Micromachining of Glass by Laser Induced Deep Etching (LIDE)

LPKF Vitrion® 5000
In microsystems technology, glass is very suitable as a substrate material for a variety of applications. The basis for the great potential of glass is its specific properties:

- Chemical inertness
- High surface quality
- Ability to withstand high temperatures
- No moisture absorption and therefore no expansion
- Adjustable thermal expansion coefficient
- Dimensional stability
- Very good dielectric properties
- Low procurement costs in comparison with other substrates even in very thin forms
- Transparency and attractive haptics
New Level of Efficiency in Thin Glass Processing

Thin glass with a thickness of 50 µm to 500 µm is very interesting for many industrial applications. However, use in the microtechnology industry is often difficult because cutting and drilling in conventional machining can cause microcracks and stresses in the glass substrate. The new LIDE process with the LPKF Vitron 5000 system uses the noncontact precision laser tool with an unrivaled productivity and quality for the micromaterial processing of glass. LIDE enables new product designs in microsystems technology and has the potential to change entire process chains in production.

**Conventional Glass Modifications are Limited**
- Conventional processing methods for cutting and drilling thin glass often cause microcracks or stresses, which compromise quality and can lead to component failure. Quality deficiencies make the use of glass in industrial microsystems technology uneconomical.
- Especially in thin glass substrates with thicknesses of 50 µm – 500 µm, structures cannot be generated with the high aspect ratios required for applications in microtechnology. The embedded structures are not small and precise enough for many applications.
- The production speed for fragile glass substrates is too low for conventional materials to be used economically.

**The Consequence:**
The industrial use of glass often fails.

**The Solution:**
The Laser Induced Deep Etching (LIDE) process developed by LPKF. LIDE is a two-step process. In the first step, the glass is locally laser-modified according to the desired layout. This is done by laser radiation from a specially developed source. The radiation is focused within the workpiece and guided through its entire thickness.

The optical and chemical properties of the material are modified to enable selective chemical etching in a second process step. The modified areas of the glass are removed much more rapidly than the unmodified material is. In order to yield structures with specific widths, the glass is soaked in the etching bath for a predefined time.

About 24,500 microholes in one square inch – without chipping, microcracks, or stresses

Vias are formed in the modified regions using a standard wet etching process. The modified material etches at a significantly faster rate than the unmodified glass does.
The LPKF Vitrion® 5000 laser system is solely designed for processing delicate glass wafers up to 18” in diameter and panels with sizes of up to 510 mm x 510 mm. The process can be configured for a manual or automated production environment.

The LPKF Vitrion 5000 utilizes a laser that was developed specifically for these applications. System control is accomplished with user-friendly system software that enables differentiation between programming and production mode as well as integration into an MES.

- Formation of up to 5000 vias/s
- Precision and homogeneity
- Laser technology for high yield
• Clean room compatibility
• Easy maintenance
• Laser safety class 1 under normal operating conditions
• Through-glass via operation mode
• Microcutting operation mode

The LPKF Vitrion 5000 is clean room-compatible and can easily be integrated into a wall without any additional effort. All maintenance work can be performed from the back, enabling the unit to be integrated into typical semiconductor production lines. The standard version of the Vitrion 5000 is supplied with a workbench for manual handling.

The camera system for precise part position detection (parts finder) and an integrated SMEMA interface facilitate the automation of the overall interposer production process.

Complete Solution for LIDE Production
LPKF offers consulting services along with the Vitrion system to ensure an optimum etching process.

This comprehensive package reduces the time and effort required to integrate a Vitrion system into your production process.
High-Speed Operation Modes

Through-Glass Via (TGV) Operation Mode

The Vitron 5000 machine is equipped with a high-speed air bearing axis. In TGV operation mode, the high-speed axis is used to scan the glass substrate in a meandering way. The laser pulses are emitted according to the desired TGV pattern design while the axis is traveling at full speed. This means that the laser pulses are emitted on the fly. Thus, a laser processing speed of > 5000 TGV modifications per second can be reached in this mode – with glass thicknesses of up to 500 µm.

After laser modification, the glass is modified in a multitude of spots placed with a position tolerance of ± 5 µm (Cpk > 1.33) across an area of 510 mm x 510 mm. These modified areas can be transformed into blind or through holes in the subsequent wet etching step. Without further measures being taken, the modified regions are removed by the etching solution on both sides of the glass substrate to yield hourglass-shaped holes.

V-shaped vias are obtained through masking of one side of the glass during the etching step. Typical taper angles range from 3° to 8°, depending on the nature of the glass and the chemical composition of the bath.

Scanning electron microscope (SEM) image of the cross sections of LIDE-produced TGVs

Microscopic holes and hole shapes in glass; high quality without any microcracks.

One laser pulse modifies the glass; holes are formed in the subsequent etching process.
The LPKF Vitrion 5000 can also be operated in a microcutting mode. In this case, the laser beam is moved along an arbitrary two-dimensional tool path. The laser pulses are emitted at equal distances along the path, resulting in a curtain of modified regions extending from one side of the glass substrate to the other.

As in the TGV operation mode, the final features are then generated through removal of the modified areas of the glass by etching. The minimal feature size is in the range of 10 µm. The modification speed in this mode is up to 100 mm/s and is independent of the glass thickness up to a thickness of 500 µm.
Worldwide Support for Laser Induced Deep Etching (LIDE)

Wherever they are in the world, users of LPKF systems can be supported from our application centers in Germany, USA, Japan, Korea, and China. At these centers, users have access to LPKF’s extensive experience in laser material processing.

### Technical Data: LPKF Vitrion 5000

| Laser class | 1 |
| Max. working area (X x Y) | 510 mm x 510 mm (20” x 20”) |
| Max. material size (X x Y) | Panel: 510 mm x 510 mm (20” x 20”)  
Wafer: up to 18” |
| Data input formats | DXF |
| Laser processing speed (drilling) | >5000 vias/s |
| Laser processing speed (cutting) | 100 mm/s |
| Pattern accuracy (µm) | ±5 µm, Cpk 1.33 @ 510 mm x 510 mm |
| System dimensions (W x H x D) | 1700 mm x 1700 mm* x 1620 mm (67” x 67” x 63.7”) |
| Weight | ~1600 kg (3527 lbs) |

* Height incl. StatusLight = 2100 mm (82.7”)

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LPKF Service & Support

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LPKF Laser & Electronics AG sells and markets products and provides support in more than 50 countries. Find your local representative at [www.lpkf.com](http://www.lpkf.com).

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