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GlobalWafers GaN epitaxy

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Outline

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2. Why GaN?
3. GaN application and market
4. Why GWC
5. GWC GaN epitaxy technology

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GlobalWafers overview

01 **16** manufacturing sites in **10** countries

02 **Profound technological integration** from worldwide talents

03 **7000+ employees** (Taiwan* 23% vs. Overseas 77%)

Note : As of 2018.end / Including GWC & Taisil employees

01 World's **#3** silicon wafer supplier.

02 Markets **Full-scale** product, offering 3" to 12" wafers.

03 Holds over **1,200+** patents in **6** regions and World Intellectual Property Organization.

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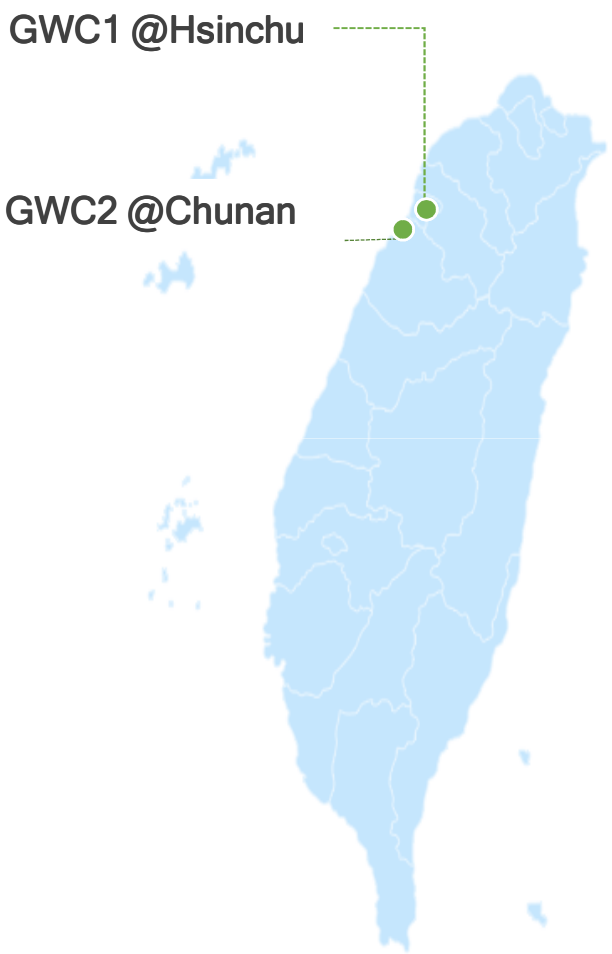
GlobalWafers overview



GWC 1 Hsinchu

- **Plant area :** 4,600 m^2
- **Production area :** 7,400 m^2
- **Year :** 1981
- **Product :** CZ, FZ semiconductor 3”～6” ingot/wafering (etching, lapping, polish, diffusion)

GWC2 Chunan

- **Plant area :** 12,000 m^2
- **Production area :** 27,400 m^2
- **Year:** 2006
- **Product :** CZ, FZ , SiC semiconductor

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Why GaN?

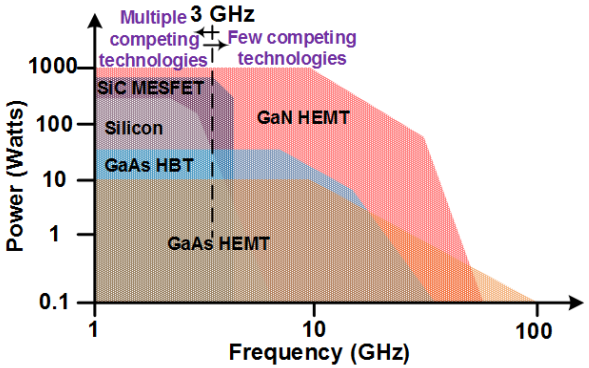
Properties	Si	GaAs	SiC	GaN
Band gap, E_g (eV)	1.12	1.42	3.26	**3.42**
Electric breakdown field, E_c (kV/cm)	300	400	2500	**3300**
Charge density (# x $1x10^{13}/cm^2$)	0.3	0.3	0.4	**1**
Thermal Conductivity (W/cm-K)	1.5	0.5	4.5	**1.5**
Electron mobility, μ_n ($cm^2 \cdot V^{-1} \cdot s^{-1}$)	1400	8500	1020	**2000**
Saturated electron drift velocity v_{sat} (cm/s)	$1x10^7$	$2x10^7$	$2.2x10^7$	**$2.7x10^7$**

→ **High voltage**

→ **High current density**

→ **High frequency**

→ **High Power Amp**



☐ **GaN shows high power and high frequency at the same time.**

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GaN power application and market

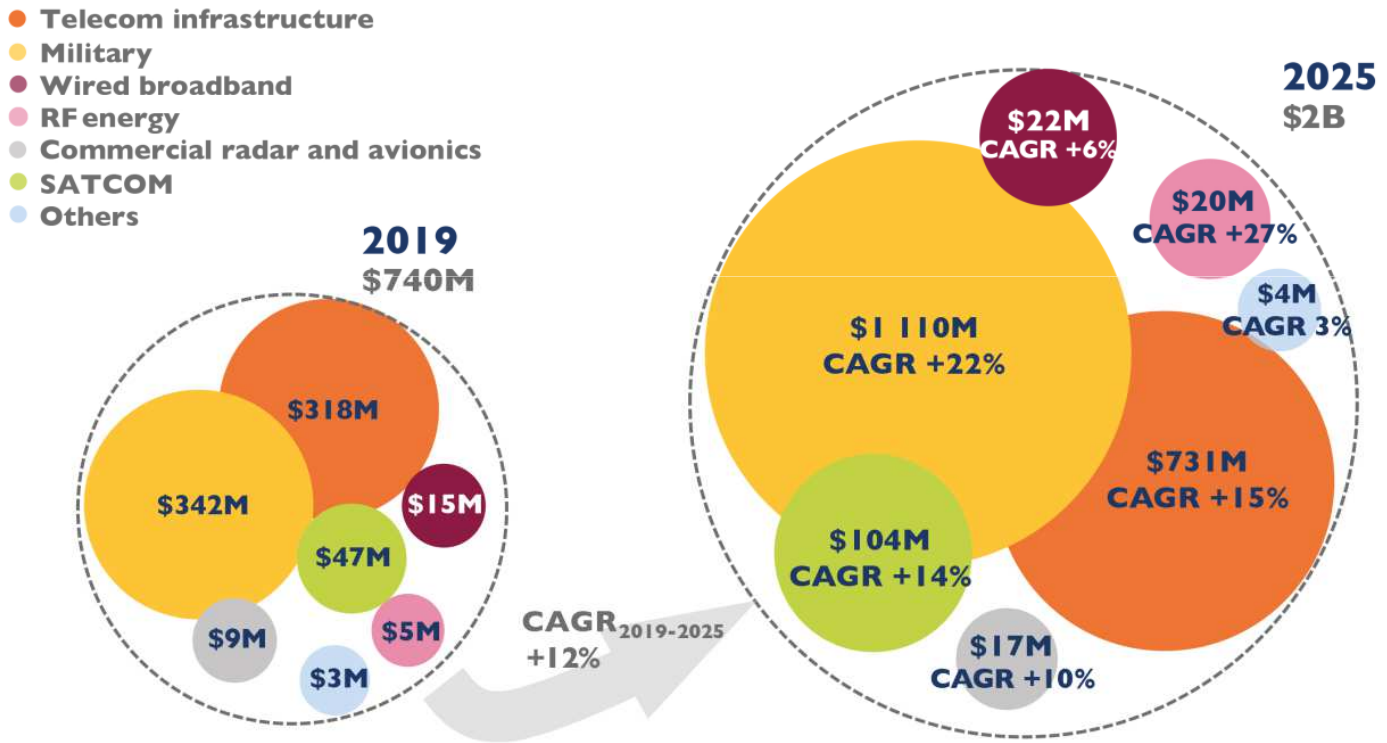
Long term GaN power market evolution

(Source: Power GaN 2019: Epitaxy, Devices, Applications & Technology Trends report, Yole Développement, 2019)

GaN RF application and market

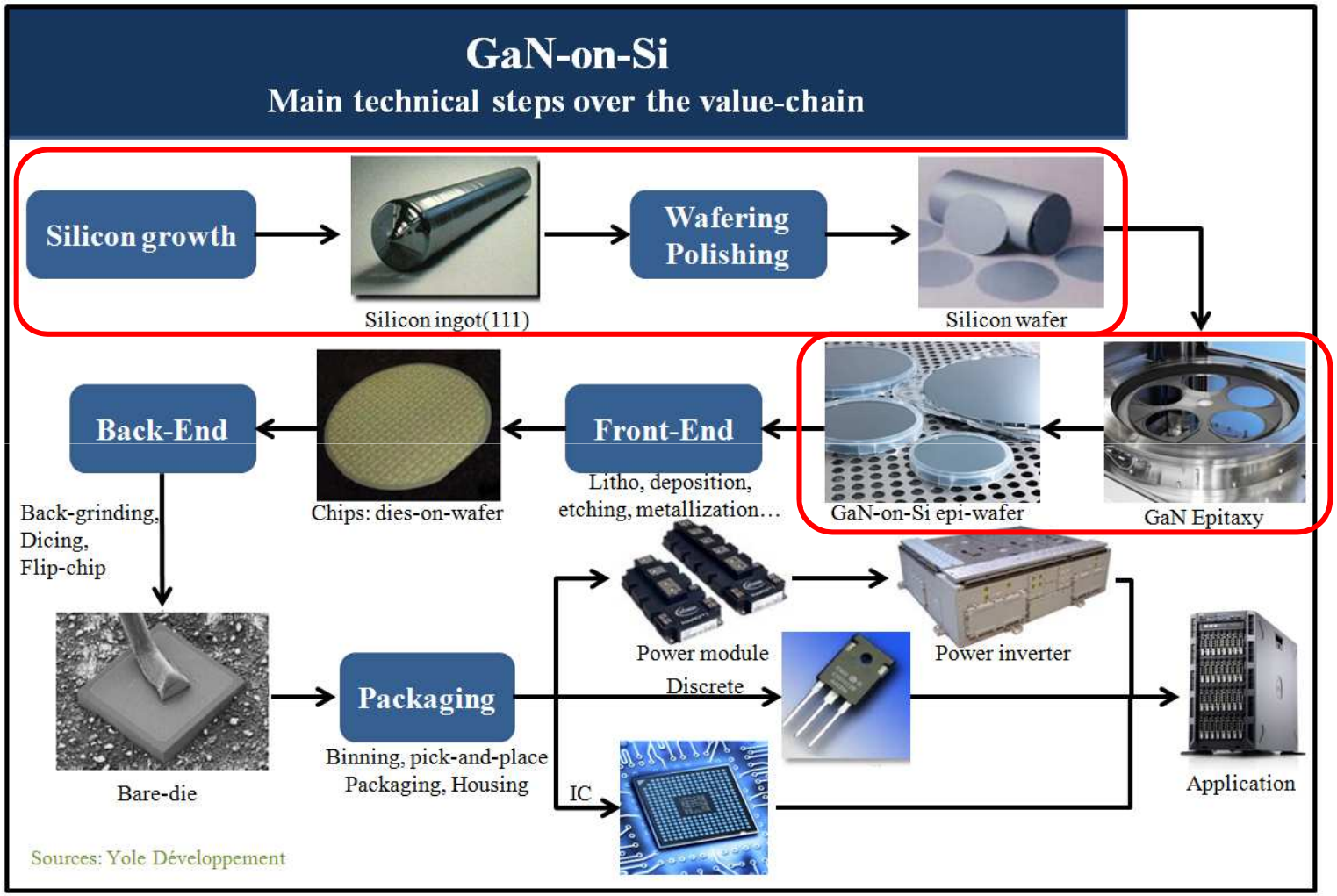
2019-2025 packaged GaN RF device market forecast - Split by application

(Source: GaN RF Market: Applications, Players, Technology, and Substrates 2020 report, Yole Développement, 2020)



YOLE Développement

Why GWC



☐ GWC own complete Si substrate products and have epi tool for GaN epitaxy

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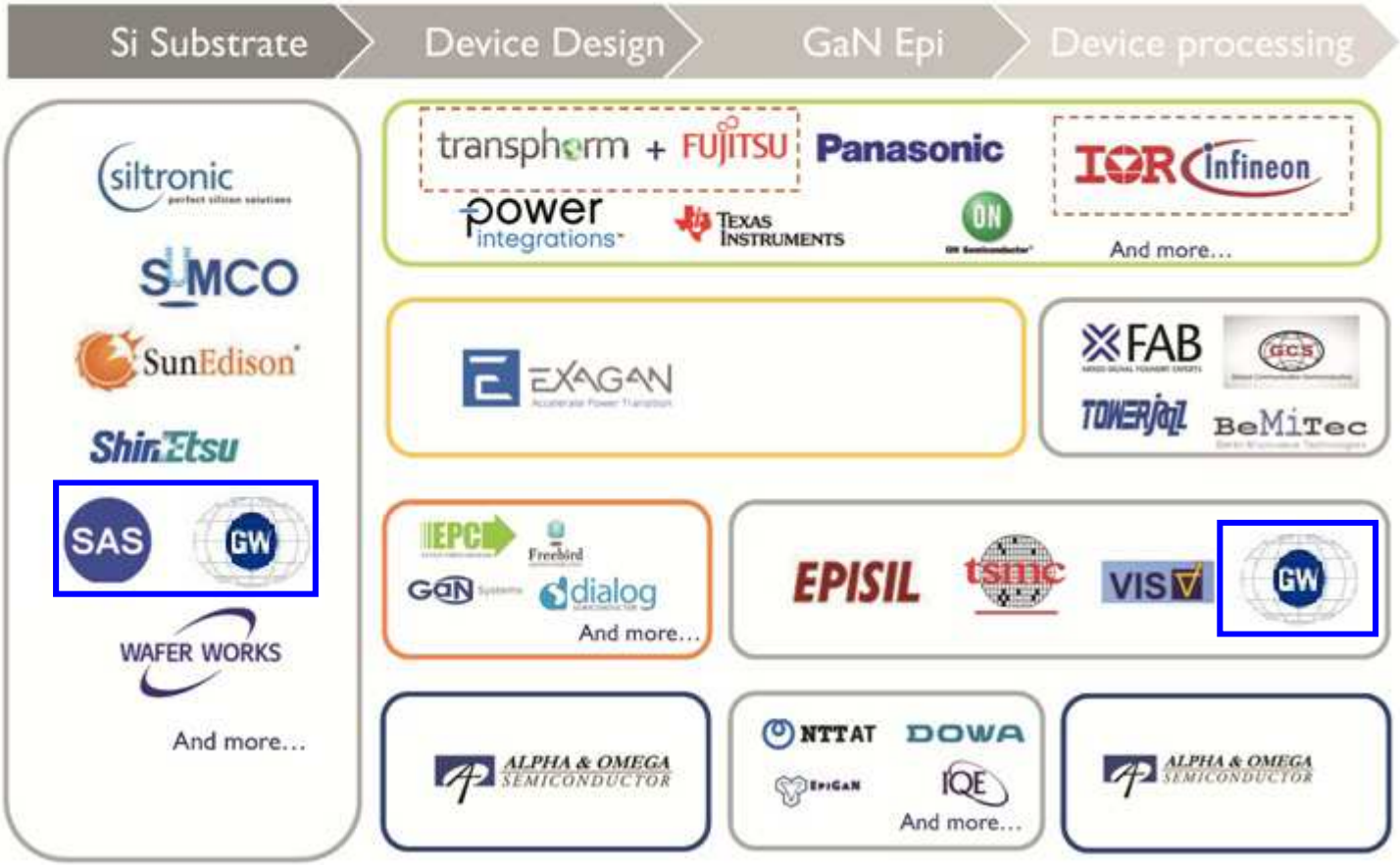
Why GWC



- GWC is top 3 substrate provider and is developing GaN epitaxy technology
- Capable to supply SiC substrate

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Why GWC

GWC aim to be a total solution provider in power and RF area

- ☐ Capability in providing 6” and 8” (111) Si and SOI substrate, SiC substrate
- ☐ Provide various substrate thickness and resistance spec. upon request
- ☐ Robust substrate for world wide GaN HEMT Epi houses
- ☐ Extend GWC substrate service business to Nitride based Template and Epi
- ☐ Provide GaN HEMT Epi OEM services

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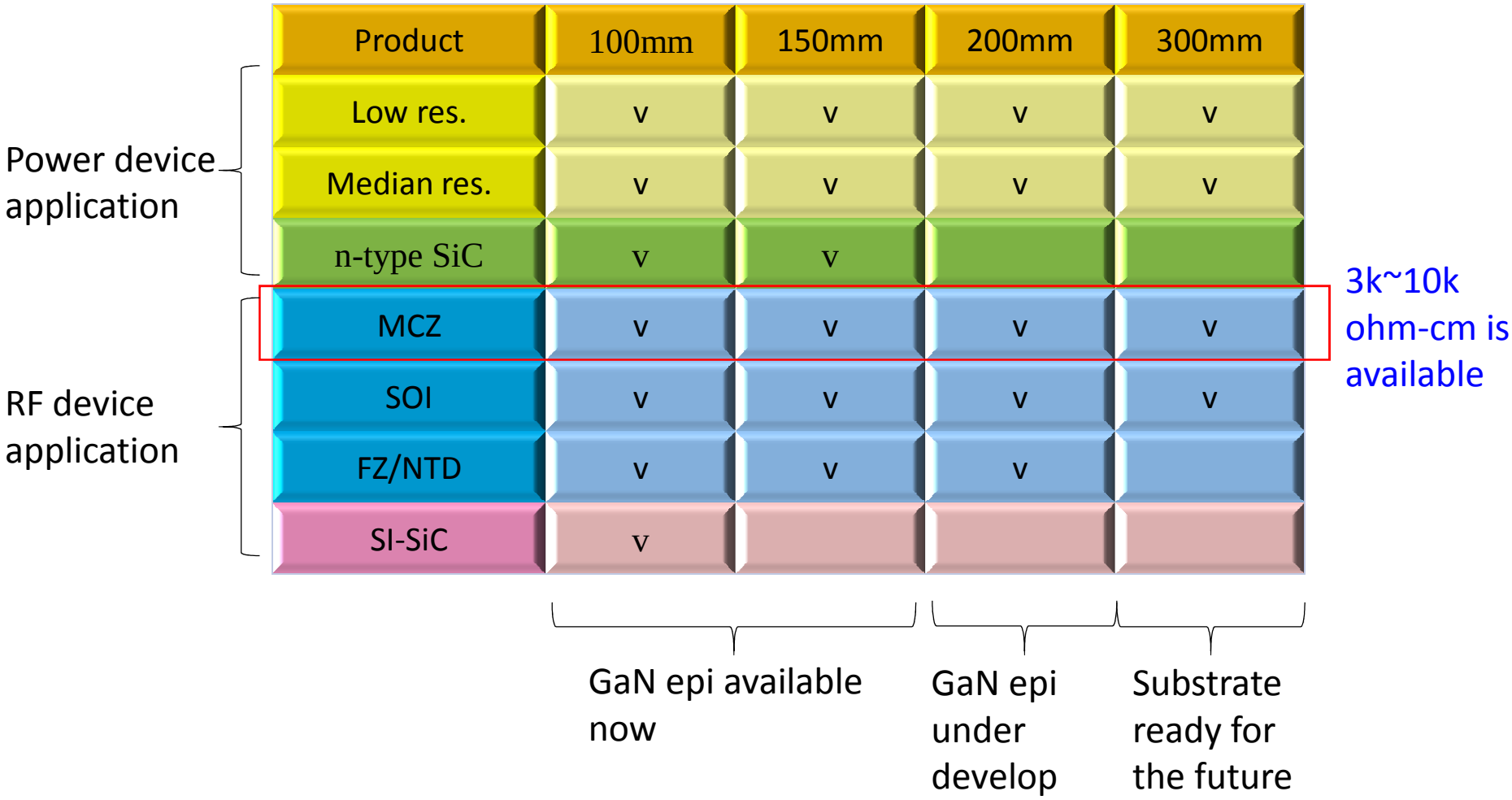
GWC GaN epitaxy technology

Total solution for various type of Si and SiC substrate



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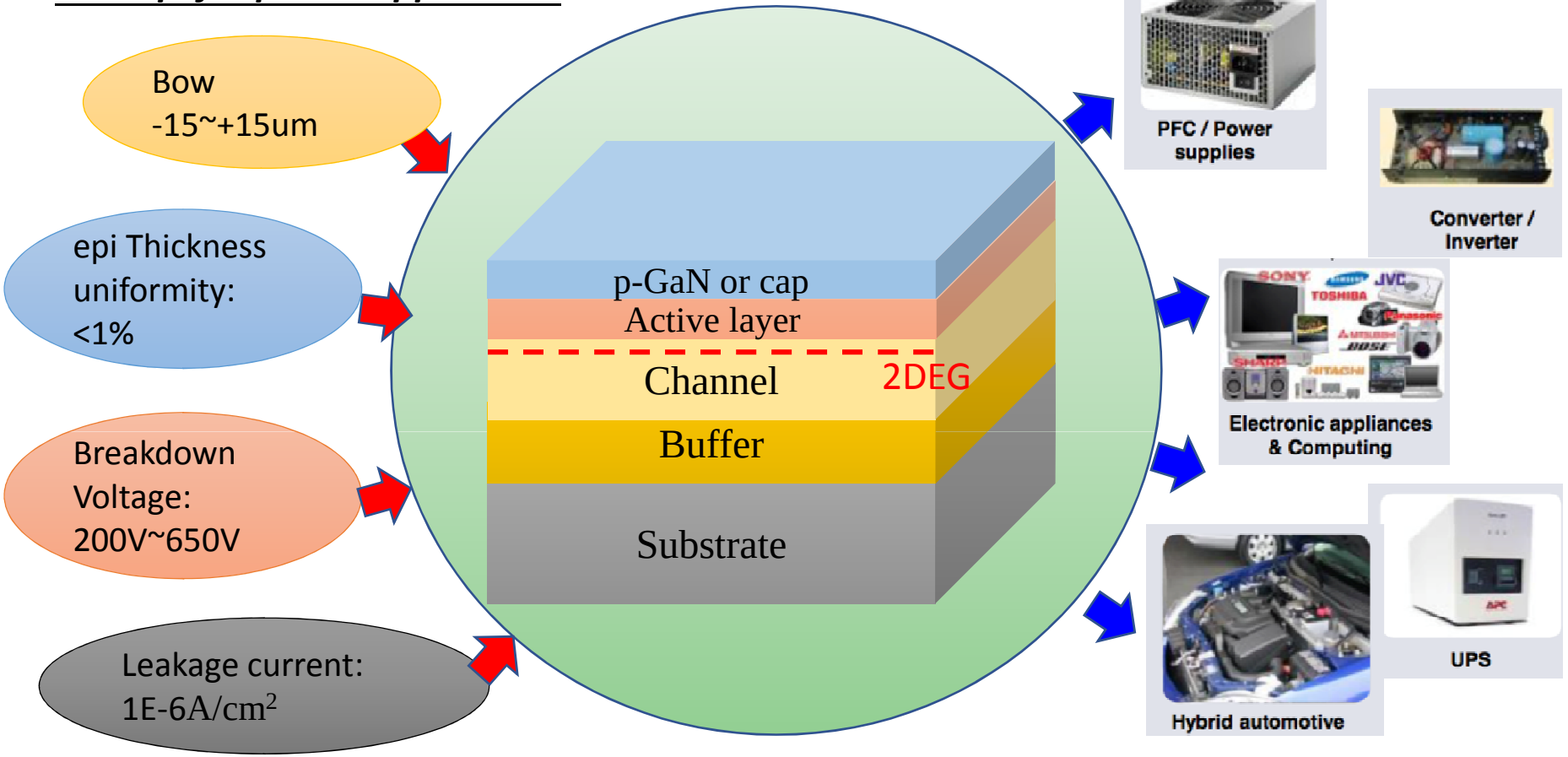
GWC GaN epitaxy technology

GaN epi for power application



GaN epi technology:
-Good flatness
-Good isolation property
-Full customization is possible

Application advantage
-High power density
-High efficiency
-Small size

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GWC GaN epitaxy technology

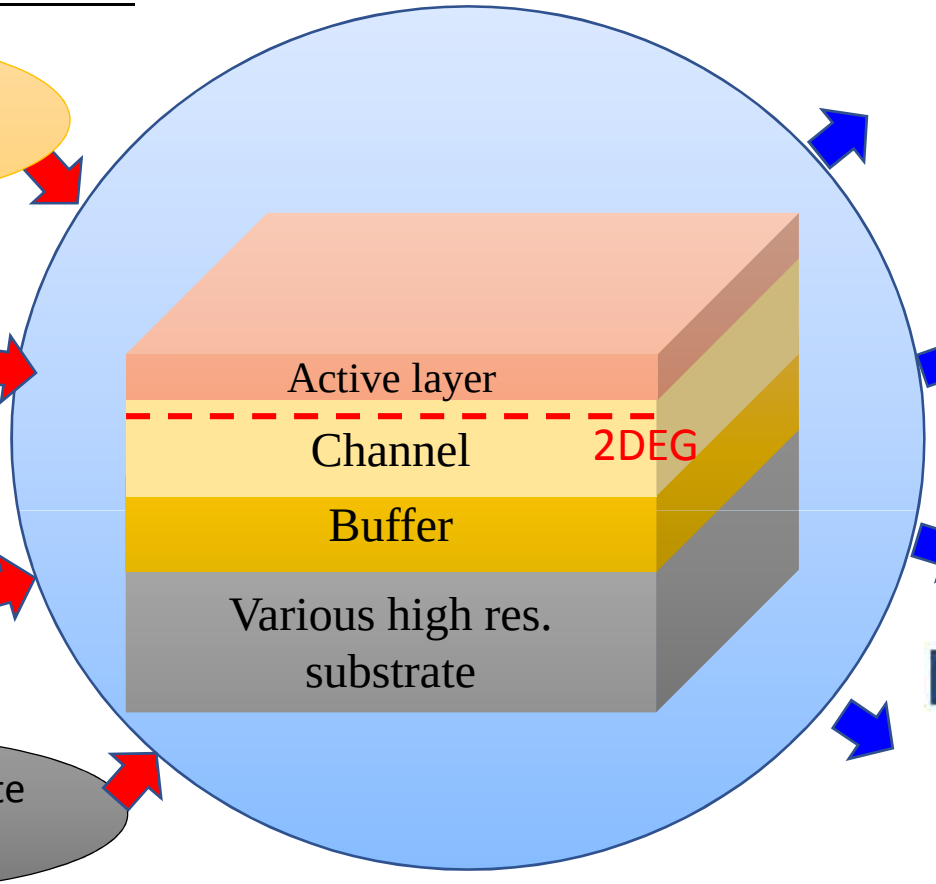
GaN epi for RF application

Bow
-15~+15um

epi Thickness uniformity:
<1%

Various kind of substrate: HR CZ, FZ, SiC

6", 8" SOI substrate available



GaN epi technology:
-Good flatness
-High res, large size substrate
-Full customization is possible

Application advantage
-High frequency
-High power density
-large bandwidth

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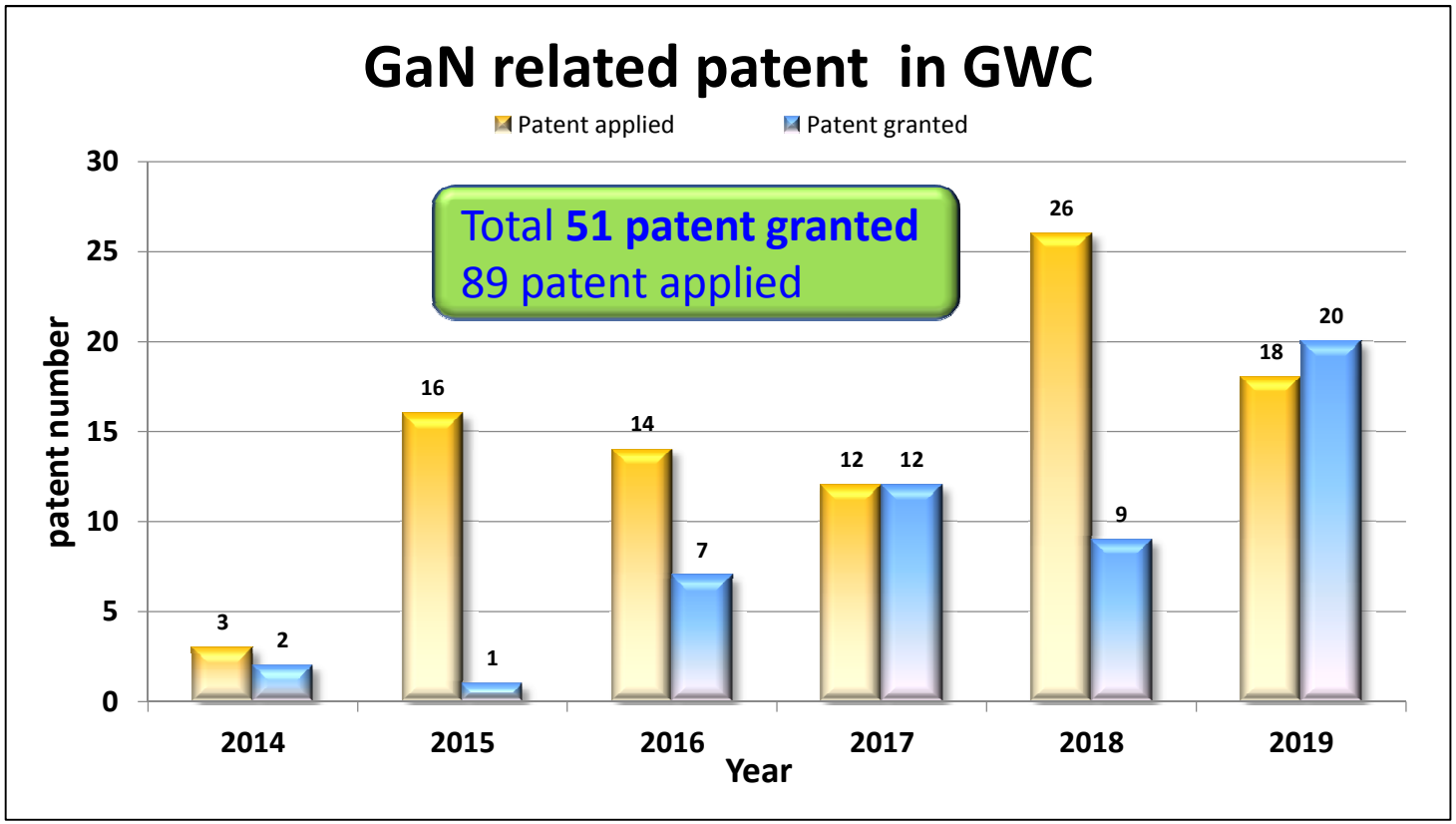
GWC GaN epitaxy technology

GWC GaN patent trend chart



Total 51 GaN patent granted

Keeping innovation on GaN epitaxy technology.

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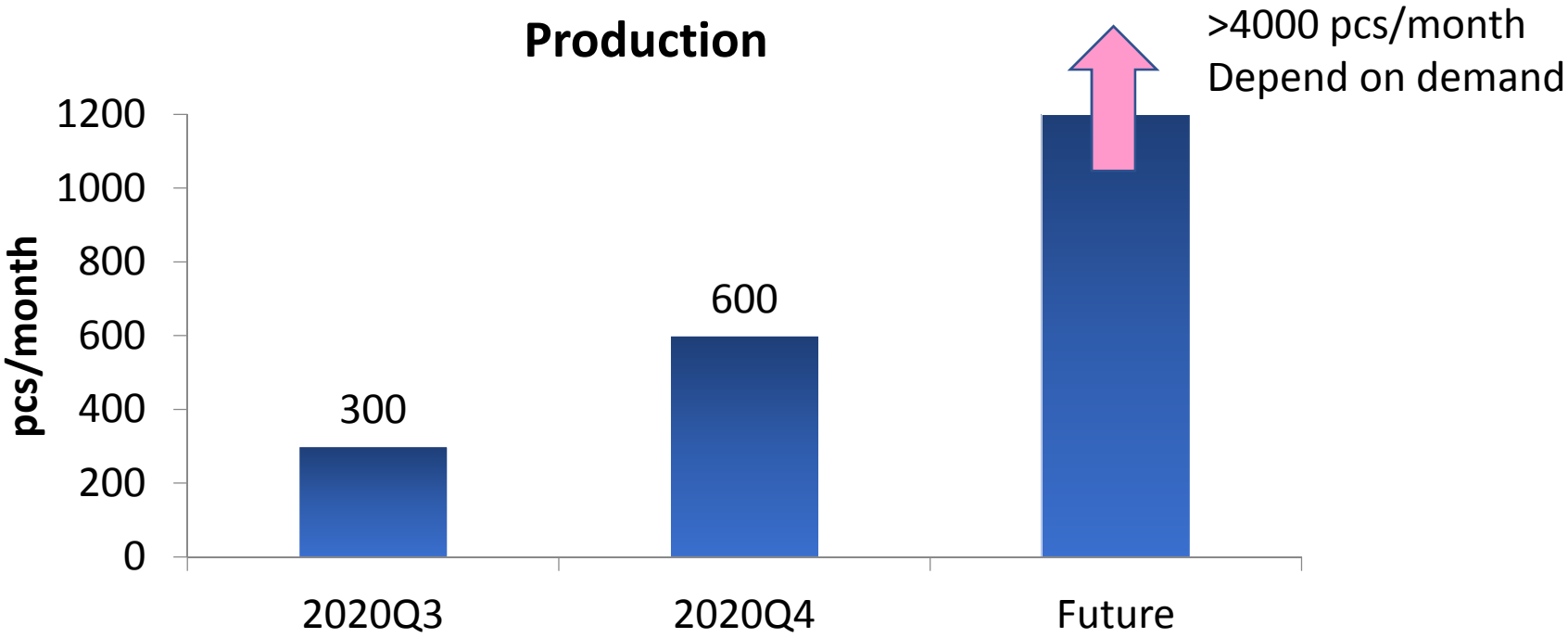
GWC GaN epitaxy technology

GWC GaN production capability



GWC have available space for expansion to capacity >4000pcs/month
Depend on demand of market.

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GWC GaN epitaxy technology

Contact information:

Contact window: Jeromy

Email: jeromy@saswafer.com

Tel: +886 35772255 ext 2108

Your satisfaction is our responsibility

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Thank You