

Epitaxy equipment towards a billion-dollar mark

V.Kumaresan, E. Jolivet

Yole Développement, 75 Cours Emile Zola, 69100 Villeurbanne France, e-mail : vishnu.kumaresan@yole.fr – Phone : +33.6.61.64.09.03.

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Abstract

Epitaxy has remained a crucial step in MtM applications such as Power GaN, Power SiC, MicroLED and VCSELs. With COVID-19 accelerating the technological curve for these applications, the capital investment in the epitaxy equipment space is booming. In addition, the dynamic geo-political situation has added an additional level of demand for epitaxy equipment as device manufacturers in China are spending on equipment at record levels. In this paper, we aim to provide an overview of the status and market forecast for the epitaxy equipment (MOCVD, HTCVD and MBE) in MtM space, along with a brief outlook on the role of China in the equipment demand and how it is shaping the competitive landscape of epitaxy equipment vendors.

INTRODUCTION

We are at a crucial period of history where each device around us is becoming smarter, greener, and more compact. In such an innovation race to add more functionalities into our everyday devices using the More-than-Moore (MtM) approach, the power-performance-area-cost (PPAC) factor is improved by using non-Si materials and by heterogeneously integrating them to one another. In this regard, Si, along with compound semiconductors such as GaAs, GaN, SiC, and InP, is growing at significant CAGRs. However, the choice of these materials comes with stringent material quality

requirements and hence necessitates ultra-pure thin films grown using epitaxy equipment.

PLETHORA OF APPLICATIONS DEMANDING EPITAXY EQUIPMENT

There are three major epitaxy equipment types used in MtM space: MOCVD, HTCVD and MBE. Historically, MOCVD is required for commodity devices such as GaN-based traditional LEDs. However, an increasing number of upmarket applications, such as fast chargers, MicroLED displays, and VCSELs for 3D sensing, will drive demand in the years to come. For HTCVD, the primary market remains the Power applications, which are based on Si and SiC epimaterial and are mainly deployed in market segments such as automotive and industrial. As a third technique, MBE is already used in low-volume, high-performance demanding applications (e.g., high power VCSELs, MicroLEDs etc.) as a potential competitive solution to MOCVD.

As of 2020, epitaxy equipment sales for MtM applications amounted to around \$692 M and was shared between MOCVD, HTCVD and MBE as 61%, 32% and 7% respectively. This market is expected to grow to \$1.1 B by 2026, with a CAGR₂₀₂₀₋₂₀₂₆ of 8% (shown in fig. 1). However, these figures do not do justice to the vitality and omnipresence of the epitaxy step in mission-critical applications in market segments such as automotive (EV/HEV), consumer (smartphone, smartwatch, AR/VR), and aerospace & defense.

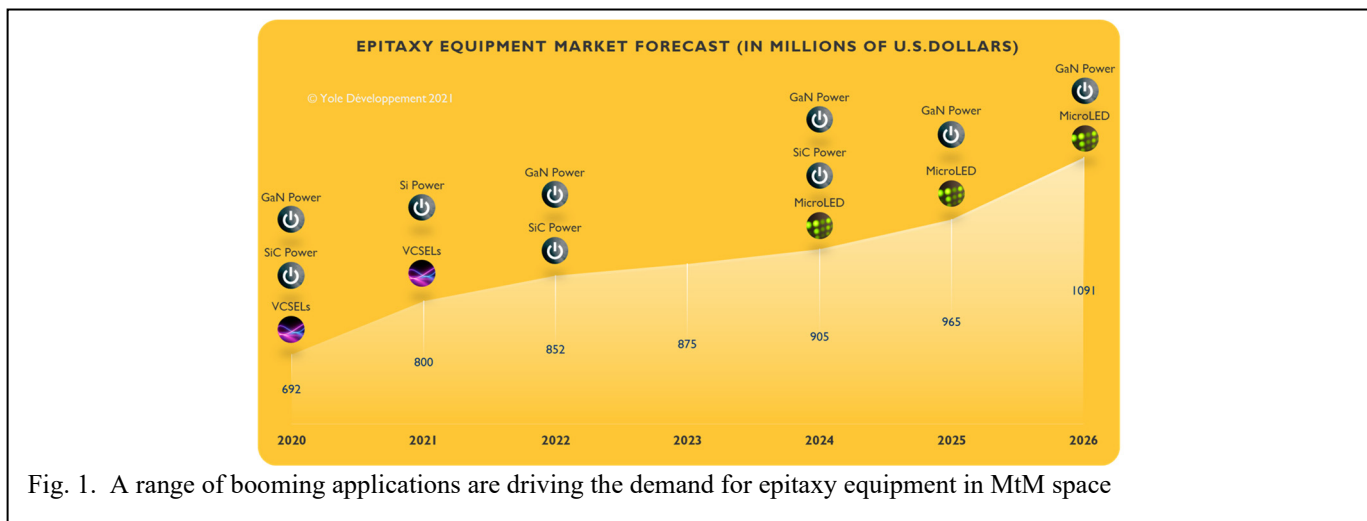


Fig. 1. A range of booming applications are driving the demand for epitaxy equipment in MtM space

Between the forecasted period of 2020 – 2026, the equipment market is quite solid and is projected to have a cumulative sale of 6.2 billion USD for all epitaxy equipment type included in this paper.

MACROECONOMIC FACTORS ARE FURTHER PUSHING THE DEMAND FOR EPITAXY EQUIPMENT

Accounting for all these three equipment types, demand from a wide range of applications translates directly to growth of different sets of epi-materials. SiC, in particular, is experiencing a lot of demand in China. Having said that, we believe that in many cases, the investments in 2020 and 2021 for this equipment are rather strategic than the actual market demand. Overall equipment spending peaked in 2020 (~ \$70 billion) and China emerged to be the biggest investor (fig. 2). The equipment market is estimated to jump by 15% in 2021, and we believe the momentum will continue into 2022 as well. To explain this jump, we must consider the various macro-economic factors that have accelerated the technological transition at the device level. For example, the penetration of GaN and SiC is happening at lightning speed into the automotive and consumer market segments.

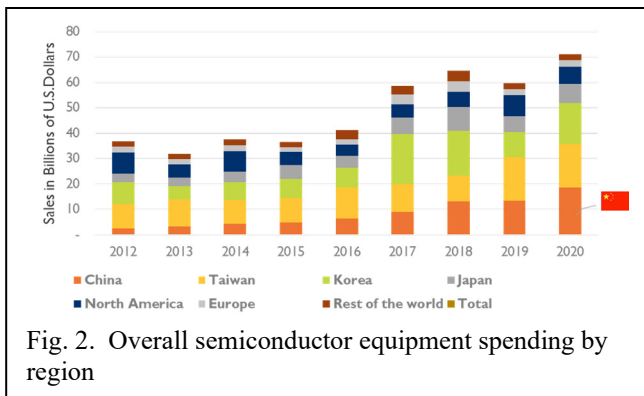


Fig. 2. Overall semiconductor equipment spending by region

GEO-POLITICS INTENSIFYING THE COMPETITIVE LANDSCAPE OF EPITAXY EQUIPMENT VENDORS

It is intriguing to realize that these complex epitaxy equipment systems used in HVM are supplied by only very few players, including some not very well known in the mainstream front-end market. In total, we have identified 11 major epitaxy equipment vendors in the MtM space, and the top three (Aixtron from Germany, Veeco from the US, and AMEC from China) dominated in 2020 with more than 60% of the market share by revenue (figure 3). However, this market is also occupied by various other front-end equipment giants (such as AMAT, TEL, ASM International, Naura), domain-specific players (such as Taiyo Nippon Sanso, NuFlare, LPE), and some unidentified start-ups from China.

If we look at the top-2 players, between 2018 and 2020, Aixtron increased its market share by 10%, while Veeco has seen its market share fall by 15%. One of the many reasons

for this is the US-China trade tension, which has chosen the semiconductor industry as one of their battlegrounds. This battle is even more pronounced in the epitaxy equipment space as the demand is primarily driven by China. As a result, 2020 resulted in one of the best sales years in China for Aixtron, with approximately 57% of their revenue coming from the region, in contrast to Veeco’s modest 13% revenue. Naturally, Aixtron continues to be the leader, with Veeco retaining its second spot. AMEC follows closely in third place with a good volume of equipment shipped for LED devices. However, as the geopolitical situation remains dynamic, we expect the scenario to change anytime soon.

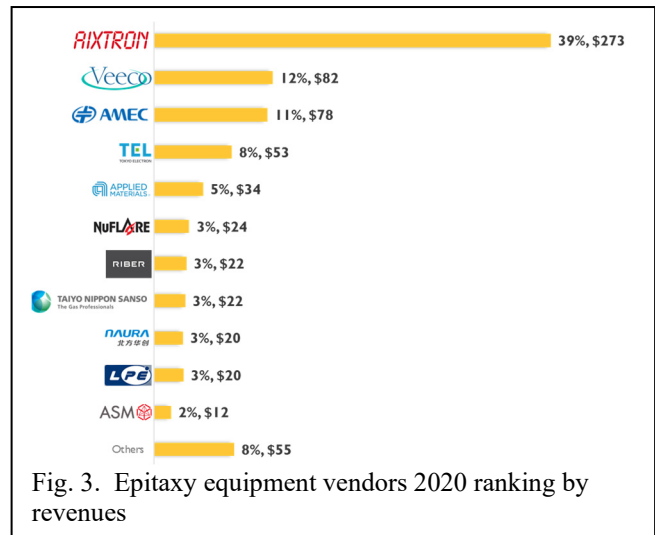


Fig. 3. Epitaxy equipment vendors 2020 ranking by revenues

CONCLUSIONS

Epitaxy remains to be a mission-critical step in various MtM applications such as Power SiC, Power GaN, MicroLED, and VCSELs. As technology acceleration is gather pace, these applications are penetrating consumer and automotive markets rapidly. This directly translates into peak demands for epitaxy equipment, with 2020 and 2021 being one of the best years for equipment providers. We expect the tailwinds to last at least until end of 2022 and eventually the total market for epitaxy equipment in MtM to certainly exceed a billion dollar by 2026. With the geopolitical situation evolving and the supply chain ever more fragile, we expect the competition between equipment vendors to intensify in the coming years.

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ACRONYMS

MtM: More than Moore
CAGR: Compound annual growth rate
MOCVD: Metal Organic Chemical vapor deposition
MBE: Molecular beam epitaxy
HTCVD: High temperature chemical vapor deposition
LED: Light emitting diodes
VCSEL: Vertical cavity surface emitting laser
EV: Electric vehicles
HEV: Hybrid electric vehicles
AR: Augmented reality
VR: Virtual reality
HVM: High volume manufacturing

