LASER TECHNOLOGIES FOR SEMICONDUCTOR MANUFACTURING
Market & Technology report - October 2017

Which semiconductor manufacturing processes and solutions will drive the laser equipment market’s growth?

WHICH SEMICONDUCTOR PROCESS STEPS, MARKET SEGMENTS, AND LASER TYPES WILL DRIVE THE LASER EQUIPMENT MARKET’S GROWTH?

Since its invention in 1958, laser technology has become well-established in various scientific, military, medical, and commercial applications. And over the last several years, the laser industry has found new opportunities and garnered significant interest for use in semiconductor manufacturing.

Today, laser applications in the semiconductor industry are broad and diversified. Various laser technologies have started integrating into major semiconductor processes, including laser cutting, drilling, welding/bonding, debonding, marking, patterning, marking, measurement, deposition, driven by motherboards. They are used to process semiconductor devices, flexible and high density interconnect (HDI) printed circuit boards (PCBs), and in integrated circuit (IC) packaging applications.

Drivers of laser methods differ from one process step to another. However, there are similar and common drivers for applicability of lasers to semiconductor and PCB processing applications. The key trends driving laser applicability and contributing to its growth are:

- The desire for die size reduction and thus further miniaturization of devices driven by computers, hand-held electronic devices such as mobile phones, tablets and electronic book readers, wearable devices and consumer electronics
- Demand for increased yield and throughput
- Better die quality
- The need to inspect voids and particles through a transparent material such as glass, which requires the use of laser methods
- Laser annealing for very high flexibility

However, the choice of the most suitable laser processing type depends strongly on the material to be processed, processing parameters, and the manufacturing process step.

Yole Développement’s Laser Technologies for Semiconductor Manufacturing report provides a thorough analysis of the different existing laser equipment and laser source solutions used for each semiconductor process step, along with the status of the technologies. This report will present the maturity level of each laser type, by semiconductor process step and application. A technical roadmap showing the future steps for these laser solutions is also included.

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**KEY FEATURES OF THE REPORT**

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- Laser equipment for semiconductor manufacturing market volume and value metrics forecasted for 2016 - 2022
- Laser equipment market forecast, segmented by semiconductor process step including drilling, dicing, patterning, marking, trimming, bonding/debonding/welding, measurement and annealing, and by laser type
- Laser equipment market forecast, by laser type, including gas lasers such as excimer and CO₂, and solid-state lasers
- Market shares for key laser equipment and laser sources involved in the semiconductor industry
- Overview and status of the laser equipment and laser sources applied today for each key semiconductor process step
- Comprehensive overview of the competitive landscape and market shares for all main laser equipment manufacturers involved in the semiconductor industry
- 2016 market shares for key laser equipment suppliers
- Important technical insights and a detailed analysis of laser tool solutions, trends, requirements, and challenges by semiconductor process step
- Laser solution technology roadmap for new technology adoption

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**LASER APPLICATIONS: FROM FRONT-END TO BACK-END ASSEMBLY**

<table>
<thead>
<tr>
<th>LASER PROCESSING</th>
<th>PROCESS STEP</th>
<th>APPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removal process</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dicing / Scrib</td>
<td>Thin Si wafer</td>
</tr>
<tr>
<td></td>
<td>Drilling</td>
<td>Laser on IC, backside metal</td>
</tr>
<tr>
<td></td>
<td>Patterning / Lithography</td>
<td>LED sapphire doping</td>
</tr>
<tr>
<td></td>
<td>Marking</td>
<td>Compound Semi.</td>
</tr>
<tr>
<td></td>
<td>Trimming</td>
<td>Packaging dicing (ICs, LEDs with PCB)</td>
</tr>
<tr>
<td>Bonding process</td>
<td>Bonding / Welding</td>
<td>Li-ion battery</td>
</tr>
<tr>
<td></td>
<td>Temporary bonding and debonding</td>
<td>HDI for PCB, LTCC</td>
</tr>
<tr>
<td></td>
<td>Soldering / Rg chip bonding</td>
<td>IC substrate interposer</td>
</tr>
<tr>
<td></td>
<td>LSO bondings (carrier)</td>
<td>Advanced packaging platforms (BGA, flip chip)</td>
</tr>
<tr>
<td>Inspection and Metrology</td>
<td>IR measurement</td>
<td>LED Lift-off</td>
</tr>
<tr>
<td>Reforming process</td>
<td>Pulsed laser deposition</td>
<td>FO WLP↥ dipping</td>
</tr>
<tr>
<td></td>
<td>Laser annealing</td>
<td>Power ICs ↓ debonding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sensor ↓ debonding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3D memory</td>
</tr>
</tbody>
</table>

(Yole Développement, October 2017)
LASER TECHNOLOGIES FOR SEMICONDUCTOR MANUFACTURING

LASER TECHNOLOGIES: MASSIVE MARKET ADOPTION

There are a wide variety of laser technologies available to semiconductor manufacturers. Typically, laser type is defined by parameters such as wavelength, emitting ultraviolet (UV), green, or infrared (IR) light, for example, as well as the duration of pulse, for example nanosecond, picosecond or femtosecond. Users must consider which pulse length and wavelength is right for their semiconductor process step and application.

The laser equipment market will grow at a 15% compound annual growth rate from 2016-2022 (CAGR 2016-2022) to more than $4B by 2022 (excluding marking and annealing). This is mainly driven by dicing, via drilling and patterning in flexible PCBs, IC substrates and semiconductor device processing.

Nanosecond lasers are the most commonly used type of laser applied in semiconductor manufacturing and PCB processing, with more than 60% market share. They are followed by picosecond, CO2 and femtosecond lasers.

In the case of dicing step, the choice of laser type also depends on the material and substrate to be diced. For low dielectric constant (low-k) materials, nanosecond and picosecond UV lasers are used to optimise optical absorption. Picosecond and femtosecond IR lasers are typically used for cutting glass and sapphire substrates but not singulating SiC substrates.

In drilling, the type of laser employed depends on the substrate. Nanosecond UV lasers are usually employed in flexible PCBs, while CO2 lasers are largely applied for PCB HDI and IC substrates. However, for IC substrates, the choice between CO2 and nanosecond or picosecond UV lasers depends on via diameters. Below 20µm diameters, the industry tends to go to picosecond UV lasers which are much more expensive than nanosecond UV lasers but offer superior quality.

Generally speaking, CO2 is the cheapest and fastest laser solution and used in preference to nanosecond, picosecond or femtosecond solid state lasers for dicing, drilling, patterning, marking for applications that require high power and do not care about heat damage or dicing width. However, CO2 is limited when small features are needed.

Nanosecond lasers are currently the dominant technology, but picosecond and femtosecond lasers could move ahead in the laser dicing equipment market. However, femtosecond laser implementation is more complex and expensive.

This report will provide a comprehensive overview of the laser equipment and laser sources used for each semiconductor process step application, along with a detailed analysis of laser technology trends and a market forecast. It will also offer a detailed analysis of the laser equipment market by volume and value, its growth for the 2016-2022 timeframe, and breakdowns by laser type and process step application.

INCREASED COMPETITION IN THE LASER EQUIPMENT SEMICONDUCTOR INDUSTRY

The laser equipment market is diversified, with several different equipment suppliers involved in various semiconductor process steps and able to process diverse material types. While it is a highly-concentrated group of suppliers, they come from myriad fields and span the whole range from front-end to back-end. Meanwhile, the laser equipment supply chain is highly fragmented. Additionally new companies are entering the laser equipment market with well-honed expertise in specific equipment lines other than laser tools.

Overall, there are more than 30 companies worldwide intensively active in laser semiconductor manufacturing technologies and offering different types of machine. However, the majority of laser equipment vendors can be found in three regions: Germany, Asia and the USA.

The laser industry remains mostly concentrated in Germany. However, we see increased competition with the entrance of Chinese and Korean players with competitive laser solutions that could lower costs.
Han’s Laser and Delphi Laser already dominate the Chinese market and together account for 100% of their growing domestic market. Local government support helps their market position.

Increased competition is driving acquisition or merger deals between laser source companies and laser equipment vendors, such as those between ESI and EOLITE, and Rofin and Coherent. These deals will help suppliers gain more value from the supply chain by capturing share in both laser source and laser equipment markets.

This report provides a map of the key laser equipment and laser source manufacturers involved in each semiconductor process step, as well as the material types their products can process. This report also includes a quantified, detailed analysis based on the competitive landscape and major laser equipment suppliers’ market shares, segmented by process step and laser solution type.

REPORT OBJECTIVES

- Provide detailed information regarding the applicability of the laser technologies in the field of semiconductor manufacturing
- Detailed analysis of the major applications using laser methods today or potential attractive applications that could require the use of laser technology
- Laser process roadmap application
- Give the current status of the laser technology adoption and the various types of laser available on the market
- Provide an overview of the technological trends for laser
- Understand the key benefits and added value of lasers in semiconductor manufacturing
- Understand how do laser tools differ from alternative technologies
- Understand the remaining challenges in the implementation of laser technology in the field of semiconductor manufacturing
- Offer market metrics at laser equipment and laser source market level for semiconductor applications from 2016-2022
- Give an overview of the key laser equipment suppliers and position them by application, laser type and process step
- Technology process, specification and value chain

COMPANIES CITED IN THE REPORT (non exhaustive list)


TABLE OF CONTENTS

| Introduction, definition & methodology | 6 |
| Executive summary | 16 |
| Laser techniques classification and definition | 26 |
| Laser technologies in the field of semiconductor | 44 |
| Laser equipment and source suppliers: competitive landscape | 59 |
| 2016 - 2022 laser market forecast | 76 |
| In-depth analysis on the laser technologies by semiconductor process step | 84 |
| Conclusions & Perspectives | 280 |

This report is authored by Amandine Pizzagalli, a Technology & Market Analyst at Yole Développement (Yole). Amandine is part of the development of the Advanced Packaging & Semiconductor Manufacturing Business Unit of Yole with the production of reports and custom consulting projects. She is in charge of comprehensive analyses focused on semiconductor equipment, materials and manufacturing processes. Previously, Amandine was engaged in many projects of development focused on CVD and ALD processes for semiconductor applications at Air Liquide.

Amandine is graduated in Electronics from CPE Lyon (France), with a technical expertise in Semiconductor & Nano-Electronics and has a master focused on Semiconductor Manufacturing Technology, from KTH Royal Institute of Technology (Sweden). She has spoken in numerous international conferences and has authored or co-authored more than 10 papers.
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