Glass Substrate for Semiconductor Applications 2020

Market and Technology Report 2020
REPORT OBJECTIVES

• This report is a research update for the glass material market in the field of semiconductor applications to provide an understanding of the applications, the technology trends and market forecasts by function and the end applications.
METHODOLOGIES & DEFINITIONS

Yole’s market forecast model is based on the matching of several sources:

- **Comparison with existing data**
  - Monitoring of corporate communication
  - Using other market research data
  - Yole développement’s analysis (consensus or not)

- **Comparison with prior Yole Développement’s reports**
  - Recursive improvement of dataset
  - Customer feedback

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**Top-to-bottom approach**
- Aggregate of market forecasts
  - @ System level

**Bottom-up approach**
- Ecosystem analysis
- Aggregate of all players’ revenue
  - @ System level

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**Top-to-bottom approach**
- Aggregate of market forecast
  - @ Semiconductor device level

**Bottom-up approach**
- Ecosystem analysis
- Aggregate of key players’ revenues
  - @ Semiconductor device level

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**Market**
- Volume (in Munits)
- ASP (in $)
- Revenue (in $M)

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**Semiconductor foundry activity**
- Capacity investments and equipment needs

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**Preexisting information**

**Primary data**
- Reverse costing
- Patent analysis
- Annual reports
- Direct interviews

**Secondary data**
- Press releases
- Industry organization reports
- Conferences

**Information aggregation**
Amandine PIZZAGALLI, Market & Technology Analyst, Equipment and Materials Manufacturing

Amandine Pizzagalli oversees the equipment and materials fields for the Advanced Packaging and Manufacturing team at Yole Développement. She holds an international MBA from IAE Lyon, School of Management (France) and an engineer in Electronics, specializing in semiconductors and nanoelectronic technologies. Prior to Yole Développement, Amandine worked for Air Liquide, with an emphasis on CVD and ALD processes for semiconductor applications.

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COMPANIES CITED IN THIS REPORT

3D Glass solutions, 3D micromac, 3M, Array it, Agilent Technologies, AGC, Amkor, AMS (Austria Microsystems)/Heptagon, Anteryon, ASE Group, Biel Crystal, Boehringer Ingelheim, Bosch, Bullen, Caliper (PerkinElmer Company), CDGM Glass, Coherent/Rofin, Corning, Dolomite, EVG, Fujitsu, Fraunhofer IZM, Georgia Tech, Himax, HOYA, Ibiden, Illumina, IMT MEMS, IMT, AG, Infineon, Intel/ Lemeptix, Kiso Micro, Kulite, Lenovo, LensVector, LPKF, Luminex, Medimate Minilab, Micronics, Menlo Micro, Micron, Micronit technologies, Mimetras, Murata, Nanosphere, Nepes, Nippon Electric Glass (NEG), NSG Group, Ohara OPC, Omron, ON Semiconductor, Optopac, Pacific Biosciences, PlanOptik, Polight, Power Technology, Qualcomm/TDK Epcos, Saint Gobain, Samsung, Samtec, Schott, Sensata technologies, Sensirion, Shinko, Silicon Sensing, SK Hynix, SPIL, ST Microelectronics, STATSChipPAC, SUSS MicroTec, Sy&Se, Teledyne Dalsa/Micralyne, Texas Instrument, TE Connectivity, Tecniscc, Tissuse, Translume, TSMC, Unimicron, Waveoptics, Wavelens, WLCSP, Xintec, YEK Glass and many more…

(non-exhaustive list)
• Introduction, definitions & methodology
  o Companies cited in this report
  o Acronyms/glossary
  o Objectives of the report
  o Definitions, limitations & methodology
  o Who should be interested in this report?

• 3-page summary
• Executive summary
• Glass substrate for semiconductor applications
  o Scope of the report
  o Methodology
  o Glass benefits
  o Applicability of potential applications for glass material in semiconductor field. Where is glass required?
  o Glass material at a glance: application markets

• 2019 - 2025 Glass wafer market status & evaluation breakdown
  by end-application and functionality
  o Glass substrate market forecast (in wspy) by semiconductor application and by functionality
    • 2019 shipment forecast
    • 2025 shipment forecast
  o Glass substrate market forecast (in $M)
    • 2019 revenue forecast
    • 2025 revenue forecast
  o Breakdown by substrate size (6 vs 8 vs 12 inch vs panel)

• Competitive landscape - Glass material suppliers
  o Key suppliers in the field of semiconductor
  o Business model: technology offer and capabilities for glass
  o Positionnement of the glass substrate suppliers by functionality and by end application, by glass type
    • 2019 market share per application
    • 2019 overall market share

• In-depth analysis on the glass material by end application
  o Actuators & sensors devices
    o Glass functionalities: how the glass material is applied within actuators & sensors
    o Glass material benefits for actuators & sensors
    o Tipping point to use glass material
    o Technical specifications required
    o Type of actuators & sensors devices using glass material today and that could use glass material in the future
    o Type of glass material used
    o Benchmark of glass material vs alternative solutions
    o Players identified using glass wafers in the actuators & sensors
    o Market forecast in wafers and in revenue
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    o 2019 Glass Market share for actuators & sensors
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  - Glass material suppliers involved in the CIS
  - 2019 Glass market share for CIS devices

- **Memory and logic**
  - Glass functionalities: how the glass material is applied for memory
  - Carrier trend
  - Glass material benefits for memory and logic
  - Potential players identified that could use glass material
  - Market forecast in wafers and in revenue
  - Glass material suppliers involved in the memory and logic

- **RF devices**
  - Glass functionalities: how the glass material is applied in the field of RF devices
  - Glass material benefits for RF devices
  - Tipping point to use glass material
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  - Type of RF devices using glass material today and that could use glass material in the future
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- **Power devices**
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- **Microfluidics**

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  - Glass functionalities in FO WLP: process flow
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  - Type of glass material used
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  - Market forecast in wafers and in revenue
  - Breakdown by type of glass material
  - Glass material suppliers involved in the FO WLP applications
  - 2019 Market share

- **Wafer vs Panel trends**
  - Market forecast in wafers and in revenue
  - Breakdown by type of glass material
  - Glass material suppliers involved in the FO WLP applications
  - 2019 Market share

- **Glass material suppliers involved in the FO WLP applications**

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    - Drilling technologies available on the market
      - Benchmark and applicability of the drilling technologies
      - Key players
    - Roadmap/Trends
    - Applications that could require the use of TGV interposer
      - Benchmark TGV interposer vs alternative solution
    - Supply chain
  - WLOptics
  - IR cut filter
  - Glass carrier
    - Type of glass material used?
    - Roadmap/trends
    - Supply chain

- Conclusions and perspectives
- Yole Corporate presentation
SIGNIFICANT INDUSTRY EVENTS IN THE GLASS SECTOR

2015 (July)
IDEX CORPORATION (NYSE:IEX) announced today the acquisition of CIDRA Precision Services, LLC offering microfluidic components for life science, health and industrial markets. Transaction: $19.5 million with an earn-out up to $5.5 million contingent on the achievement of financial objectives in the 12-month period following closing.

2016
Micronit Microfluidics has acquired IX-factory who has stringent capabilities such as Deep Reactive Ion Etching of silicon and glass allowing the fabrication of high aspect ratio structures for MEMS and microfluidics applications. Transaction: ~$3M

2017
Corning acquired invenios. Varioptic became a part of Corning in 2017 through an acquisition to strengthen position in liquid lens solutions for machine vision, barcode readers, medical imaging, and other industrial applications that require accurate, fast-focusing, and long-lasting lenses.

2018
Schott (Mainz, Germany) acquired Primoceler Oy (Tampere, Finland), a Finnish pioneer in glass micro bonding, to create new possibilities for the protection of sensitive electronics in medical implants, MEMS devices, and other reliability-critical applications.

2019
Schott acquired miniFab (Australian microfluidic company) offering customized polymer microfluidics to enhance their portfolios in the diagnostics market.

2020 (July)
ASML has acquired full shares of the Berliner Glass Group, the German-based provider of optical key components, including refined technical glass and glass touch assemblies in order to support ASML’s continued and future development of EUV and UV products.

ASML
IDEX Corporation
Micronit Microfluidics
Corning
Schott
Varioptic
PrimoCeler
MiniFab
ASML

## Glass Applicability in the Field of Semiconductor

<table>
<thead>
<tr>
<th>End market</th>
<th>End application</th>
<th>Potential device</th>
<th>Glass Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Life Science</strong></td>
<td>DNA Sequencing</td>
<td>Flow cells</td>
<td>Permanent substrate</td>
</tr>
<tr>
<td></td>
<td>Point of Care (PoC)</td>
<td>Diagnostic devices</td>
<td>WLCapping</td>
</tr>
<tr>
<td></td>
<td>Organs-On-Chips (OOC)</td>
<td></td>
<td>TGV interposer</td>
</tr>
<tr>
<td><strong>Datacom/Telecom</strong></td>
<td>Optical communication</td>
<td>Silicon Photonics</td>
<td>Permanent substrate</td>
</tr>
<tr>
<td></td>
<td>Storage memory (SSD)</td>
<td>3D memories</td>
<td>WLCapping</td>
</tr>
<tr>
<td><strong>Consumer</strong></td>
<td>Augmented Reality (AR)</td>
<td>AR heads-up/ Waveguide</td>
<td>Glass carrier</td>
</tr>
<tr>
<td></td>
<td>3D sensing</td>
<td>VCSEL</td>
<td>DOE</td>
</tr>
<tr>
<td></td>
<td>Storage memory</td>
<td>Time-Of-Flight</td>
<td>Lens</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3D memories</td>
<td>DOE</td>
</tr>
</tbody>
</table>
Glass substrate is applied as a permanent material and remains in the final product.

Temporary substrate

- Glass substrate is applied for temporary use in the process flow and then removed after the IC device is processed.
- This temporary substrate is used for the fabrication of device but does not remain in the final product.
### 2019 GLASS SUBSTRATE FUNCTIONALITIES VS SEMICONDUCTOR DEVICES

<table>
<thead>
<tr>
<th>Applications Functionality</th>
<th>Device</th>
<th>Package type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass-based product</td>
<td></td>
<td>FO WLP</td>
</tr>
<tr>
<td>Permanent Substrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WLC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TGV interposer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WL optics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lens</td>
<td></td>
<td></td>
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<tr>
<td>DOE</td>
<td></td>
<td></td>
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<tr>
<td>IR cut filter</td>
<td></td>
<td></td>
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<tr>
<td>Glass carriers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wafer in production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panel in development/evaluation</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Actuators &amp; Sensors</th>
<th>CIS Imaging</th>
<th>Memory</th>
<th>Logic</th>
<th>RF devices</th>
<th>Power</th>
<th>Photonic devices</th>
<th>µfluidics/Biochips</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

Glass Substrate for Semiconductor Applications 2020 | Sample | www.yole.fr | ©2020
TYPE OF GLASS MATERIAL IN THE FIELD OF SEMICONDUCTOR

- Borosilicate
- Aluminosilicate
- Photo-sensitive glass
- Fused Silica/Quartz
- High Index
- Lead glass
- Soda lime

Glass material for semiconductor

Fused Quartz
Fused Silica

Not applied in the field of semiconductor
<table>
<thead>
<tr>
<th>Device</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Actuators &amp; Sensors</td>
<td>CIS Imaging</td>
</tr>
<tr>
<td>Permanent Substrate</td>
<td>Borosilicate HPFS</td>
</tr>
<tr>
<td>Glass-based product</td>
<td>Borosilicate alkaline doped-materials</td>
</tr>
<tr>
<td>TGV interposer</td>
<td>Borosilicate</td>
</tr>
<tr>
<td>WLOptics</td>
<td>Borosilicate</td>
</tr>
<tr>
<td>Glass carriers</td>
<td>Borosilicate Aluminosilicate</td>
</tr>
</tbody>
</table>
# Glass Application Roadmap

<table>
<thead>
<tr>
<th></th>
<th>Today (2019)</th>
<th>Middle-term term (~3 years)</th>
<th>Longer term (&gt;5 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Actuators &amp; Sensors</strong></td>
<td>Permanent Substrate</td>
<td>WLC Glass carrier TGV interposer</td>
<td>Permanent Substrate</td>
</tr>
<tr>
<td><strong>CIS</strong></td>
<td>WLC IR cut filter</td>
<td>WLC IR cut filter WLAutofocus</td>
<td>TGV interposer</td>
</tr>
<tr>
<td><strong>RF devices</strong></td>
<td>Permanent Substrate</td>
<td>WLC</td>
<td>TGV interposer</td>
</tr>
<tr>
<td><strong>Power devices</strong></td>
<td>Glass carrier</td>
<td>Glass carrier</td>
<td>Glass carrier</td>
</tr>
<tr>
<td><strong>Optical photonic</strong></td>
<td>Permanent Substrate</td>
<td>Permanent Substrate</td>
<td>Permanent Substrate</td>
</tr>
<tr>
<td><strong>Microfluidics</strong></td>
<td>Permanent Substrate</td>
<td>WLC</td>
<td>TGV interposer</td>
</tr>
</tbody>
</table>
2019 - 2025 OVERALL GLASS WAFER MARKET REVENUE FOR SEMICONDUCTOR DEVICES*

- FO WLP
- RF devices
- Microfluidics
- MEMS Actuators & Sensors
- Power
- CIS
- Photonics
- Memory

2025
>$580M

2019
>$196M

$41.7M
CAGR 16%

$2.5M
CAGR 8%

$0.7M
CAGR +10%

$4.4M
CAGR 18%

>$145M
CAGR 16%

$104M
CAGR 18%

>$55M
CAGR 3%

>$60M
CAGR 20%

>$37M

>$53.5M

>$271M
CAGR 28%

*$Glass Panel for Semiconductor devices is not included in this chart but included in the report.
2019 VS 2016 GLASS WAFER MARKET SHARE FOR SEMICONDUCTOR DEVICES

*Non exhaustive list of companies
Semiconductor applications requiring glass wafer with different functionalities
**Glass substrate market share**

**2019 GLASS WAFER MATERIAL MARKET SHARE**
Glass wafer (glass based product & glass based process) used for devices manufacturing (panel is not included)

**2019 GLASS MATERIAL SUPPLIERS MARKET SHARE – SEMICONDUCTOR DEVICE!**
TOTAL: ~$196M

**GLASS PLAYERS CAPABILITIES – NOT EXHAUSTIVE LIST**

*Market forecast as well as 2019 market share are included in this report*
YOLE GROUP OF COMPANIES RELATED REPORTS & MONITORS

Yole Développement

Status of the Microfluidics Industry 2020

Status of the Power Electronics Industry 2020

5G’s Impact on RF Front-End & Connectivity for Cellphones 2020

Fan-Out Packaging Technologies and Market 2020:

Status of the MEMS Industry 2020
HOW TO USE OUR DATA?

Yole Group of Companies, including Yole Développement, System Plus Consulting and PISEO, are pleased to provide you a glimpse of our accumulated knowledge.

We invite you to share our data with your own network, within your presentations, press releases, dedicated articles and more, but you first need approval from Yole Public Relations department.

If you are interested, feel free to contact us right now!

We will also be more than happy to give you updated data and appropriate formats.

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