EMERGING SEMICONDUCTOR SUBSTRATES: MARKET & TECHNOLOGY TRENDS 2019

Market & Technology Report - May 2019

Emerging semiconductor substrates are expected to grow at a 24% CAGR from 2018 - 2024.

REPORT KEY FEATURES

- State-of-the-art technology development of GaSb, InSb, bulk GaN, Ga2O3, bulk AlN, diamond, GaN, AlN templates, and emerging engineered substrates
- Application potential for each material
- Key players/ecosystem for each material
- Materials market size (in $M) in 2018 and 2024
- Materials price in 2018 and 2024

ELECTRONICS AND PHOTONICS APPLICATIONS ARE CREATING PLENTY OF OPPORTUNITIES FOR EMERGING SEMICONDUCTOR SUBSTRATES

Silicon isn't the perfect semiconductor, and with it currently being pushed to its limits, alternative platforms and compound semiconductors have emerged. The success stories include GaAs for RF and photonics applications, SiC for power and RF applications, GaN-on-sapphire for LEDs, and SOI for RF and CIS imaging sensors.

Fueled by a desire to push performance limits and reduce cost, new materials are being explored for different semiconductor applications. This report looks at the drivers involved.

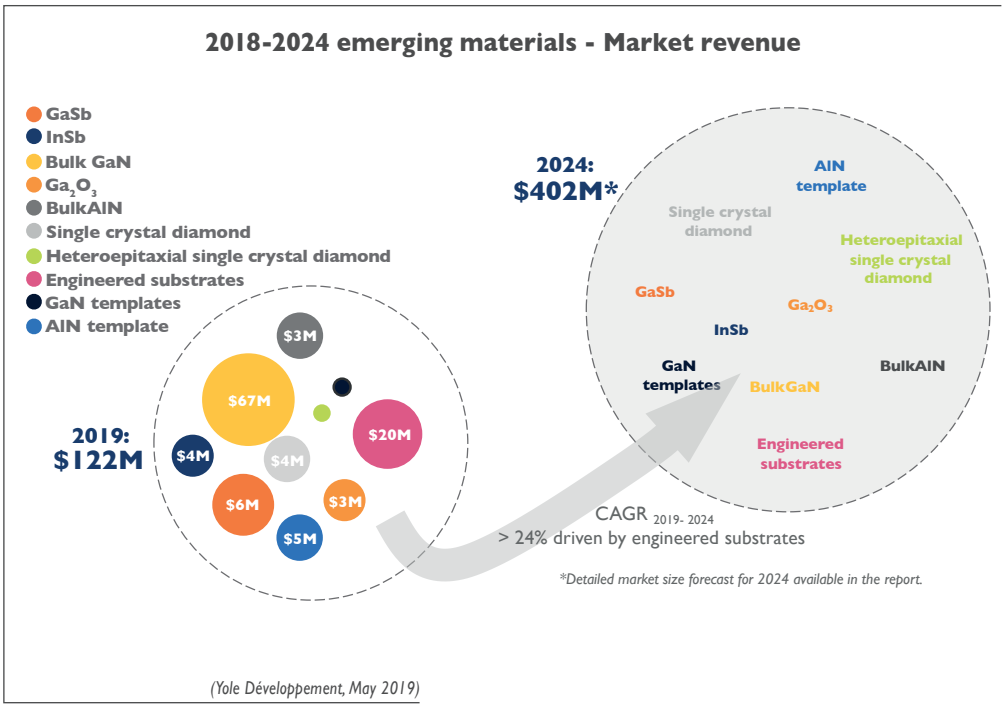
Starting with RF applications, there are numerous market drivers, including 5G for infrastructure and handsets, defense applications and civil automotive radar, and more. For example, 5G deploys MIMO, which is used in high-end 4G LTE phones. MIMO is obligatory for handsets, and more filters will be needed. Plus, better performance is required, which implies a big market opportunity for new materials.

Regarding the power electronics market, which is currently driven by the electrification of transportation, renewable energy, motor drive, and numerous power supply applications, enhanced device performance to reduce power consumption is a general trend that has created market opportunities for wide band gap materials like SiC. Indeed, the SiC power device market is taking off, though the substrate remains expensive. Is there a place for other wide band gap and ultra-wide band gap semiconductors, like Ga_2O_3?

The photonics market, ranging from ultraviolet (UV) to the infrared (IR) spectrum, brings huge opportunities: from water purification and gas sensors, to infrared imagers. Since the wavelength is determined by the bandgap of the material (which is intrinsic to each material), different materials are being developed to push the wavelength towards shorter or longer regions.

Electronics and photonics applications are creating plenty of opportunities for emerging semiconductor substrates. Combined, Yole Développement (Yole) expects the emerging semiconductor substrate market to surpass $400M, growing at a 24% CAGR from 2018 - 2024.

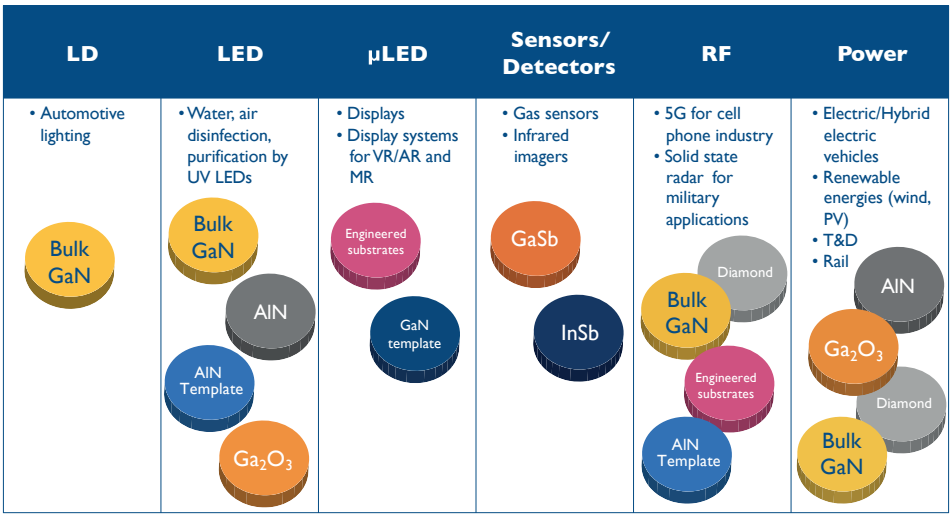
This report covers state-of-the-art crystalline semiconductor substrates, including GaSb, InSb, GaN, Ga_2O_3, AlN, and diamond. GaN, AlN templates, and engineered substrates like piezo-on-insulator (POI) are also covered.



(Yole Développement, May 2019)

THERE ARE MANY DRIVERS FOR EMERGING MATERIALS

2018-2024 emerging materials' target markets



(Yole Développement, May 2019)

Researchers and engineers have plenty of ideas, and now the questions are, "Which emerging semiconductor substrate will be the next game-changer?" and "For which application"?

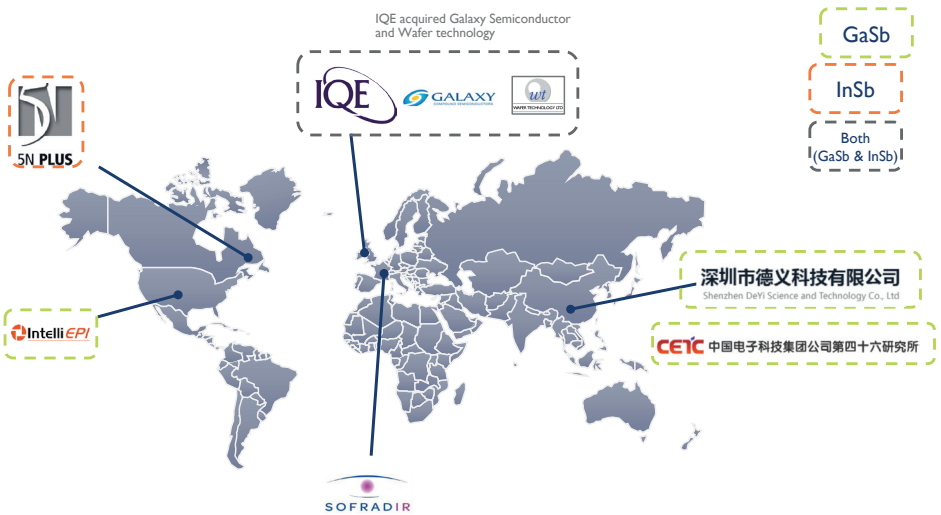
Starting with GaSb and InSb, laser diodes (LDs) and photodiodes (PDs) based on these materials are already deployed in performance-driven military applications. But this is not all. For example, IQE, a leading antimonide wafer and epiwafer supplier, is actively engaged with tier1 OEMs on new opportunities to migrate antimonide-based "see in the dark" IR technologies into consumer markets. Yole also sees that an emerging GaSb-based type-2-superlattice (T2SL) technology is being developed by several major detector players including FLIR, Semiconductor Devices, and IRnova. This technology is expected to penetrate into consumer applications, with ramp-up in the coming years.

Bulk GaN wafers have for many years been widely used for laser diode applications. Recently, researchers have explored their usage in power electronics and RF applications. We see a growing effort, led by Japanese players (ranging from materials suppliers to device suppliers like Toyoda Gosei), to make vertical GaN-on-GaN power devices happen. In the meantime, an ultra-wide band gap material (Ga_2O_3) is garnering increased attention. Wafers up to six inches have been demonstrated, with the promise of potentially lower cost than today's SiC solutions. Future ramp-up will depend on technology/cost competition from other existing solutions.

Up to now we have considered bulk crystal materials, but they are not the whole story. Templates and engineered substrates are also being developed for either lower cost (i.e. SiC and poly SiC bonding) or better performance, such as piezo-on-insulator for filter applications.

This report conveys Yole understanding of these substrates' application potential in RF, power electronics, photonics (including laser diodes), LEDs, sensors, and detectors.

Mapping of GaSb and InSb wafer suppliers* (Q1, 2019)



Mapping of other semiconductor substrates are available in the report.

non-exhausitve list of companies

(Yole Développement, May 2019)

REPORT OBJECTIVES

- Overview of different emerging semiconductor substrates other than Si, GaAs, InP and SiC
- Understanding of the driver and the barrier of each materials
- Time to market discussion
- Application potential assessment
- Identification of the key players

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TABLE OF CONTENTS (complete content on i-Micronews.com)

Glossaries & definitions 2
Table of contents 4
Report objectives 7
Methodology 8
The authors 9
Companies list 10
Executive summary 11
Context 31
> Report scope
> Semiconductor applications
Market forecasts 34
> Wafer prices, as of 2018
> Emerging materials - market size forecast 2018 - 2024
Market trends 40
> Photonics applications
- Ultraviolet applications
- Infrared applications
> Electronics applications
- Power electronics applications
- RF applications
> Applicative market trend overview
> Emerging materials' target markets
Supply chain & ecosystem 55
> Mapping of GaSb and InSb wafer suppliers (Q1 / 2019)
> Mapping of FS and bulk GaN players (Q1 / 2019)
> Mapping of Ga_2O_3 players (Q1 / 2019)
> Mapping of diamond players (Q1 / 2019)
> Mapping of bulk AlN players (Q1 / 2019)
> Mapping of engineered substrates (Q1 / 2019)
> Mapping of GaN template (Q1 / 2019)
> Mapping of AlN template (Q1 / 2019)
Technology trends 70
> Gallium antimonide and indium antimonide
> Bulk GaN
> Gallium oxide
> Diamond
> Bulk AlN
> Alternative solutions for single-crystal wafers - engineered substrates and templates
Perspectives and conclusions 182
> Different crystal diameter expansion - History
> Maturity of emerging materials (Yole Développement's understanding)
> Technology and market barriers
> General conclusions

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As a Technology & Market Analyst, Compound Semiconductors, **Ezgi Dogmus,** PhD is a member of the Power & Wireless division at Yole Développement (Yole). Ezgi's contributions to the daily development of the division's activities include a dedicated collection of market & technology reports, as well as custom consulting projects. Prior to joining Yole, Ezgi was deeply involved in the development of GaN-based solutions at IEMN (Lille, France). She has also participated in numerous international conferences and authored or co-authored more than 12 papers. Upon graduating from the University of Augsburg (Germany) and Grenoble Institute of Technology (France), Ezgi received her PhD in Microelectronics at IEMN (France).

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