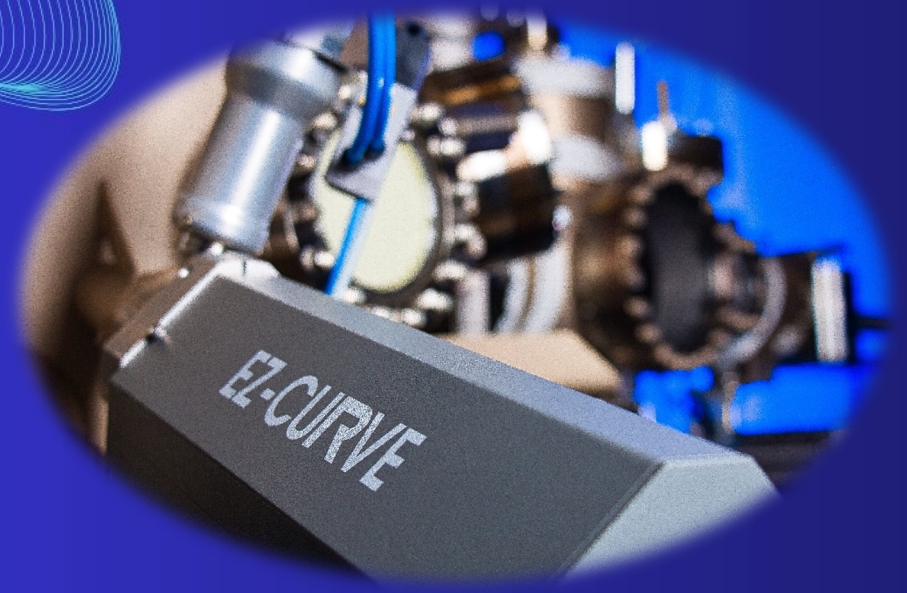


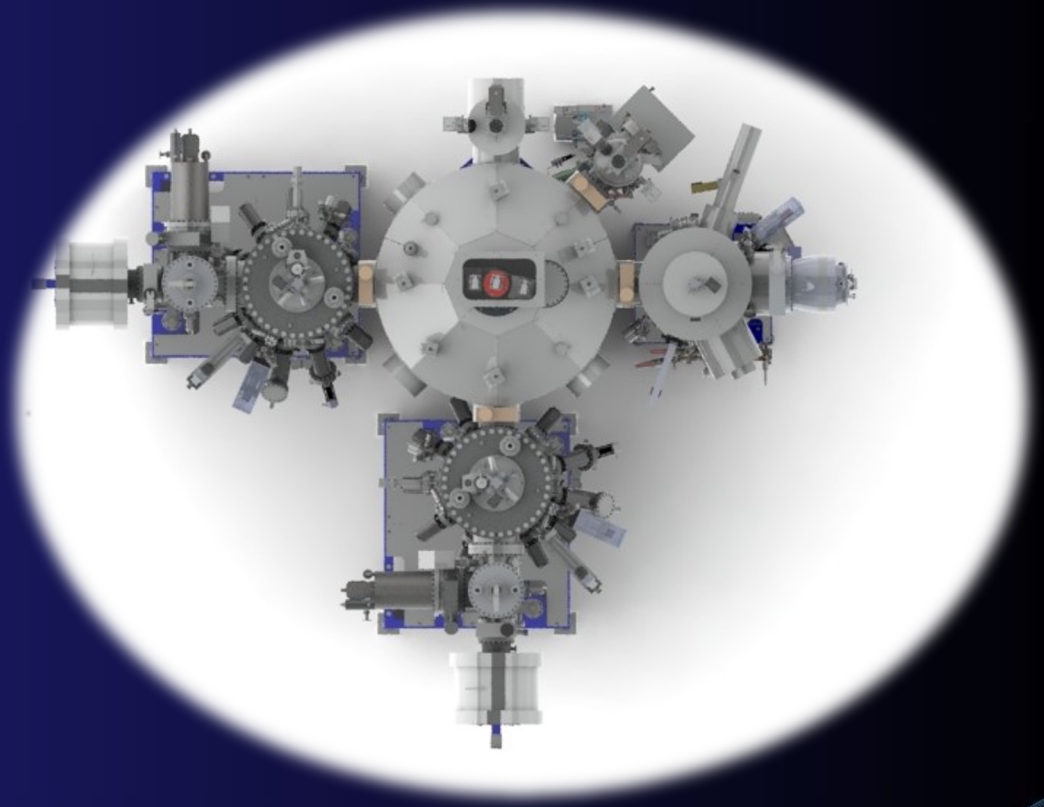

Uniformity Data

# Looking Ahead – Continued Innovation

New in - situ monitoring instrumentation

*Substrate bow measurement & monitoring of relaxation thickness limits*



From multi wafer to single wafer:
Compact 6” (8”) single wafer reactors + cluster
*Optimization of pressure during growth and pumping speed “by design”*

# Concluding remarks

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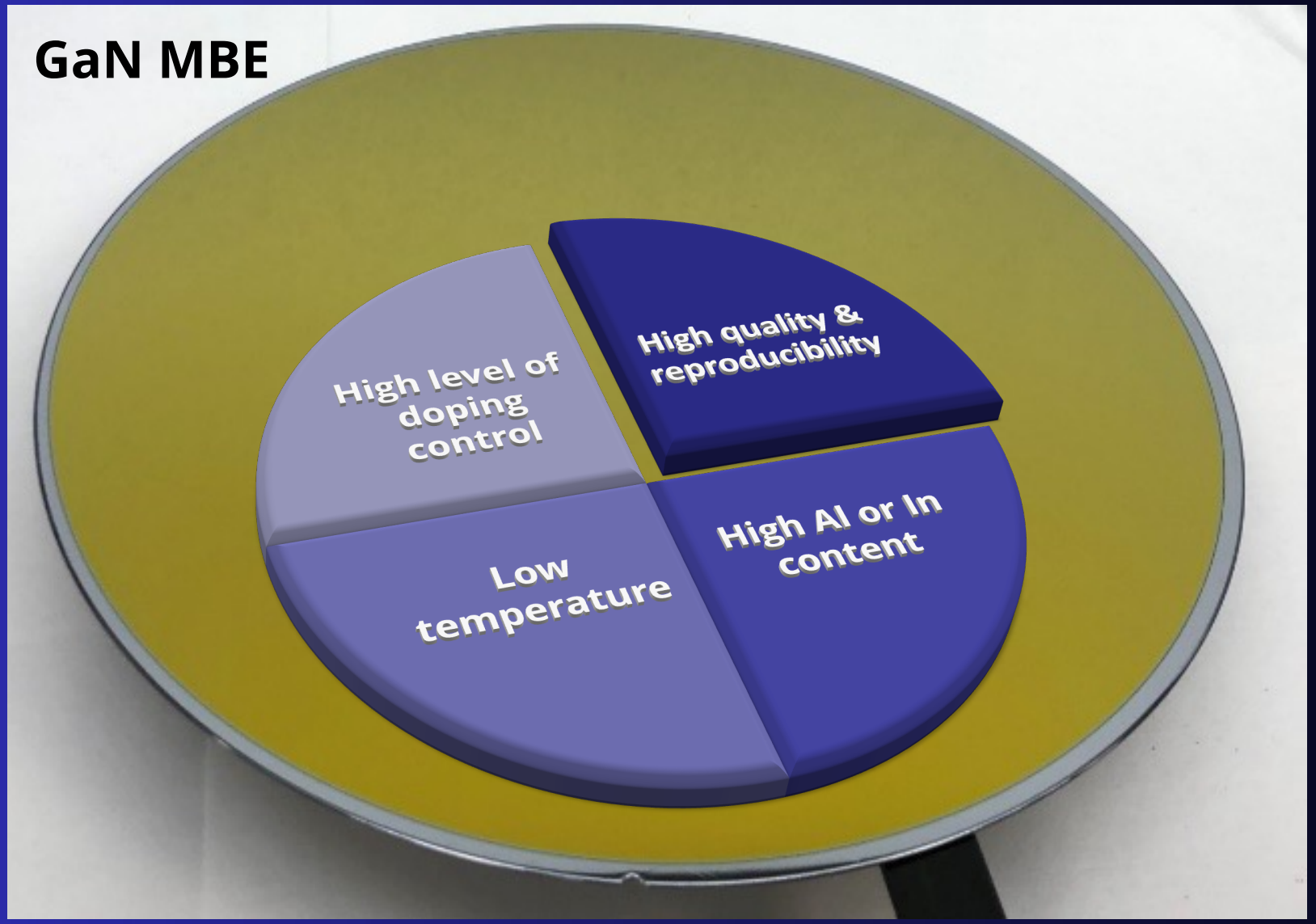



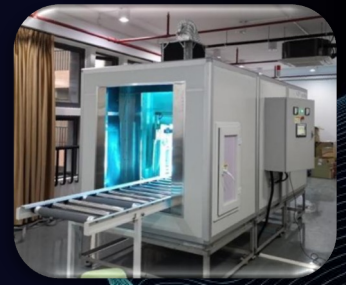

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60 YEARS OF PERFORMANCE

From Research to Production

*INNOVATIVE SOLUTION FOR SEMICONDUCTOR INDUSTRY*

# MBE IS OUR DNA

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