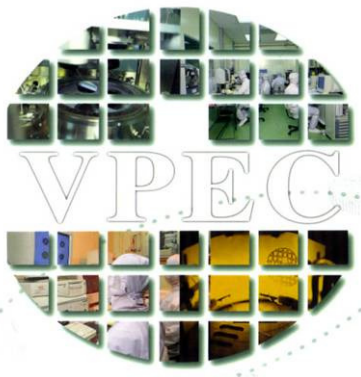




Trend and Prospect of the Third- Generation Semiconductor Materials

Visual Photonics Epitaxy Co., Ltd

World-class leading edge with MOCVD





Outline

- 1. Company Status**
 - 2. Core Technology**
 - 3. VPEC Technology and Opportunity**
 - 4. GaN Market and Technology**
 - 5. 2021 Outlook**
-



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Introduction

- **Founded in November 1996**
- **Factory: Ping-Jen Dist., Taoyuan City, Taiwan**
- **Factory Area: Building A: 10,000 sqm.
Building B: 6,600 sqm.**
- **Capital: NT\$ 18.5 billion yuan.**
- **Employees: 254 employees (R&D >10%)**
- **US office: Los Angeles, CA**
- **Product: 2" ~6" Epi wafer**





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Core Technology

Production
Reactor

MOCVD Metal Organic Chemical Vapor Deposition

Way to
Produce

Through the organic metal chemical vapor deposition method, the semiconductor film is grown on the substrate, and the epitaxial layer is accurately controlled through the real-time monitoring of the machine to complete the production of epitaxial wafers for different products such as gallium arsenide and indium phosphide.

Production
Principle

The epitaxial layer is heated by MOCVD in the cavity of the substrate, and an atomic layer is stacked layer by layer to form an epitaxial layer.

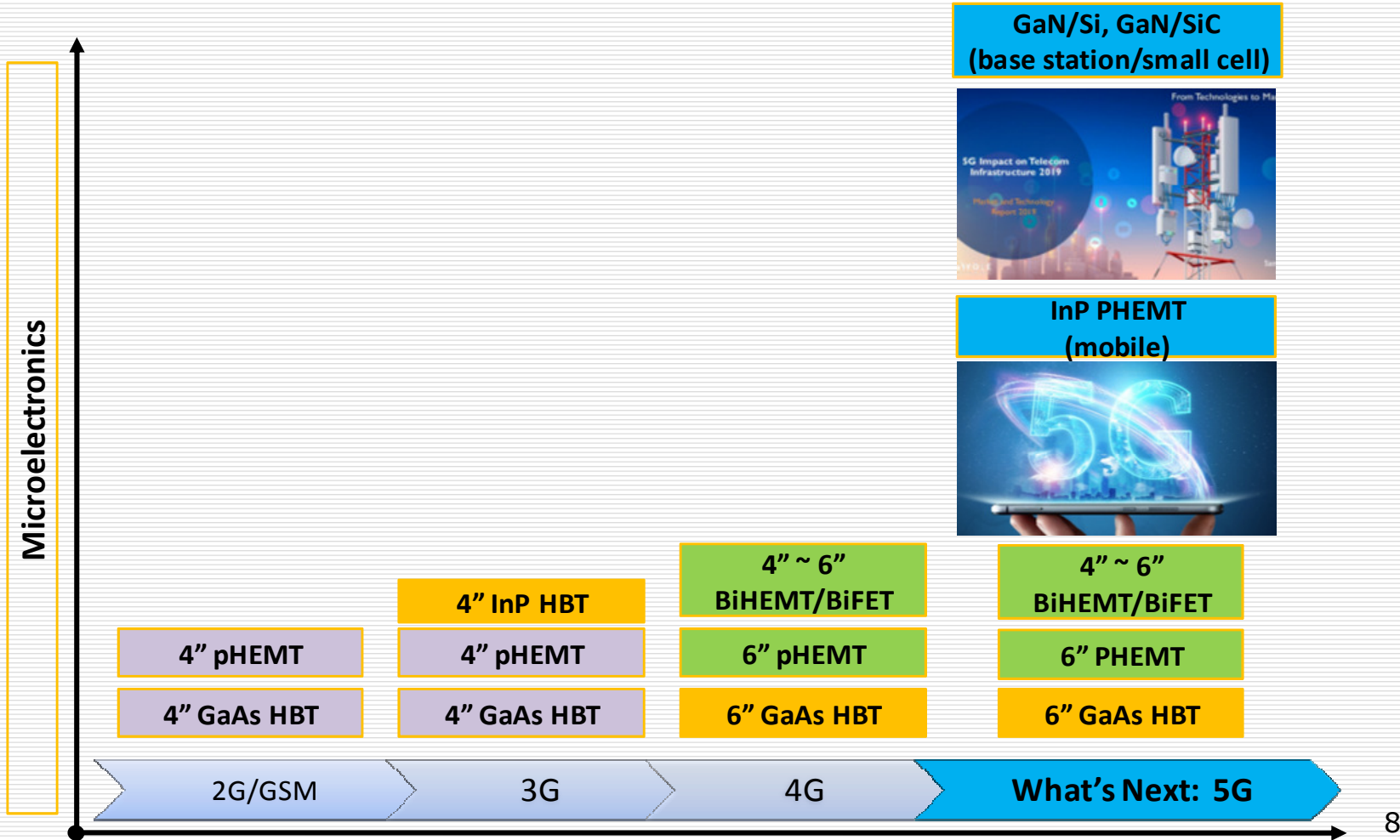


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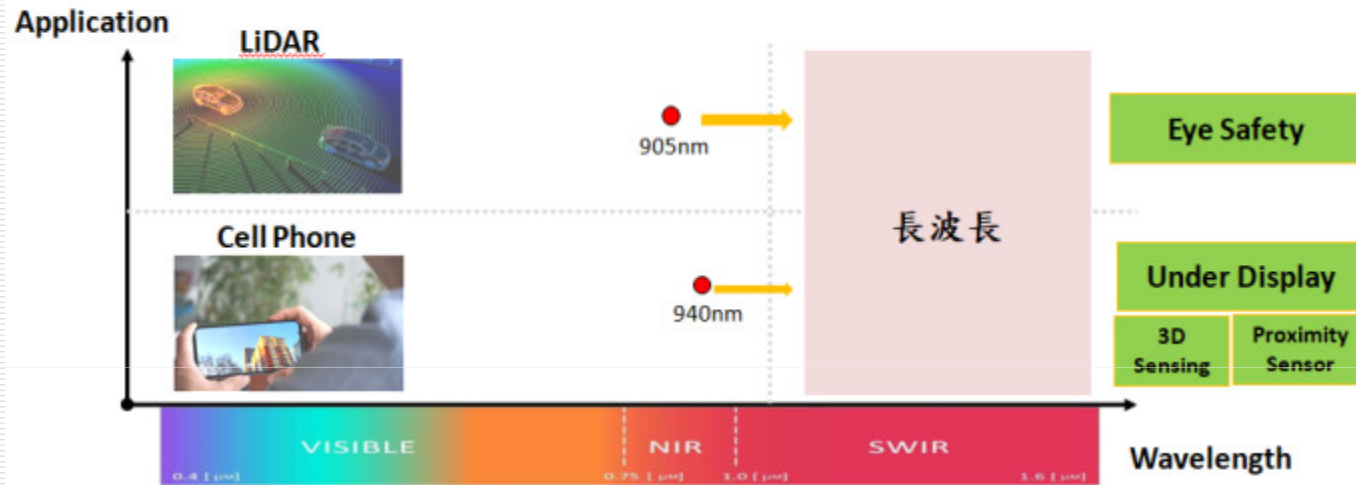
Leadership in Epi Technology





VPEC is Ready for Next Trend

• VPEC Technology Roadmap: migrate to SWIR technology



• VPEC Can Provide




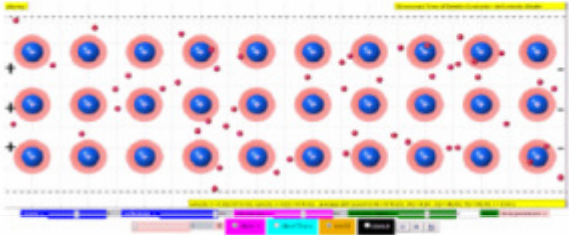

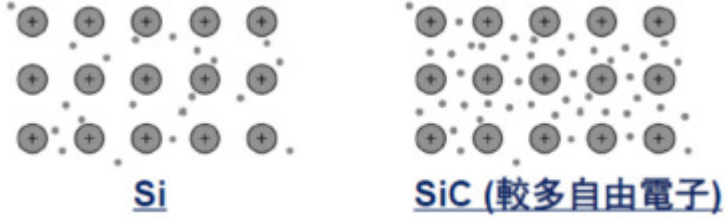


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Advantages of third-generation semiconductors

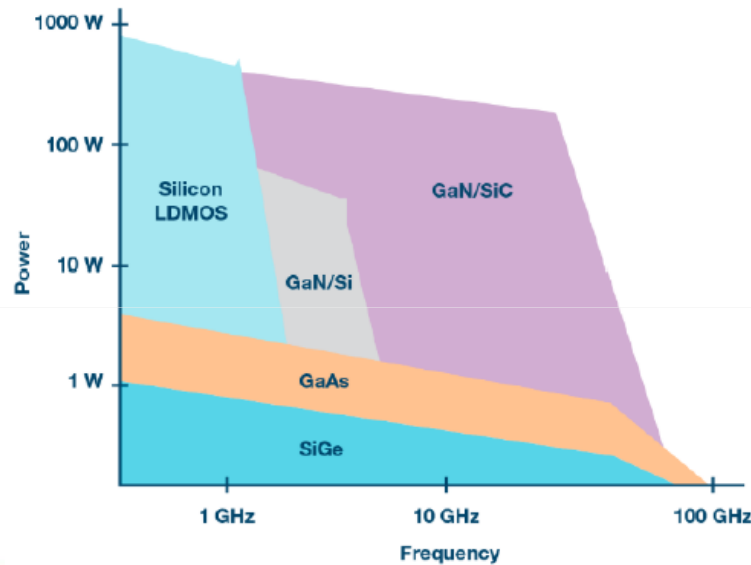
能階 (第三代能階高出3倍以上)	電子飽和飄移速度 (第三代速度高出2倍以上)
<ul style="list-style-type: none">在寬的溫度範圍內, 漏電流表現穩定偏低 (耐高溫)自由電子需要更高的能量才能激發 	<ul style="list-style-type: none">電子飽和飄移速度 = 電子移動最快的速度可以擁有更高的開關速度 (高頻開關使用) 
擊穿電場 (第三代電場高出10倍以上)	熱導率 (SiC 熱導率高出3倍以上)
<ul style="list-style-type: none">可以減薄晶片厚度同時降低了阻抗跟熱阻= 降低了功耗= 優化效率摻雜濃度比矽高2倍, 元件表面電阻降低, 傳導損耗也顯著減少  <p>同樣電壓下, 厚度可以只有Si的 1/10</p>	<ul style="list-style-type: none">SiC 高熱導率可以反映在較優的工作溫度與熱應力可以更快速的傳輸電子(熱能激發動能)  <p>SiC (較多自由電子)</p>

Ref.兩岸第三代半導體供應鏈整合與崛起:新科顧問(2020)



GaN Technology

图表：微波频率范围功率电子设备的工艺



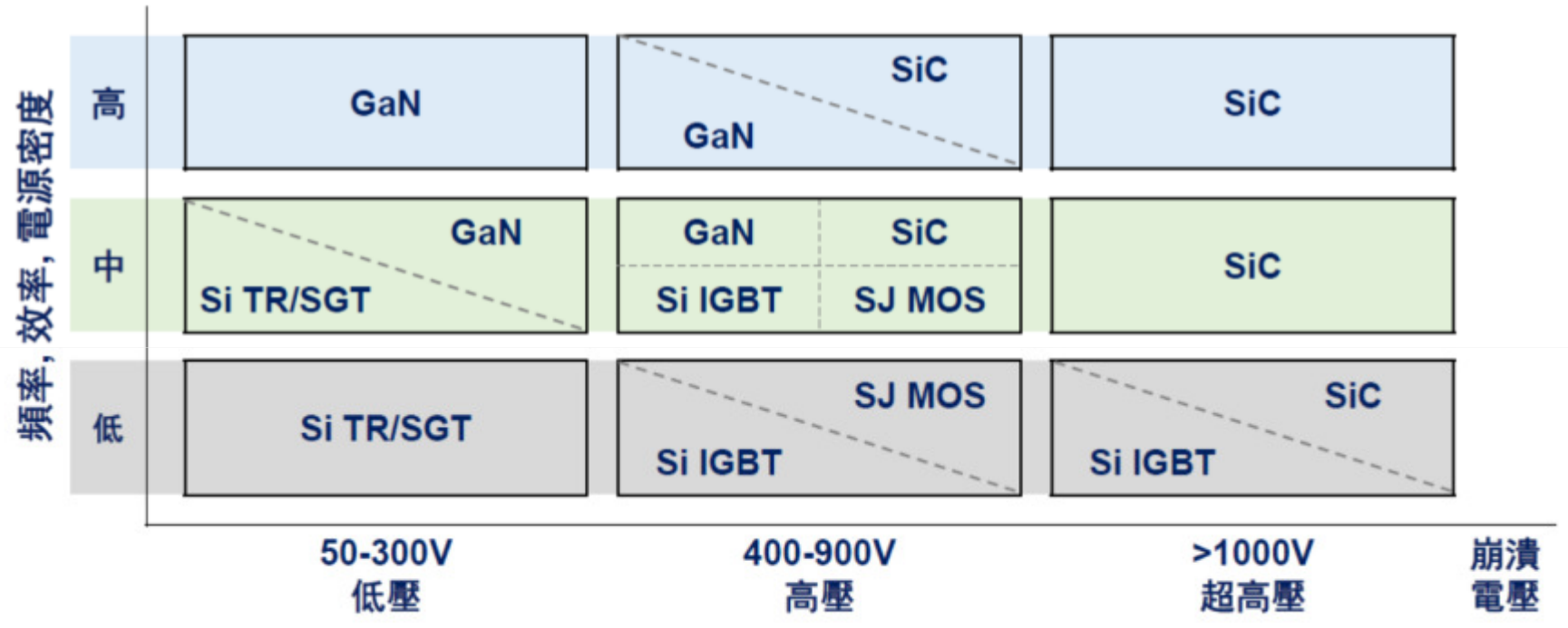
图表:GaN射频器件结构示意图



The market share of LDMOS is gradually decreasing, and GaN radio frequency components will occupy the main body of radio frequency front-end. Since LDMOS cannot support higher frequencies, GaN devices are expected to be used in most macro network unit applications in the future. In the application of millimeter wave, **GaN also has a great advantage. Under the same coverage area and user positioning function, it can reduce the number of receiving and receiving channels and reduce the size of the original PA.**



GaN Technology



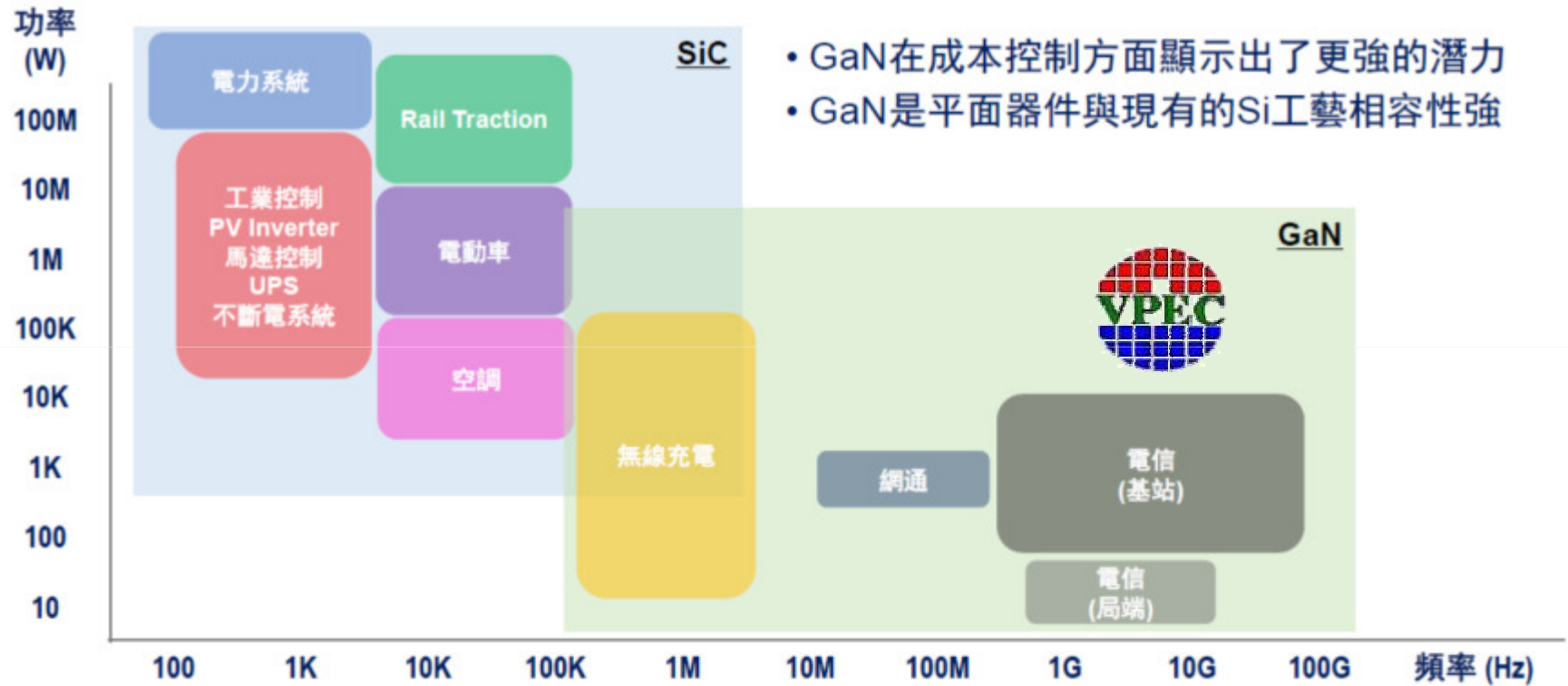
Ref.兩岸第三代半導體供應鏈整合與崛起:新科顧問(2020)

Application of high voltage resistance: SiC advantage

High frequency/high current density: GaN



GaN Main Application Markets



Ref.兩岸第三代半導體供應鏈整合與崛起:新科顧問(2020)

Microwave RF market: Obtain the excellence performance of GaN at high frequencies.

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GaN Epitaxy Technology

根據襯底	GaN on Si	GaN on SiC	GaN-on-Sapphire	GaN on GaN
磊晶質量	☆	☆☆☆	☆☆	☆☆☆☆
可量產尺寸	8"	6"	4"	2"
成本	☆☆☆☆	☆☆	☆☆☆	☆
困難點	<ul style="list-style-type: none"> 生產良率較低 易翹片(晶格不匹配) 	<ul style="list-style-type: none"> 受限於SiC的襯底 不易切割 	<ul style="list-style-type: none"> 導電性能差 不易切割 	<ul style="list-style-type: none"> 製備GaN單晶材料困難不易於量產
優勢	<ul style="list-style-type: none"> 降低成本潛力大 可以擴充到8寸 長速是SiC 2~300倍 	<ul style="list-style-type: none"> 結合SiC優異導熱性和的GaN高功率密度和低損耗的能力 	<ul style="list-style-type: none"> 化學穩定性好 不吸收可見光 製造技術成熟 	<ul style="list-style-type: none"> 降低位元錯密度 提高工作壽命 提高工作電流密度
主要應用	<ul style="list-style-type: none"> 電力電子器件 	<ul style="list-style-type: none"> 微波射頻器件 	<ul style="list-style-type: none"> LED晶片 (佔有率>90%) 	<ul style="list-style-type: none"> 鐳射顯示&儲存 鐳射照明
技術趨勢	<ul style="list-style-type: none"> 大尺寸外延技術 	<ul style="list-style-type: none"> 降低成本 	<ul style="list-style-type: none"> 向6"方向發展, 降低雜質污染 提高表面拋光質量 	<ul style="list-style-type: none"> 提升量產能力

Ref.兩岸第三代半導體供應鏈整合與崛起: 新科顧問 (2020)

Microwave Radio Frequency Market (Base station):

. Above 2 GHz: GaN/SiC is currently the mainstream product. (4~6 inch wafer)

. Below 2 GHz: GaN/Si has a cost advantage. (6 inch wafer)



GaN brings new optimization solutions

GaN 的核心優勢				
開關速度		高頻		低阻抗
與Si器件的對比	10倍以上優勢		5倍以上優勢	2倍以上優勢
	Si	GaN	Si	GaN
目標應用	雷射雷達 LiDAR		快充	5G 電信
GaN 的優勢	開關速度可提高10倍		可大幅度減小終端應用產品體積並大幅提高功率轉化效率	較LDMOS工作頻率提高2倍以上
				功率密度提升2倍 & 節能50%

Ref.兩岸第三代半導體供應鏈整合與崛起: 新科顧問 (2020)

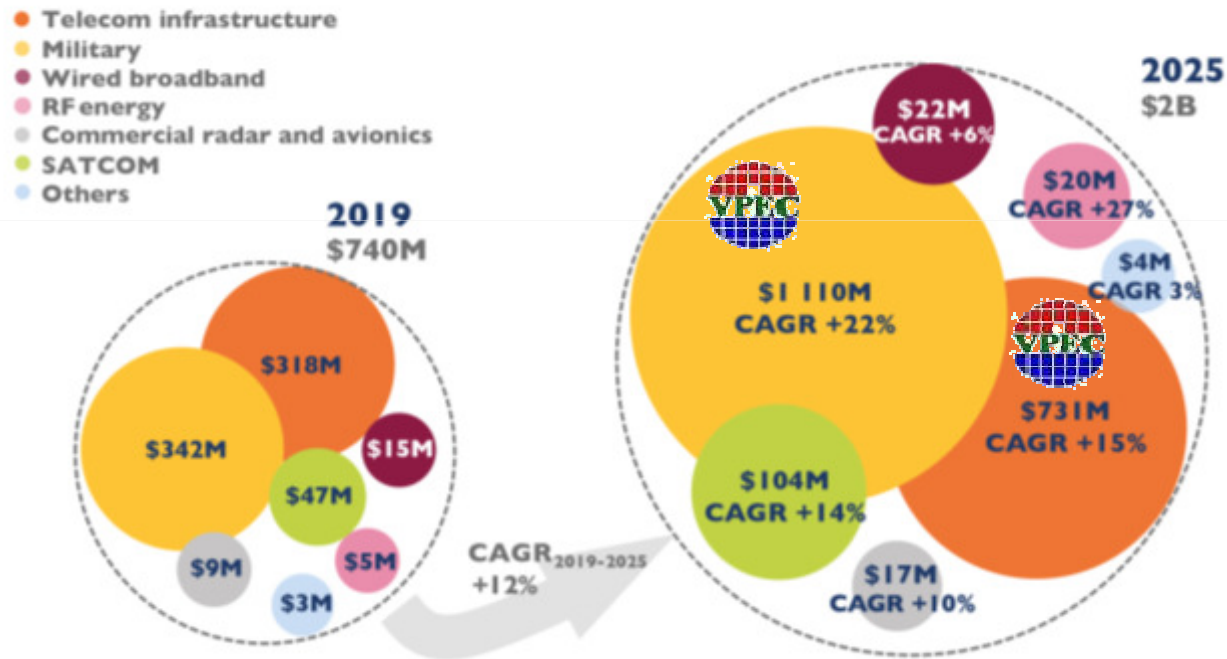
Microwave RF market: compared with LDMOS, the operating frequency is increased by more than twice.



Third-generation semiconductor: RF-GaN Market size

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)



Compound annual growth rate: 12% mainly grown into a base station and military.



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2021 Outlook

5G mobile phone penetration rate



WiFi6 & WiFi6E



IoT Smart Link



Microelectronics

Automotive PA



5G millimeter wave ba...



Defense industry



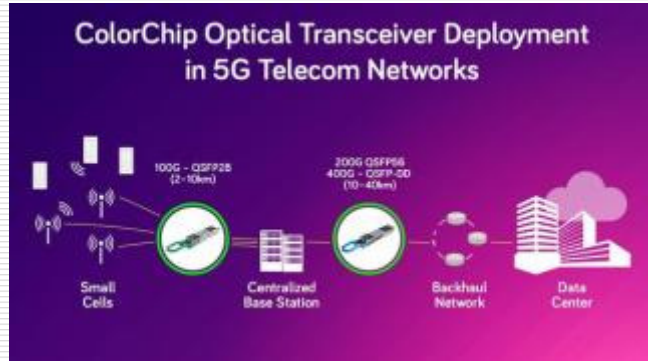
Low-orbit satellite LNA





2021 Outlook

5G Base station infrastructure

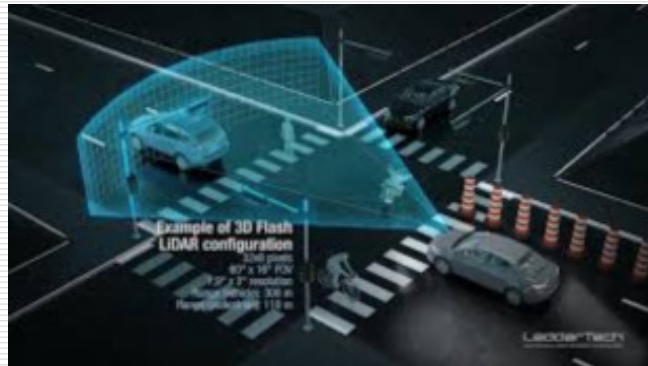


3D Sensing



Optoelectronics

LiDAR for vehicles



Intelligent machine vision

