Glass is a common material used in everyday applications and spread across various products: windows, eye glasses, and bottles, as well as in electronic components such as LCD displays, notebook computers, and smartphones. Due to its excellent chemical, mechanical, electrical, and optical properties, glass’s applications are constantly evolving. Glass is making serious inroads in the semiconductor market, adopting various functionalities within IC semiconductor devices.

Specific to semiconductors, glass material is typically implemented in two formats (wafer and panel) and is available in two densities (thin & thick). Moreover, glass material can be used in two different ways to fabricate a semiconductor device’s product:

- Glass-based product where the glass material is applied as a permanent material and remains in the final product, i.e., permanent substrate, WLCapping, TGV interposer, and IR cut filter functionalities
- A non-glass-based product where the glass substrate is only applied for temporary use in the process flow and then removed after the IC device is processed. In this category, the glass carrier functionality is used for device fabrication, but does not remain in the final product.

8-inch eq glass wafer is expected to increase at a 23% CAGR through 2022, reaching around 14M 8-inch eq wafer. Some IC device applications using glass material are fairly mature, such as CIS, microfluidics, and actuators & sensors, with relatively low growth opportunity except for FO WLP packaging applications driven by glass carrier usage. Regarding functionalities, the glass wafer market is driven by WLCapping and permanent substrate, which are fueled by the automotive and medical fields.

The glass material market’s ascent will be due to the fast growth of glass carriers for FO WLP and actuators & sensors. On the other side, TGV interposer is still perceived as immature, but we expect an adoption rate for production by 2019 - 2020.

This report provides detailed information regarding the current and potential applicability of glass material in the semiconductor field, as well as its processing functionalities. Also included is a detailed analysis of the major applications currently using glass material, and the potential applications that could require the use of glass substrate.

**Key Features of the Report**
- Detailed analysis of glass substrate use in the following applications’ devices: actuators & sensors, CMOS image sensors, memory & logic, RF devices, power devices, optoelectronic components, microfluidics, and FO WLP packages
- Thorough analysis of glass substrate use in different glass-based functionalities, including permanent substrate, wafer-level capping, TGV interposer, and non-glass-based, incl. glass carrier
- 2016 - 2022 glass substrate market metrics (wspy/panel and value): breakdown by end-application and functionality
- 2016 - 2022 glass substrate market forecast, by wafer size and panel size
- 2016 global glass substrate market share in the semiconductor field
- 2016 glass material market share by application
- Overview of the players using glass material, by application and functionality
- Roadmap for glass technology adoption
- Updated technology trends analysis across different semiconductor segments
- Complete study of glass substrate opportunities in the semiconductor field, with cost, technology, and supply chain status

**Why will the glass wafer market’s revenue double over the next five years?**

**Which semiconductor applications and functionalities will drive the glass material market’s growth?**

Glass wafer substrate market size (in 8 inch wspy)

Breakdown per end application

Overall glass wafer substrate market size (in 8 inch wspy)

Breakdown per end application

Actuators & sensors  CIS  RF devices  FO WLP  Optoelectronics  Power devices  Microfluidics  Memory & logic

(Yole Développement, July 2017)
WHAT’S NEW
• Glass substrate industry - status and evolution since 2013
• Update of our 2016 - 2022 glass material market forecast for actuators & sensors, CMOS image sensors, memory & logic, RF devices, power devices, optoelectronic components, and microfluidics, as well as a detailed study of glass material for the FO WLP platform
• Glass material market overview, segmented by semiconductor device and glass functionality permanent substrate, IR cut filter, WL-Capping, TGV interposer, glass carrier
• Update regarding key 2016 glass material suppliers: raw material and processor companies
• A new analysis based on the competitive landscape and market share of glass material suppliers, by semiconductor segment
• Key technical insights and a detailed analysis of glass material solutions, trends, requirements, and challenges, by semiconductor device and functionality

THE GREAT “GLASS - PANEL QUESTION”: WILL PANEL’S INTRODUCTION CONSIDERABLY IMPACT THE GLASS SUBSTRATE MARKET’S GROWTH IN THE SEMICONDUCTOR FIELD?

Some applications using glass material are already manufactured on panel size for IR cut filter, implemented in the CIS camera module as well as CIS proximity sensors. IR cut filter is already well-established and represents a huge business in the glass substrate market. With IR cut filter already manufactured in panel format, the question pertaining to glass panel-based is increasingly important. Indeed, we expect other devices to use glass substrate in panel format, i.e. FO WLP and RF devices. Since glass material is already available in panel size and adopted for large-volume manufacturing in the display and touch-panel areas, there is an ease of transitioning from glass wafer to glass panel since the glass manufacturing processes and tools are leveraged. Therefore, going from wafer to large-panel format will offer a path to scalability, delivering a lower cost process compared to glass wafer-based.

We estimate that panel demand will reach 28M of mm² in 2017, 100% of which will be captured by today’s CIS applications. Furthermore, demand is expected to exceed 46M of mm² by 2022, driven by FO WLP package applications.

Although it is difficult to predict the success of glass panel-based, we expect the first glass panel activities to be deployed by 2019, mainly driven by FO WLP and RF device applications. These semiconductor devices will be respectively fueled by glass carrier and TGV interposer functionalities. The mm wave starting above 28 GHz will strongly influence the growth of glass material within RF devices, and will drive TGV interposer panel-based. Additionally, some firms have already invested in a panel line for FO WLP, integrating glass-carrier panel format into their process flow due to its high mechanical properties and ease of thickness control. They have also adjusted CTE up to 12 ppm.

This report offers an analysis of glass wafer-based vs glass panel-based trends in semiconductor applications, as well as detailed forecasts of panel-based glass volume shipments for some devices.

THE GLASS MARKET’S GROWTH AND THE SEGMENTATION OF APPLICATIONS HAS LED TO INCREASED COMPETITION IN THE GLASS SEMICONDUCTOR INDUSTRY

The glass material market for semiconductor is concentrated amongst glass material suppliers from different categories:
• Raw material manufacturers like Schott, Corning, and AGC providing raw glass material and blank wafers or sheets. These companies have limited wafer-processing capabilities.
• Glass processors and structured substrate manufacturers like PlanOptik and Tecnisco, which can pattern and structure glass wafers from the raw material provided by raw-glass material suppliers. These companies typically purchase wafers from raw-glass material suppliers and then design/create products from the raw material.
• Structured/patterned glass wafer manufacturers (mainly from MEMS & microfluidics) focused mainly on microfluidic and MEMS devices. This category mostly includes foundries that start from blank or pre-patterned wafers. However, the difference
between them and a typical foundry (i.e. Silex) is that they create their own products.

Established glass applications such as CIS and microfluidics have led Schott to dominate the glass material market in the semiconductor field. However, emerging applications (RF devices, FO WLP, etc.) could require the use of glass material and thus represent an opportunity that might offer nice upsides to glass companies able to capture them.

In the quest to acquire market share, we’re seeing the entrance of aggressive players like Neg in the FO WLP field. We also see increased competition, even in mature markets like actuators & sensors and power devices where Chinese glass processor companies are likely to challenge established players like PlanOptik and Tecnisco.

Increased competition has created a challenging environment for glass substrate makers. They must drop their price, especially for technologies that are not well-established, while stimulating technology improvements. Moreover, RF devices and FO WLP applications will become the areas where most material suppliers compete and try to gain as much share as possible.

In this immature market, there exist unquantified business opportunities that could reshuffle the rankings. As usual, performance level and cost will determine the winner. Also detailed in this report is the competitive landscape and major glass material suppliers’ market share, quantified by application

COMPANIES CITED IN THE REPORT (non exhaustive list)

REPORT OBJECTIVES
• Provide a detailed analysis of the glass material industry’s status for:
  > Applications like actuators & sensors, CIS, memory & logic, RF devices, power, photonics, microfluidics and FOWLP
  > Glass functionalities including permanent substrate, WL Capping, TGV interposer, IR cut filter, and glass carrier
• Identify established applications and emerging applications using glass material substrate, and provide trends and drivers
• Detail the current status of glass material adoption, and the various glass materials available on the market
• Highlight the key glass technologies used in the semiconductor field
• Provide an overview of glass material’s technological trends
• Understand the key benefits and added-value of glass material in the semiconductor field
• Review glass’s technical characteristics, challenges, and entrance barriers for each market segment and functionality
• Supply a 2016 - 2022 glass market forecast in revenue and volume, by application, functionality, and substrate size
• Describe a competitive landscape and identify key players in technology development and manufacturing

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