Accelerated Adoption of GaN RF in Telecom Infrastructure as Opportunities for GaN-on-Si

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Abstract

This paper presents the GaN RF evolution through the Telecom infrastructure, Defense, and other markets. The market growth is expected to pick up again due to the adoption of OEMs. We illustrate the global picture for GaN RF today with the trends and Yole's forecast for the coming 5 years. As of 2023, GaN on SiC is the mainstream technology adopted by the market. Meanwhile some well-known semiconductor players are investing and developing GaN on Si technology to address the 5G infrastructure, SatCom and potentially handset markets.

INTRODUCTION

At the dawn of this new decade, the two market drivers for Radio Frequency (RF) GaN remain 5G telecom and defense. Emerging segments, such as satellite communication (SatCom), will contribute additional momentum to grow the market. The total GaN RF market's value will increase from $1.2B to more than $2.8B with a Compound Annual Growth Rate for the period from 2021 to 2027 ($CAGR_{2021-2027}$) of 16%.

GAN-RF ADOPTION FASTER THAN EXPECTED

In the telecom infrastructure, GaN has penetrated different types of base stations to offer benefits at high power and wide bandwidth. Following adoption for remote radio heads (RRHs) and massive Multiple-input Multiple-output (MIMO) active antenna system (AAS), the global GaN-based macro/microcell segment is expected to grow faster than expected, reaching beyond $1.2B by 2027, due to the strong interests from new emerging Indian Telecom Infrastructure Market. Other opportunities on Telecom Market such as Backhaul and mmWave Small-Cell can increase as well the GaN RF devices volumes in the coming years. This will represent more than 95% of the total GaN Telecom infrastructure market.

As an established market, the defense segment remains one of the main drivers for RF GaN. Amongst various systems, radar accounts for the main application to adopt GaN, owing to the increase of lightweight transmit/receive modules in active electronically scanned array (AESA) radars in airborne systems. Overall, GaN is expected to grow, with a $CAGR_{2021-2027}$ of more than 17% for defense radars. Already deployed in fixed SatCom systems, mobile SatCom is poised to be the next market driver for GaN RF solutions in the long term. GaN with more efficient at higher power and smaller size RF devices is taking share from GaAs solutions in transmit chain slowly here, while GaAs solutions are still preferred in receiver chain thanks to low noise characteristics and reliability. Meanwhile, in mobile satellite systems, GaN's penetration is still limited due to tough qualification cycles. Ongoing European Space Agency projects with Airbus, UMS and OMMIC open new possibilities for GaN in space. As shown in Fig. 1, we expect growth in other segments such Consumer market and Others including RF energy, CATV.

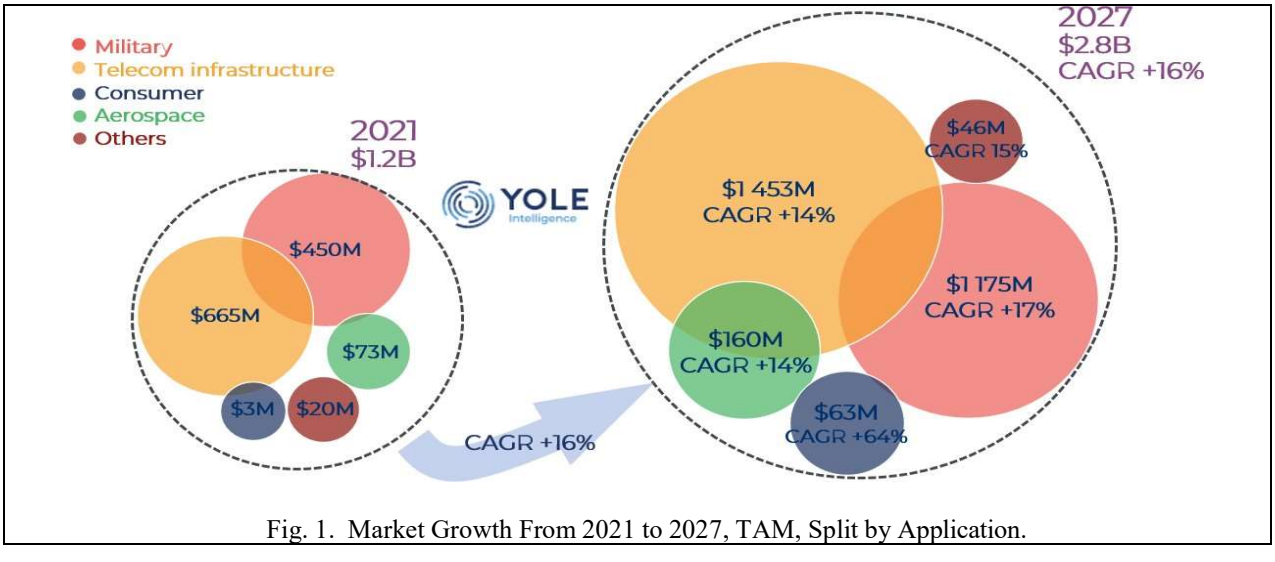

Fig. 1. Market Growth From 2021 to 2027, TAM, Split by Application.

GaN-on-SiC Dominates While GaN-on-Si Emerges

In the RF GaN industry, everything started with GaN-on-SiC technology. Launched more than 20 years ago, GaN-on-SiC is now a serious rival to LDMOS and GaAs in RF power applications. In addition to its deep penetration in military radar, GaN-on-SiC has also been the choice of telecom OEMs such as Huawei, Ericsson, Nokia, and Samsung for 5G massive MIMO infrastructures. Owing to their high bandwidth and efficiency, GaN-on-SiC devices continue to take share from LDMOS in the 5G market and are starting to benefit from a 150 mm wafer platform transition. In this context, the GaN-on-SiC device market is expected to reach over $2.4B in 2027 by posting a 17% $CAGR_{2021\text{-}2027}$. However, GaN-on-Si is coming into the game as a key competitor by providing promising cost-efficient and scalable solutions with 150 mm or 200 mm manufacturing platform. Despite the market starting with only initial volume of few thousand of wafers per year for now mainly for R&D and qualification process, GaN-on-Si will primarily grow with the demands of Sub-6 GHz and mmWave applications, as the technical requirement for Power Amplifiers (PAs) goes for higher frequency in Sub-6Ghz bands and lower output power of around 5-10W in AAS solutions. Industry actors, such as Infineon, Macom, STMicroelectronics, and Globalfoundries, are working on the transition. In fact, it is more challenging for GaN on Si to afford good GaN Epilayer Quality due to its lattice mismatch with Silicon, compared to that with Silicon Carbide. Consequently, reliability issues such as leakage current and linearity remain as main technical challenges for GaN-on-Si technology. In addition, transition of manufacturing platform from 100 mm to 150 mm and eventually to 200 mm to gain cost competitiveness is not straightforward from epitaxy quality and homogeneity as well as potential technical challenges in FE/BE processes. On the other hand, some smartphones OEMs are evaluating GaN-on-Si as the candidate for the next generation of handset PAs, owing to their large bandwidth and small form factor. However, it will require a change in architecture to apply higher battery voltage, in order to leverage the advantage of GaN. It shows the potential market for GaN-on-Si to grow in a longer-term perspective. Driven by 5G telecom infrastructure applications and defense, the GaN-on-Si device market is expected to reach $510M in 2027 by posting a 86% $CAGR_{2020\text{-}2027}$ (Fig. 2).

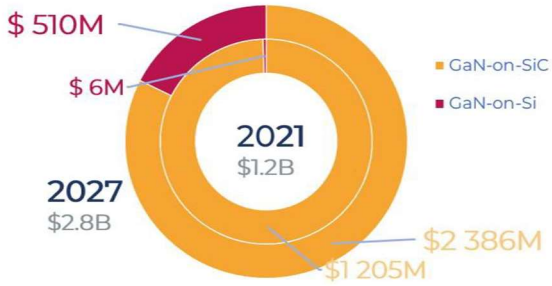

Fig. 2. Device Market Share GaN-on-Si vs GaN-on-SiC

Conclusions

Global GaN for RF applications market is growing with the trends in end applications. Mainly driven by Telecom infrastructure and Defense, GaN devices are becoming standards for some applications. The competition between LDMOS and GaN for Telecom infrastructure is still here with the requirement of today, and more market share of GaN in the coming years due to the advantages at higher frequency over LDMOS. On the other hand, industry players show strong interests in GaN-on-Si. By gaining maturity of technology and supply chain, GaN-on-Si is also considered as an alternative for some applications.

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Acronyms

RFFE: Radio-Frequency Front-End
MIMO: Multiple Input, Multiple Output
PA: Power Amplifiers
CAGR: Compound Annual Growth Rate
RRH: Remote Radio Head
AAS: Active Antenna Systems
LDMOS: Laterally Diffused Metal Oxide Semiconductor
BTS: Base Transceiver Station
TAM: Total Available Market