# Laser Application

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<th>Ablation Process</th>
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<td>DFL7161</td>
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<td>DFL7160</td>
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<th>Stealth Dicing</th>
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<td>DFL7560L</td>
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ABLATION PROCESS


**What is ablation?**

Ablation is a method that sublimes and vaporizes a solid workpiece by irradiating it with a very strong laser for a short period of time.

- Little or no heat damage to the workpiece
- Non-contact processing with a 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 (depending on workpiece conditions)

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**Application Examples**

**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 the feed speed (compared to blade dicing)

**Si+DAF full cut**
- High quality cutting of DAF (die attach film)
Stealth dicing, a new Kiru technology, provides high-quality, high-speed wafer processing of MEMS devices and thin wafers.

What is stealth dicing?

Stealth dicing is a processing 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, making it suitable for workpieces that are vulnerable to contamination
- A dry process that does not require cleaning, making it suitable for processes that are vulnerable to loading (e.g., MEMS)
- Greatly contributes to street reduction because the kerf width can be made extremely thin

The DFL7341 and DFL7361 laser saws incorporate an SD engine which has a modularized laser and dedicated optical system.

The SD engine was developed for DISCO by HAMAMATSU Photonics K.K.

Application Examples

Silicon wafer
- Cross-section photograph
- MEMS die

Sapphire
- Cross-section photograph
- SEM x500
- Freq. speed: 30 mm/s, 1 pass
- Wafer thickness: 100 µm
- Top view photograph
- SEM x200
- Wafer thickness: 90 µm

GaAs
- Cross-section photograph
- SEM x100
- Wafer thickness: 100 µm

MEMS
- MEMS die

Glass
- Cross-section photograph
- SEM x50
- 700 µm thick

LiTaO3
- Cross-section photograph
- SEM x100
- 350 µm thick
Ablation Process

A method that uses a laser to process sapphire used as a substrate in high-brightness LED.

Breaking with a diamond scriber was widely used for processing sapphire used as the substrate material in high brightness LED. In accordance with the expansion of the market, however, demands for higher throughput and yield have been increased, thereby expanding the laser processing technology. Laser is now the main method for processing sapphire in high brightness LED.

Advantage of Processing Sapphires with a Laser

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

Increased Yield
Uniform processing quality and stable die separation are realized regardless of the skill of the operator just by setting the processing parameter data.

Better Throughput
The very fast feed speed generally enables processing at speeds several times higher than diamond scribing.

Stress-Free Operation
In fully automatic equipment, once the device data has been entered and the cassette has been placed, fully automatic operation can be conducted. The man-hours spent replacing consumables such as expensive diamond probes and the time spent setting data are greatly reduced.

Provides the optimal laser processing in accordance with customers’ required processing quality

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

### Table: Ablation vs Stealth Dicing

<table>
<thead>
<tr>
<th>Process</th>
<th>Diamond scribing</th>
<th>DFL7020</th>
<th>DFL7160</th>
<th>DFL7341</th>
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<tbody>
<tr>
<td>Productivity</td>
<td>Brightness</td>
<td>Fair</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td></td>
<td>Throughput</td>
<td>Fair</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td></td>
<td>Yield</td>
<td>Good</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>Cost</td>
<td>Burnishing costs</td>
<td>Fair</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>Consumables (consumables + personal expenses, etc)</td>
<td>Fair</td>
<td>Good</td>
<td>Good</td>
</tr>
</tbody>
</table>

Sapphire scribing process using ablation

- Mounting on tape
- HogoMax Coating
- Laser process
- Cleaning
- Breaking
- Expand
- Tape re-mount

Sapphire processing using stealth dicing

- Mounting on tape
- Stealth Dicing
- Breaking
- Expand
- Tape re-mount

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 through the wafer. However, if metal film is attached to the backside, alignment cannot be performed and the process cannot be used. The backside alignment mechanism enables alignment from the chuck table side for these types of wafers.

(The backside alignment unit is an optional specification used only in ablation.)
**Laser Grooving**

**What is laser grooving?**
A processing method that forms a narrow groove in the cut street using a laser.

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

**Low-k Grooving Examples**

Performing laser grooving prior to blade dicing enhances the quality and throughput when processing low-k wafers.

Combining laser grooving and stealth dicing achieves significant street reduction.

**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.

**Laser Full Cut**

**What is a laser full cut?**
A method that completely cuts the workpiece only with a laser process.

A laser full cut is effective for thin silicon, compound semiconductors, wafers with backside metal film, high-brightness LED substrates, 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, high-quality processing and significant street reduction by focusing the laser beam on a spot less than 10 µm in diameter. This laser process also enables a Si + DAF (die attach film) full cut.

**Thin Silicon Wafer Full Cut**
This process realizes high quality, high-speed full cutting with a laser on thin silicon wafers that are very difficult to process.

**Compound Device Full Cut**
Previously, 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, high-quality processing.

**Si + DAF Full Cut**
Uncut DAF (whiskers) tends to occur when dicing DAF with a blade. Laser cutting can significantly reduce this.

**Metal Full Cut**
The laser enables high-quality and high-speed full cuts of metals such as Cu and molybdenum used in high-brightness LED substrates and heat sink. The kerf loss can also be reduced.
What is a Hasen cut?

A processing method involving laser irradiation in a broken (dotted) line.

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.

Processing Polygonal-Shaped Die

Linear processing can be combined to enable processing of hexagonal, octagonal, and other polygonal shapes.

Continuous polygonal-shaped die are processed by combinations of linear processing.

Multi-project Wafer (MPW) Processing

Processing is also possible for sample wafers, evaluation wafers, and other wafers with varying sized 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 by Combining Stealth Dicing and the Hasen Cut

Processing is possible for sample wafers, evaluation wafers, and other wafers with varying sized die. Processing is even possible for wafers with long or other irregular-sized die where the die are offset in order to increase the yield.

DBG + DAF Laser Cut

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 risk of damage in thin wafers. The DBG + DAF cut process attaches DAF to the backside of a wafer for which the die were separated in the DBG process, and then cuts only the DAF. Laser DAF cutting is effective because it can process shifted die and improves processing quality. When DAF is applied to the DBG process, it is possible to use DBG in the production of the ultra-thin die used in SiP.
Laser processing particles (debris) generated during the ablation process cannot be removed by deionized water cleaning once attached to the wafer surface. Debris causes device defects such as bonding defects and increased current leaks. HogoMax, an original water-soluble protective film developed by DISCO, contributes to the improved reliability of devices when applied to the processing surface before laser processing by greatly reducing the adhesion of debris. Moreover, HogoMax003 can be applied evenly and prevents thermal adhesion of the protective film, contributing to a boost in yield.

**Prevents Debris Adhesion on the Wafer Surface**
- Coating the laser processing surface with HogoMax prevents adhesion of debris during processing.
- Due to the superior processability by UV laser, the protective film surrounding the processing point does not peel.
- The film can be removed after laser processing just by cleaning with deionized water.

**Best Suited for Laser-Processing on a Concave/Convex Wafer**
- With conventional products, the protective film between bumps becomes thin due to surface tension, causing coating irregularities. Thermal adhesion occurring at thin areas of the protective film during processing and causing stains is also an issue.
- HogoMax003 eliminates coating irregularities between bumps and prevents thermal adhesion.

**Full-Auto Processing From Coating to Cleaning**
- HogoMax makes it possible to process fully automatically from HogoMax coating to laser processing and deionized cleaning. (The coating function is an optional specification. Applicable models: DFL7020, DFL7161, DFL7160)

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**Laser Lift-off**

Laser lift-off is a process for peeling substrates made of sapphire or glass. It is used for peeling off the sapphire substrate from the crystal layer of GaN (gallium nitride) compound materials, which are primarily used for making vertical structured blue LEDs.

**High-Yield and Low-Running-Cost Manufacturing**
- Employs a solid-state laser to save a significant amount of maintenance time (reducing the frequency of replacing consumable products and adjusting the optical axis), achieves stable processing quality, and improves productivity.
- Employs DISCO’s original optics system to process at an extensive focal range with optimal power. This suppresses wafer damage and minimizes detachment failures. In addition, the surface roughness after detachment becomes one-third of the current value.

**Example of Applicable Processes: Sapphire Substrate Detachment for V-LED**
- The light emitting layer is remounted on a highly exoergic conductive substrate for the purpose of improving brightness and better heat sink. LLO is used in this sapphire substrate detachment process.

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Precautions for the Patent: If laser lift-off is performed for LED, please note that you may be in violation of patent nos. 4285776 in Japan and US6071795 and US6420242 in other countries.
### Wafer Transfer (Standard Specification)
1. The workpiece is withdrawn from the cassette by the wafer pick and transferred to the load table
2. The workpiece is transferred to the chuck table by the rotation arm → laser processing
3. The workpiece is transferred to the unload table by the rotation arm
4. The workpiece is returned to the cassette by the frame pick

### Laser Lift-off
1. Unload workpiece from cassette to upper arm
2. Transfer workpiece to C/T with Upper arm → laser processing
3. Transfer workpiece from C/T to robot pick with lower arm
4. Robot pick returns workpiece to cassette
### 7000 Series Specifications

<table>
<thead>
<tr>
<th>DFL7020</th>
<th>DAL7020</th>
<th>DFL7161</th>
<th>DFL7160</th>
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<tbody>
<tr>
<td><strong>Ablation</strong></td>
<td>Fully automatic</td>
<td>Automatic</td>
<td>Fully automatic</td>
</tr>
<tr>
<td><strong>Processing method</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Workpiece size</strong></td>
<td>mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-axis (Chuck table)</td>
<td>Processing range</td>
<td>mm</td>
<td></td>
</tr>
<tr>
<td>Max. processing speed</td>
<td>mm/sec</td>
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<tr>
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<td>0.003/160 (Single error)0.002/5</td>
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<tr>
<td>Machine weight</td>
<td>kg</td>
<td>Approx.1,310</td>
<td>Approx.810</td>
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<tr>
<th>DFL7341</th>
<th>DFL7360FH</th>
<th>DFL7361</th>
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<tr>
<td><strong>Stealth Dicing</strong></td>
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<td><strong>Processing method</strong></td>
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<td><strong>Workpiece size</strong></td>
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<tr>
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<td>Machine weight</td>
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<tbody>
<tr>
<td><strong>Laser Lift-off</strong></td>
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<tr>
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<tr>
<td>Machine weight</td>
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### Environmental Conditions
- Use clean, oil-free air at a dew point of -15°C or less. (Use a residual oil: 0.1 mg/m³ or less. Filtration rating: 0.01 µg/95.6 µm or more).
- Keep room temperature fluctuations within ±1°C of the set value. (Set value should be 20-25°C)
- The machines should be used in an environment free from external vibration. Do not install the machines near a ventilation opening, heat-generating equipment, or oil mist generating parts.
- The above specifications may change due to technical modifications. Please confirm when placing your order.
- All the pressures are described using a pressure gauge.

### Laser Safety
- This product uses invisible light. Please handle with extreme care.
- Avoid eye or skin exposure todirect or scattered laser light.
- Do not place shiny objects such as metals in the laser path.
- The above seven models correspond to a Class 4 laser under CDRH or IEC standards but meet safety standards so that they can be used as a Class 1 laser product (CDRH 21 CFR 1040. Performance Standards for Laser Products Source, IEC Pub.60825-1: Laser Product Safety Part 1).
- Please read the manual and follow the instructions set forth in the manual.
- Do not attempt to modify or repair the machine in a manner not approved by DISCO.