5G SMARTPHONE AND TELECOM INFRASTRUCTURE ARE EMPOWERED BY COMPOUND SEMICONDUCTOR

P. CHIU, E. Dogmus, A.B Slimane, C. Malaquin, A. Bonnabel, C. Troadec
Yole Développement, 75 cours Emile Zola, 69100 Villeurbanne France, e-mail: poshun.chiu@yole.fr – Phone : +33.7.66.35.65.45.

Keywords: wireless infrastructure, compound semiconductors, RFFE, 5G, GaN, GaAs, SiC, Covid-19

Abstract

The paper presents the market overview of different compound semiconductor such as GaN, GaAs, and SiC impacted by the deployment of 5G in wireless infrastructure and in the new generation of handset applications. The Covid-19 impact and trade war issue are discussed, as well as technology and market trends and Yole's forecast for the coming years.

INTRODUCTION

5G plays the main driver for both the markets of radio frequency front end (RFFE) applications and telecom infrastructure to grow. By using compound semiconductor, including GaAs, GaN and SiC, more mature supply chain empowers new applications based on the 5G's advantages of faster data rates and reduced network latency.

5G'S IMPACT ON FRONT-END AND CONNECTIVITY

As 5G has started, China, South Korea and USA are early adopter countries of 5G where all major carriers have launched their network. In Japan, in Europe and for the rest of the world, 5G network rollout is moving forward at a slower pace. The Chinese market will pull most of the demand for 5G smartphones in 2020. Whereas the US government is putting a strong emphasis on 5G and Wi-Fi 6 with unprecedented spectrum action plans to accelerate the technology adoption at a broader scale.

RF content and complexity is increased with the introduction of 5G and WiFi6, a 5G handset will feature a 4x4 Multiple Input Multiple Output (MIMO) downlink for frequencies above 2.5GHz. Also, WiFi 6E will extend the frequency coverage of Wi-Fi signals to 6 GHz, where SiGe performance is limited and GaAs adoption is favorable. And in return it will result in a greater penetration of GaAs power amplifiers (PAs) for the high-end sub-6GHz phones.

Overall, the RF-front-end and connectivity market was valued at $15.2B in 2019, and will grow with 11% Compound Annual Growth rate (CAGR) between 2020 and 2025 to reach $25.4B by 2025, as shown in Fig.1. GaAs is the main building block for 3G and 4G handset PAs. With the transition to 5G, it will continue its significant deployment in sub-6GHz phones, as the GaAs PA meets the stringent requirements for power and linearity in the RFFE handset module. In the automotive market, connected vehicles and V2X (Vehicle-to-Everything) will become standard features by 2022, increasing the RF GaAs market in the mid-long term.

GAN BASED WIRELESS INFRASTRUCTURE MARKET

Over recent years, GaN has been significantly adopted by the RF industry owing to its higher power output at high frequencies, and its smaller footprint. In the dynamic 5G infrastructure market, deployment of higher frequencies in the sub-6GHz as well as in the mm-wave regimes has pushed manufacturers to look for more efficient antenna technology platforms.

Worldwide investment in telecom infrastructure has remained stable in the past decade, with a recent increase coming from Chinese government efforts. The trend toward higher frequencies offers a sweet spot for RF GaN in PA in 5G network at frequencies below 6GHz, in remote radio head (RRH). This application is expected to drive GaN market growth in the next five years. Even though the next generation active antenna systems (AAS) could offer an advantage to silicon LDMOS technology, due to technical limitations such

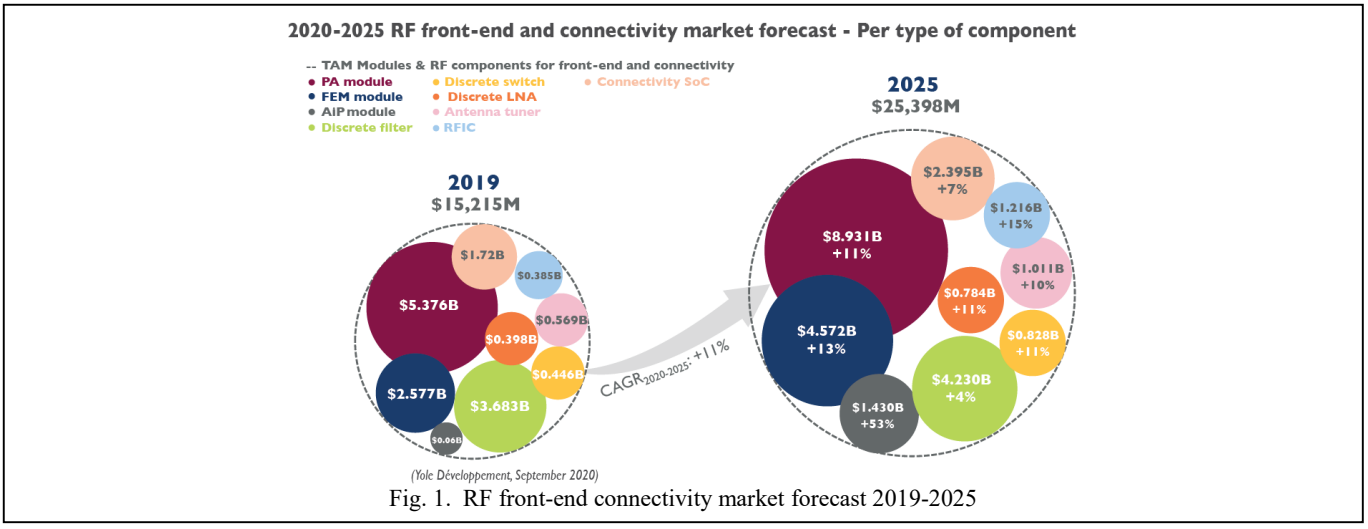

Fig. 1. RF front-end connectivity market forecast 2019-2025

as thermal management and the localized need for such antennas in mostly high-density areas, RRHs will not be replaced and will stay for the long term, using GaN PAs.

In fact, since the apparition of first commercial products 20 years ago, GaN has become a serious rival to silicon Laterally Diffused Metal Oxide Semiconductor (LDMOS) and GaAs in RF Power applications, with a continuous improvement of performance and reliability at lower cost. The first GaN-on-Silicon Carbide (SiC) and GaN-on-Si devices appeared at almost at the same time, but GaN-on-SiC has become more technologically mature. Currently dominating the GaN RF market, GaN-on-SiC penetrated the fourth 4G Long-Term Evolution (LTE) Wireless infrastructure market and is expected to be deployed in RRH architectures in 5G's sub-6Hz implementations. Nevertheless, in parallel, there has also been remarkable progress in cost-efficient LDMOS technology, which is likely to challenge GaN solutions in 5G sub-6Ghz AAS and massive MIMO deployments. In this context, GaN-on-Si stands as a potential challenger with possible expansion to production on 8-inch wafers and promises cost-efficient solutions for commercial markets. Even though, as of 2019, GaN-on-Si remains in small volume manufacturing, it is expected to challenge the existing LDMOS solutions in the Base Transceiver Station (BTS) and RF energy market. Another target of GaN-on-Si companies is the high-volume consumer 5G handset PA market, it could have opportunity to coexist with GaN-on-SiC.

As shown in Fig. 2, the GaN RF device is valued at $740M in 2019, and it will reach beyond $2B by 2025, driven by two main applications: telecom infrastructure and defense.

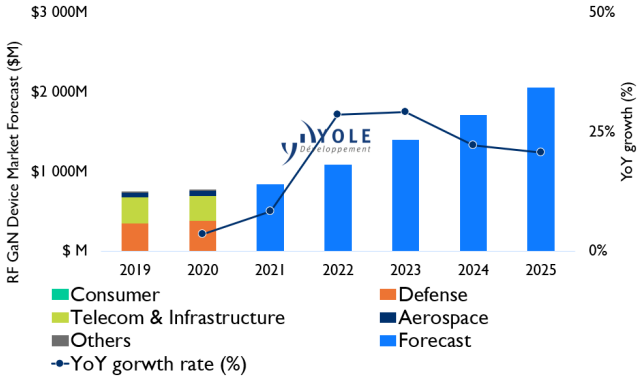

Fig. 2. GaN RF device market forecast

COVID-19 AND TRADE WAR IMPACTS

Two major global incidents shake the global economy in 2020, the Covid-19 and the tension between the US and China. While Chinese 5G deployment remained unchanged following the pandemic, the European and US 5G deployments had slight delays in H1-20. Starting H2-20, we witnessed an acceleration of 5G network build-out and GaN-based design wins. The situation is expected to come back to normal slowly by the end of H2-20.

In consumer segmentation, the handset production decreased in H1-2020 compared to the same period in 2019. The lockdown in China created disruption in the supply chain, but the strong penetration of 5G and WiFi6 kept driving the strong growth of GaAs PA market.

Since 2018, the GaN RF telecom infrastructure market has been severely impacted by the trade conflicts. The Chinese market led by Huawei represents a large market for 5G GaN wireless infrastructure. US-based device manufacturers had to stop shipping GaN PAs to Huawei in 2019. The US has banned all semiconductor manufacturers from selling to Huawei if their products contain US technology. Since a large majority of semi-insulating SiC substrates are supplied by American wafer manufacturers, the Chinese OEM is again facing a risk of short-supply in the short term.

GaAs RF has a well-established supply chain with many global players, therefore it's less impacted. Key players in the supply chain recently expanded capacity to meet the demands.

CONCLUSIONS

Despite the disruption of Covid-19 and trade war issue in 2020, 5G is still the main motivation to drive the growth of the compound semiconductor, from the perspectives of supply chain, technology development and end system adaption. GaN is expected to take more market share in telecom infrastructure for the following years and GaAs will continue empowering the adoption of 5G and wifi6 connectivity in the new generation of phones in 2021 and probably the years to come.

REFERENCES

[1] Yole's - Compound Semiconductor Monitor Service Q4-2020: Module I: Power SiC and Power GaN

[2] Yole Report: GaN RF MARKET: APPLICATIONS, PLAYERS, TECHNOLOGY, AND SUBSTRATES 2020

[3] Yole Report: GaAs WAFER AND EPIWAFER MARKET: RF, PHOTONICS, LED, DISPLAY AND PV APPLICATIONS 2020

[4] Yole Report: 5G's Impact on RF Front-End and Connectivity for Cellphones 2020

ACRONYMS

RFFE: Radio-Frequency front-end
MIMO: Multiple Input, Multiple Output
PA: power amplifiers
CAGR: Compound Annual Growth Rate
V2X (Vehicle-to-Everything)
RRH: remote radio head
AAS: active antenna systems
LDMOS: Laterally Diffused Metal Oxide Semiconductor
BTS: Base Transceiver Station
LTE: Long-Term Evolution