GLASS SUBSTRATE FOR SEMICONDUCTOR APPLICATIONS 2020
Market & Technology Report - November 2020

The glass substrate market has $200M revenue today and will triple over the next five years, driven by Fan-Out Wafer Level Packaging (FO WLP), CMOS Image Sensors (CIS) and microfluidic devices.

GLASS IS A VERSATILE MATERIAL APPLIED IN DIFFERENT FUNCTIONALITIES IN THE FIELD OF SEMICONDUCTOR APPLICATIONS

Glass is a common material already employed in everyday applications, including windows, eyeglasses, and bottles.

Over the last few years, glass has gained considerable interest for electronic components, due to its very attractive electrical, physical, and chemical properties, as well as its prospects for a relevant, cost-efficient solution.

As of today, the application scope of glass substrates in the semiconductor field is broad and highly diversified.

Glass material can adopt various functionalities within Integrated Circuit (IC) and semiconductor devices, such as MEMS actuators and sensors, CMOS Image Sensors (CIS), memory and logic, Radio Frequency (RF), power electronics, photonics, microfluidics devices as well as the Fan Out Wafer Level Packaging (FO WLP) technology platform. It can be used in the following ways:

- Permanent support glass substrates that undergo many fabrication process steps, such as etching, deposition of materials and photolithographic patterning
- Wafer Level Capping (WLCapping), which is based on mechanical sawing of a wafer cap above the sensor
- 3D TGV/Glass interposer, referring to a structure integrating vertical through via electrical connections from top to underside, Through Silicon Vias (TSVs) for interposers or Through Glass Vias (TGV) for glass interposers

Glass carriers used as temporary substrates to provide mechanical support for the thin silicon device wafers

The demand for glass today is mostly driven by WLCapping and glass carriers, fueled mostly by MEMS, CIS and FO WLP. In the coming years, the availability of other glass functionalities such as TGV interposers, still perceived as immature, in conjunction with end-applications like RF devices, could be the driving force for growth. This will create new challenges and new technical developments along the way.

This report provides a detailed overview of glass functionalities and platforms, as well as the various end-applications it is relevant for.

![2019 Glass substrate functionalities vs semiconductor devices](image-url)
Glass substrate revenue reached almost $196M in 2019 and is expected to exceed $580M by 2025, mainly supported by FO WLP packages, WLOptics, actuators, MEMS actuators and sensors.

Initially driven by CIS and MEMS applications, this growing industry will be supported by relevant end-applications such as microfluidics and FO WLP, where glass will further penetrate. Commercialization will be helped by increasing demand from photonics, memory and logic devices.

With a Compound Annual Growth Rate (CAGR) of 40%, the use of glass material for photonics will be glass’s fastest-growing field over the next five years due to the entrance of high-index material for waveguides dedicated to AR.

Additionally, RF devices and FO WLP will also provide nice niches with volume growth and a chance for any glass material supplier to penetrate the market. We expect an introduction of panel formats in those applications by 2023 for RF devices.

Moreover, memory applications will participate in the growth of the glass wafer market, driven by the adoption of glass carriers. Some memory manufacturers have already invested in laser debonding required for glass carriers. We expect that the time for qualification could last two years before mass production can begin. This brings the earliest possible date for glass carrier mass production for memory to early 2022.

Therefore, the use of glass will certainly be on the High-Volume Manufacturing (HVM) roadmap within a few years for other semiconductor applications.

**2019 - 2025 Overall glass wafer market revenue for semiconductor devices**

<table>
<thead>
<tr>
<th>Application</th>
<th>2019</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>FO WLP</td>
<td>$196M</td>
<td>&gt;$580M</td>
</tr>
<tr>
<td>Microfluidics</td>
<td>$31.7M</td>
<td>&gt;$55M</td>
</tr>
<tr>
<td>RF devices</td>
<td>$4.7M</td>
<td>&gt;$55M</td>
</tr>
<tr>
<td>MEMS Actuators &amp; Sensors</td>
<td>$27.1M</td>
<td>&gt;$55M</td>
</tr>
<tr>
<td>Power</td>
<td>$5.3M</td>
<td>$104M</td>
</tr>
<tr>
<td>Photonics</td>
<td>$0.6M</td>
<td>&gt;$4.3M</td>
</tr>
<tr>
<td>Power</td>
<td>$0.5M</td>
<td>CAGR 6.5%</td>
</tr>
<tr>
<td>CIS</td>
<td>$2.5M</td>
<td>CAGR 40%</td>
</tr>
<tr>
<td>Memory</td>
<td>$0.6M</td>
<td>CAGR 16%</td>
</tr>
<tr>
<td>CIS</td>
<td>$37M</td>
<td>CAGR 18%</td>
</tr>
<tr>
<td>Memory</td>
<td>$4.4M</td>
<td>CAGR 16%</td>
</tr>
<tr>
<td>Microfluidics</td>
<td>$0.5M</td>
<td>CAGR 28%</td>
</tr>
</tbody>
</table>

*Non-exhaustive list of companies*
NEG's market share and business is coming from the FO WLP market since it is the leading supplier of TSMC for the integrated Fan Out (inFO) product. Planoptik’s revenues account for the majority of the business for glass carriers for power applications due to its relationship with Infineon in actuator MEMS pressure sensors using WL Capping.

Although Corning and AGC are really active in the RF front-end and connectivity industries with their borosilicate products, the RF industry is also evaluating photosensitive glass material mostly offered by 3D glass solutions. Its solution could be an alternative solution for RF high frequency applications due to high thermal performance combined with low-cost manufacturing.

There are still business opportunities in this immature market that are not really well established. They could reshuffle the ranking by inviting specialized glass vendors with well-honed expertise in specific applications to enter. The level of performance and the cost will determine the winner.

Competitive landscape and major key glass material suppliers’ market share are quantified by application and detailed in this report.

COMPANIES CITED IN THE REPORT (non exhaustive list)


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REPORT OBJECTIVES
The objectives of the report are to:
- Provide a detailed analysis of the status of the glass material industry for:
  - Applications such as MEMS actuators and sensors, memory and logic, CIS, RF devices, power, photonics as well as microfluidic applications
  - Glass functionalities such as: permanent substrates, WL Capping, TGV interposers, WLOptics, IR cut-off filters and glass carriers
- Identify established applications and emerging applications using glass material substrates and provide their trends and drivers
- Give the current status of glass material adoption and the various type of glass materials available on the market
- Highlight the key glass technologies used in semiconductors
- Provide an overview of the technological trends for glass materials
- Understand the key benefits and added value of the glass materials in the field of semiconductors
- Review technical glass characteristics, challenges and barriers to entry for each market segment and functionality
- Offer market metrics at glass wafer market level for semiconductor applications for 2019-2025
- Evaluate market developments in terms of market size in volume and value, substrate sizes and formats
- Provide a competitive landscape, identify key players in technology development and manufacturing
- Give an overview of who is doing what, and details of each market

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Founded in 1998, Yole Développement (Yole) has grown to become a group of companies providing marketing, technology and strategy consulting, media and corporate finance services, reverse engineering and reverse costing services. With a strong focus on emerging applications using silicon and/or micro manufacturing, the Yole group of companies has expanded to include more than 120 collaborators worldwide covering MEMS and Image Sensors, Compound Semiconductors, RF Electronics, Solid-state Lighting, Displays, Software, Optoelectronics, Microfluidics & Medical, Advanced Packaging, Manufacturing, Power Electronics, Batteries & Energy Management and Memory.

The “More than Moore” market research, technology and strategy consulting company Yole Développement, along with its partners System Plus Consulting, PISEO and Blumorpho, supports industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to grow their business.

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