Laser Application

ABLATION PROCESS
- DFL7020
- DAL7020
- DFL7161
- DFL7160
- DFL7260

STEALTH DICING
- DFL7340
- DFL7360
DISCO's laser application lineup supports miniaturized next generation devices
Providing the optimum “Kiru” technology for various materials


What is ablation processing?
It is a processing method that irradiates a workpiece with a very strong laser for a short time to vaporize it.

- Little or no heat damage of the workpiece
- Non-contact processing with low impact and load
- Ideal for hard workpieces that are very difficult to process
- Able to process fine streets less than 10 µm in width (depends on workpiece conditions)

Application example

Low-k grooving
- Inhibits delamination (film peeling)

Sapphire grooving
- Realizes stable processing while restraining sapphire brightness deterioration
- Improves CoO with a shape recognition function for broken wafers, and with multiple-mounted wafer processing

Laser full cut
- Increases the number of die per wafer by street reduction
- Improves feed speed (compared to blade dicing)

Si + DAF full cut
- High quality cutting of DAF (Die Attach Film)
A new “Kiru” technology, Stealth Dicing
Providing high quality, high speed wafer processing of MEMS devices and thin wafers

What is stealth dicing?
It is a dicing method that forms a modified layer in the workpiece by focusing a laser inside the workpiece, and then separates the die using a tape expander.

- Able to control processing waste because it modifies the internal part of the workpiece. This is suitable for workpieces that are vulnerable to contamination.
- It is a dry process that does not require cleaning, therefore it is suitable for processes (such as MEMS) that are vulnerable to loading.
- Greatly contributes to street reduction because the kerf width can be made extremely thin.

Inline system
An inline system can be configured to support the stable processing and handling of ultrathin wafers from wafer thinning to stealth dicing and frame mounting.

Application example

- **Silicon wafer**
  - [Cross-section photograph]
  - Modified layer, Silicon wafer
  - SEM x500
  - Feed speed: 300 mm/s, 1pass, Wafer thickness: 100 µm

- **Sapphire**
  - [Cross-section photograph]
  - SEM x500
  - Wafer thickness: 100 µm

- **GaAs**
  - [Top view photograph]
  - Wafer thickness: 90 µm

- **MEMS**
  - [MEMS die]
  - [Edge enlargement]

- **Glass**
  - [Cross-section photograph]
  - SEM x50, 700 µm

- **LiTaO3**
  - [Cross-section photograph]
  - SEM x100, 350 µm

The DFL7300 and DFL7360 laser saws incorporate an SD engine, which has a modularized laser and dedicated optical system. The SD engine has been developed for DISCO by HAMAMATSU Photonics K.K.
For the processing of sapphire, which is used as the substrate material for high brightness LED, breaking with a diamond scriber used to be the main stream. In accordance with the expansion of the market, however, demand for higher throughput and yield have been increased, thereby expanding the laser process technology. Now the laser is the main process method for sapphire in high brightness LED.

### Advantages of Processing Sapphires with Lasers

DISCO provides two laser processing methods: ablation process and stealth dicing. Using a laser for sapphire processing enables increased yield, better throughput and stress-free operation while maintaining brightness equal to the conventional process.

- **Increased yield**
  Just setting processing parameter data realizes uniform processing quality and stable die separation, unaffected by the skills of operators.

- **Better throughput**
  Very fast feed speed generally enables processing at a speed several times higher than the diamond scribing.

- **Stress-free operation**
  In the fully automatic equipment, once the device data is entered and the cassette is set, full automatic operation can be conducted. Replacement of consumables, such as expensive diamond probes, and operator man-hours related to data settings can be greatly reduced.

### Providing the optimal laser processing in accordance with customers’ required processing quality

Ablation scribing is a process which is well balanced between cost and brightness, usable from developing products to high brightness products. Meanwhile, stealth dicing does not deteriorate brightness, so that it is suitable for high value added devices. Furthermore, since stealth dicing does not have a kerf width, it greatly contributes to street reduction, so that the number of die to be separated can be increased. Conducting several passes enables highly straight die separation even for a thick substrate. DISCO has several models for ablation scribing and stealth dicing so that you can select the optimal laser processing in accordance with your required processing quality.

### Alignment of wafers with backside metal film

In applications where a laser is irradiated from the side opposite to the wafer pattern surface for processing, alignment must be performed passing through the wafer. However, if metal film is attached to the backside, alignment cannot be performed, and this process cannot be used.

The backside alignment mechanism enables alignment from the chuck table side for these types of wafers. (Backside alignment unit is optional; used only in ablation.)
**Laser full cut**

**What is laser full cut?**

It is a method that completely cuts the workpiece only with a laser process.

Laser full cut is effective for thin silicon, compound semiconductors, wafers with backside metal film, high-brightness LED substrate, and metals (Cu, molybdenum), and normally cuts into the tape by irradiating a laser for one to several passes on the patterned surface. This method realizes high-speed and high-quality processing and great street reduction by focusing the laser beam to a spot less than 10 µm. This laser process also enables Si + DAF (die attach film) full cut.

**Thin silicon wafer full cut**

This process realizes high quality, high-speed full cutting with a laser of thin silicon wafers that are very difficult to process.

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**Compound device full cut**

When processing compound semiconductors, such as GaAs and SiC, high productivity could not be achieved since it was difficult to increase the feed speed in the existing blade dicing. The non-contact and low-load laser process enables high-speed and high-quality processing.

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**Si + DAF full cut**

Uncut DAF (whiskers) tends to occur when dicing DAF with a blade. It is possible to significantly reduce this with a laser cut.

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**Metal full cut**

The laser enables high-quality and high-speed full cut of metals, such as Cu and molybdenum, used in high-brightness LED substrate and heat sink. Kerf loss can also be reduced.

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**Laser grooving**

**What is laser grooving?**

It is a process method that forms a narrow groove in the cut street using a laser.

Laser grooving is a process that is suitable for wafers with low-k film (low dielectric constant). Low-k has been commonly used since the start of 90nm manufacturing for the miniaturization of semiconductor devices. After forming a narrow groove with the laser in these difficult to cut materials, the die are separated using blade or laser dicing.

**Low-k film and metal layer grooving**

Delamination (film peeling) can be a problem with blade dicing of wafers with low-k film. Laser grooving, which has no mechanical load, can be used to realize high-quality processing with minimal delamination, thereby contributing to higher productivity. DISCO laser grooving is also used in applications where the metal layer (TEG, wiring, circuits, etc.) along the dicing street is removed.

**Low-k grooving example**

After completely removing a Low-k film and metal wiring on the street by laser grooving, a full cut is conducted in the dicing process. DISCO offers various grooving methods in accordance with the layout of Low-k film and metal wiring as well as the street width.

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**Scribing on hard-to-cut materials + breaking**

The materials below, which are difficult to cut with a blade, can now be made into die by laser scribing followed by breaking.

- Aluminum nitride used in heat sink materials
- Gallium nitride used in laser diode materials
- Alumina ceramics, SiC, etc.

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**Laser full cut example**

**Street Width**

- Backside metal film
- Laser
- Work
- Tape
- TEG

**Metal wiring**

Si + DAF (whiskers) tends to occur when dicing DAF with a blade. It is possible to significantly reduce this with a laser cut.

**Low-k layers**

Complete removal of the low-k layers and metal on the street with laser irradiation

**Silicon**

Full cut with blade or laser

**Silicon Tape**

After completely removing a Low-k film and metal wiring on the street by laser grooving, a full cut is conducted in the dicing process. DISCO offers various grooving methods in accordance with the layout of Low-k film and metal wiring as well as the street width.

**Low-k layers example**

Street width Blade

Silicon

Metal wiring

Low-k layers

Alumina ceramics

SEM x100 635µm

Aluminum nitride

SEM x100 750µm

Low-k film and metal layer grooving

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**Low-k full cut**

The laser enables high-quality and high-speed full cut of metals, such as Cu and molybdenum, used in high-brightness LED substrate and heat sink. Kerf loss can also be reduced.
**DBG + DAF laser cut**

**What is DBG + DAF laser cut?**
It is a process that cuts the DAF with a laser after the DBG process.

The DBG (Dicing Before Grinding) process, which separates die during backgrinding after half-cut dicing, lowers backside chipping, improves die strength and is expected to lower the damage risk in thin wafers. The DBG + DAF cut process attaches DAF to the backside of a wafer, which has been die separated by the DBG process, and then cuts only the DAF. Laser DAF cutting is effective because it can respond to die shift and improves processing quality. When DAF is applied to the DBG process, it is possible to use DBG in the production of ultrathin dies that are used in SiP.

**Hasen Cut**

**What is a Hasen Cut?**
A processing method involving laser irradiation in a broken (dotted) line pattern.

In a Hasen Cut, the laser can be turned on and off at any point to process workpieces with different die sizes and polygonal-shaped workpieces, supporting a wide range of applications.

**Example of a Hasen Cut**

**Machining of polygonal-shaped die**
Linear processing can be combined to enable processing of hexagonal, octagonal, and other polygonal shapes.

**Multi-project wafer (MPW) processing**
Processing is also possible for sample wafers, evaluation wafers, and other wafers with varying size die. Processing is even possible for wafers where the die are offset in order to increase the yield of long or other irregular-sized die.

**Synergetic effect from combining stealth dicing and the Hasen cut**
Processing is also possible for sample wafers, evaluation wafers, and other wafers with varying size die. Processing is even possible for wafers where the die are offset in order to increase the yield of long or other irregular-sized die.
What is HogoMax003?
Water-soluble protective film that prevents thermal adhesion of the protective film and contributes to increased yield.

Preventing debris adhesion on the wafer surface
- It is possible to process fully automatically from coating of HogoMax to laser processing and deionized water cleaning.
- Due to the superior processability by UV laser, the protective film surrounding the processing point will not be peeled.
- It is possible to remove the film after laser processing just by cleaning with deionized water.

Best suited for laser processing of a concave-convex wafer
- With the existing product, a protective film between bumps becomes thin due to surface tension, therefore coating irregularity occurs. It is also an issue that thermal adhesion occurs at the thin area of the protective film during processing which causes stains.
- HogoMax003 eliminates coating irregularities between bumps and prevents thermal adhesion.

Full-auto processing from coating to cleaning
- It is possible to process fully automatically from coating of HogoMax to laser processing and deionized cleaning (Coating function is optional. Applicable models: DFL7020, DFL7161, DFL7160).

Ablation Process

DFL7260
(1) Frame pick arm moves workpiece out of cassette to pre-alignment stage → (2) After centering at pre-alignment stage, upper arm moves workpiece to chuck table → laser processing → (3) Upper arm moves workpiece to pre-alignment stage → (4) Upper arm moves workpiece to chuck table → laser processing → (5) Upper arm moves workpiece to pre-alignment stage → (6) Upper arm moves workpiece to chuck table → laser processing → (7) Upper arm moves workpiece to pre-alignment stage → (8) Frame pick arm returns workpiece to cassette

DFL7161
(1) Frame pick arm moves workpiece out of cassette to pre-alignment stage → (2) After centering at pre-alignment stage, upper arm moves workpiece to chuck table → laser processing → (3) Upper arm moves workpiece to chuck table → laser processing → (4) Upper arm moves workpiece to pre-alignment stage → (5) Upper arm moves workpiece to chuck table → laser processing → (6) Upper arm moves workpiece to pre-alignment stage → (7) Upper arm moves workpiece to chuck table → laser processing → (8) Frame pick arm returns workpiece to cassette

DFL7160
(1) Frame pick arm moves workpiece out of cassette to pre-alignment stage → (2) After centering at pre-alignment stage, upper arm moves workpiece to chuck table → laser processing → (3) Upper arm moves workpiece to pre-alignment stage → (4) Frame pick arm returns workpiece to cassette

Stealth Dicing

DFL7360
(1) Robot pick pulls the workpiece out from the cassette and transfers it to the pre-alignment table → (2) After alignment, the pre-alignment table moves, and the handling arm transfers the workpiece to the chuck table → laser processing → (3) After laser processing, the handling arm transfers the workpiece to the chuck table → cleaning → (4) The handling arm transfers the workpiece to the pre-alignment table → (5) The handling arm transfers the workpiece to the pre-alignment table → (6) The robot pick returns the workpiece to the cassette
## Machine Models

<table>
<thead>
<tr>
<th>Machine Models</th>
<th>DFL7160</th>
<th>DFL7260</th>
<th>DFL7340</th>
<th>DFL7360</th>
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<tbody>
<tr>
<td>Max. Workpiece Size (Y-axis)</td>
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<tr>
<td>Max. Workpiece Size (Z-axis)</td>
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<td>Laser Oscillator / Oscillator Model</td>
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<td>2.0 (for reference)</td>
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<td>Max. power</td>
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<tr>
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<tr>
<td>Clean air max. consumption</td>
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<tr>
<td>Machine weight</td>
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<td>Approx. 2,000</td>
<td>Approx. 2,600</td>
<td>Approx. 2,600</td>
</tr>
</tbody>
</table>

### Laser Safety
- **This product uses invisible light. Please handle with extreme care.**
- **Avoid eye or skin exposure to direct or scattered laser light.**
- **Do not place shiny objects such as metals in the laser path.**
- **The seven above models corresponds to a Class 4 laser under CDRH or IEC standards, however it meets safety standards so that it can be used as a Class 1 laser product (CFR2112 CFR104).**
- **Performance Standards for Laser Products Source, IEC60825-1 Safety of laser products Part 1**
- **Before using the machine, thoroughly read the manual and follow the instructions set forth in the manual.**
- **Never attempt to modify or repair the machine in a manner not approved by DISCO.**

### Environmental conditions
- Use clean, oil-free air at a dew point of -15 °C or less. (Use a residual oil: 0.1 ppm. Filtration rating: 0.01 μm/99.9 % or more.)
- Keep room temperature fluctuations within ±1 °C of the set value. (Set value should be between 20 – 25 °C.)
- The machine is used in an environment, free from external vibration. Do not install machine near a ventilation opening, heat generation equipment or oil mist generating parts.

* The ±1 mm indicates the actual movable range, and is not based on Z1 processing point values.

**Notes:** For the DFL7260, DFL7340 or DFL7360, the cutter unit should be installed outside of the equipment.