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Femtosecond fiber lasers
superior lifetime & performance

Breakthroughs in TGV Fabrication Using Femtosecond Laser Precision

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EPIC
EUROPEAN PHOTONICS INDUSTRY CONSORTIUM

Outline

- Company introduction
- TGV. Market need and motivation
- Materials and methods
- Fluence’s experience
- Conclusion

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About Fluence

2003 — 2016 — 2024

13 YEARS OF PRE-COMMERCIAL TECHNOLOGY DEVELOPMENT

8 YEARS OF CORPORATE EXPERIENCE

- Femtosecond laser manufacturer
- Unique all-fiber technology, perfected since 2003
- Founded in 2016*

  * Leveraging 13 years of fs product and application development at Polish Academy of Sciences
- Headquarters in Warsaw, Poland
- Ultrafast Laser Application Laboratory (ULAL) in Wrocław, Poland
- High power, industrial-grade lasers for materials processing, science and medicine

FEMTOSECOND FIBER LASERS: SUPERIOR LIFETIME AND PERFORMANCE

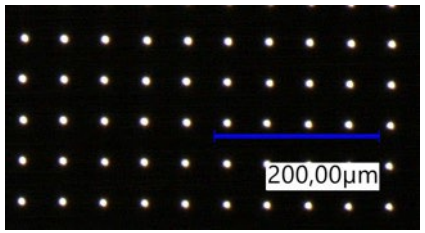
Jasper Micro
Compact Femtosecond Fiber Laser

5 W
5 µJ

- ✓ Marking
- ✓ Micromachining
- ✓ Ophthamology

Jasper Flex
Compact High Power Femtosecond Fiber Laser

30 W
30 µJ



- ✓ Micromachining
- ✓ Surface structuring
- ✓ Waveguide writing

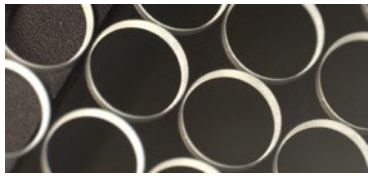
Jasper X0
High Power Femtosecond Fiber Laser

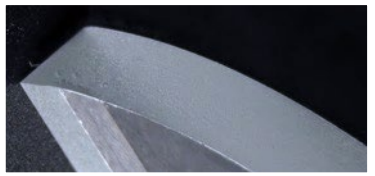
HGM
Harmonic Generation Module

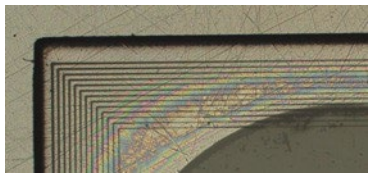
Average power:	60 W
Max. Energy:	200 µJ (300 µJ)
Max. Peak Power:	0.5 GW
Pulse duration:	<270 fs – 20 ps*
HGM wavelengths:	515, 343, 258 nm

Most powerful and versatile

- ✓ Processing brittle materials
- ✓ Processing polymers
- ✓ Micromachining
- ✓ Welding







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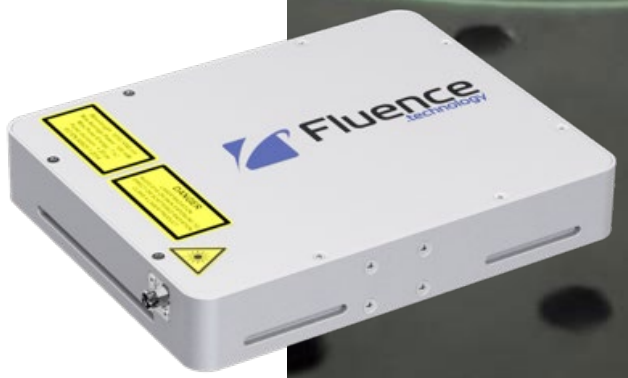
Superior Lifetime And Performance

Lasers made in Poland

- Unique all-fiber technology
- No SESAM
- No degradable components
- Modular design for fast service
- Built from the scratch



- Average power: **>20 mW**
- Wavelength: **1030 nm**
- Chirped pulse,
  compression option available **<200 fs**
- Pulse energy: **>1 nJ**
- Repetition rate: **20 MHz**

- All products are based on the same unique Fluence proprietary Oscillator
- Sophisticated design, but not overcomplicated
- Lasers built and tested to perform

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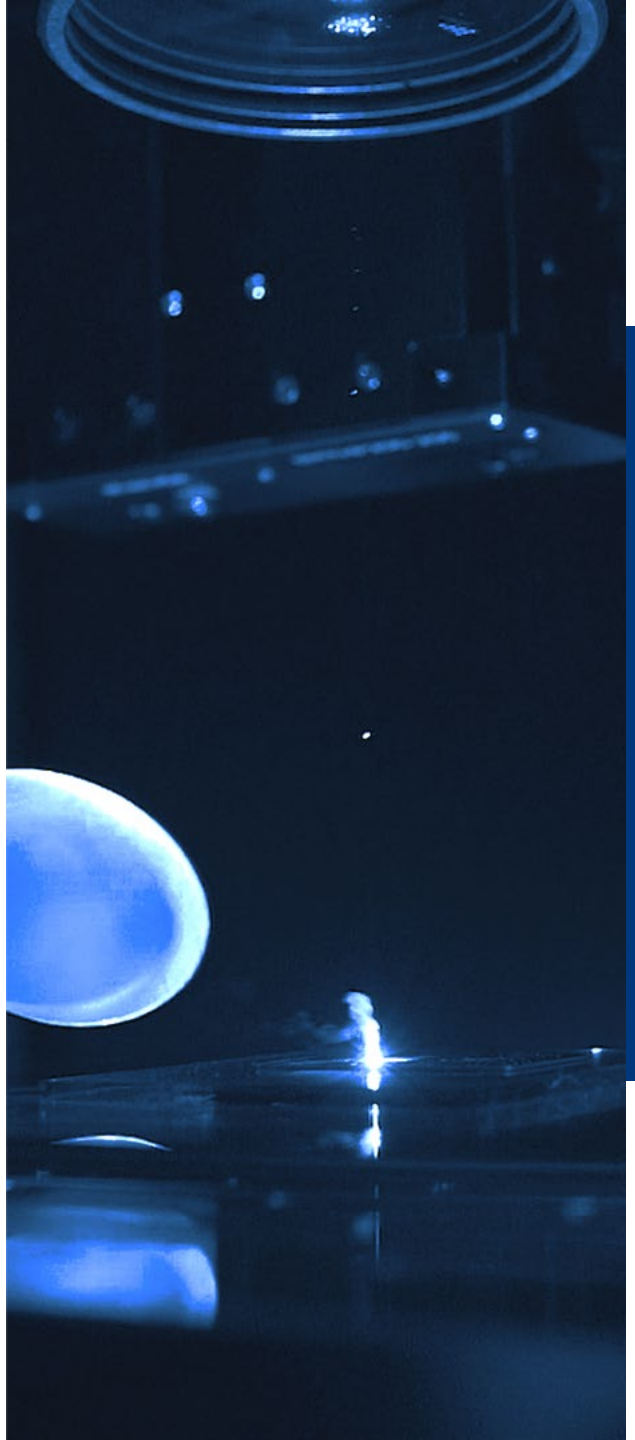
Through Glass Vias applications:

- Semiconductor Packaging
- Microelectromechanical Systems (MEMS)
- Optoelectronic Devices
- Radio Frequency (RF) Components
- Bioelectronics and Medical Devices
- Displays and Imaging Sensors
- High-Performance Computing (HPC)

etc.



Ultrafast precision in

TGV Processing

Signal Integrity

Minimizes interference and loss, crucial for high-speed performance.

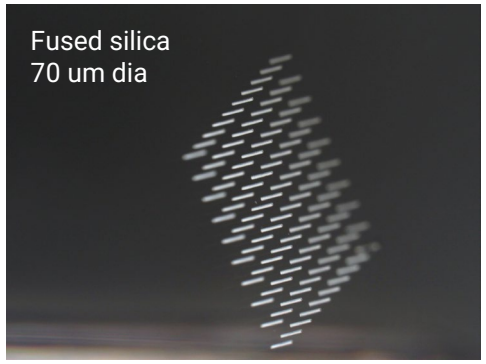
Miniaturization

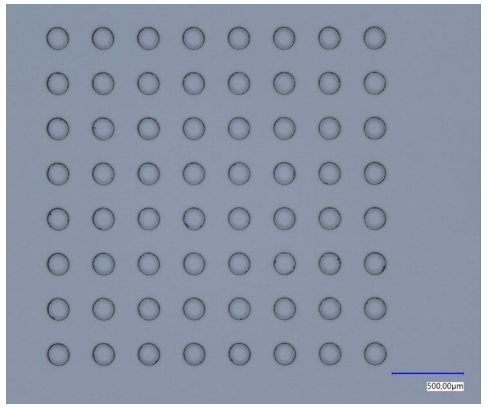
Enables compact designs for enhanced functionality in limited spaces.

Reliability

Ensures robust connections and performance in aerospace, defense, and medical applications where failure is not an option.

Why Choose Glass Over Silicone?

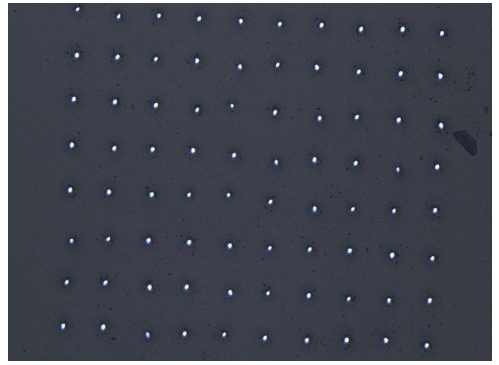


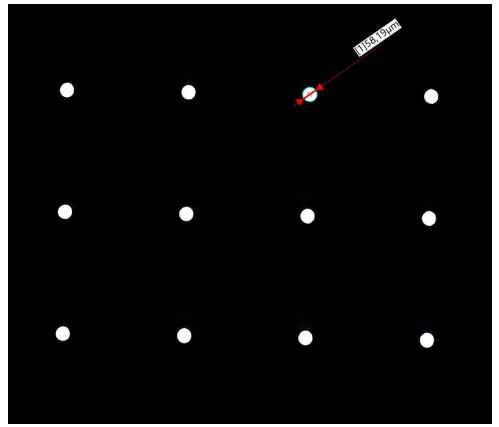


BK7
150 um dia

Advantages of Glass over Silicon:

- Lower dielectric loss and improved high-frequency performance.
- Better thermal expansion matching, reducing stress.
- Higher density of fine-pitch vias for compact designs.
- Lower cost and scalable for large-format production.
- Optical transparency for hybrid optoelectronic systems.
- Natural insulation for simpler designs and enhanced reliability.





Glass is ideal for interposers and connections in advanced electronics and communication systems.

Silicone is more vulnerable to certain chemicals and environmental conditions, requiring additional protective measures.

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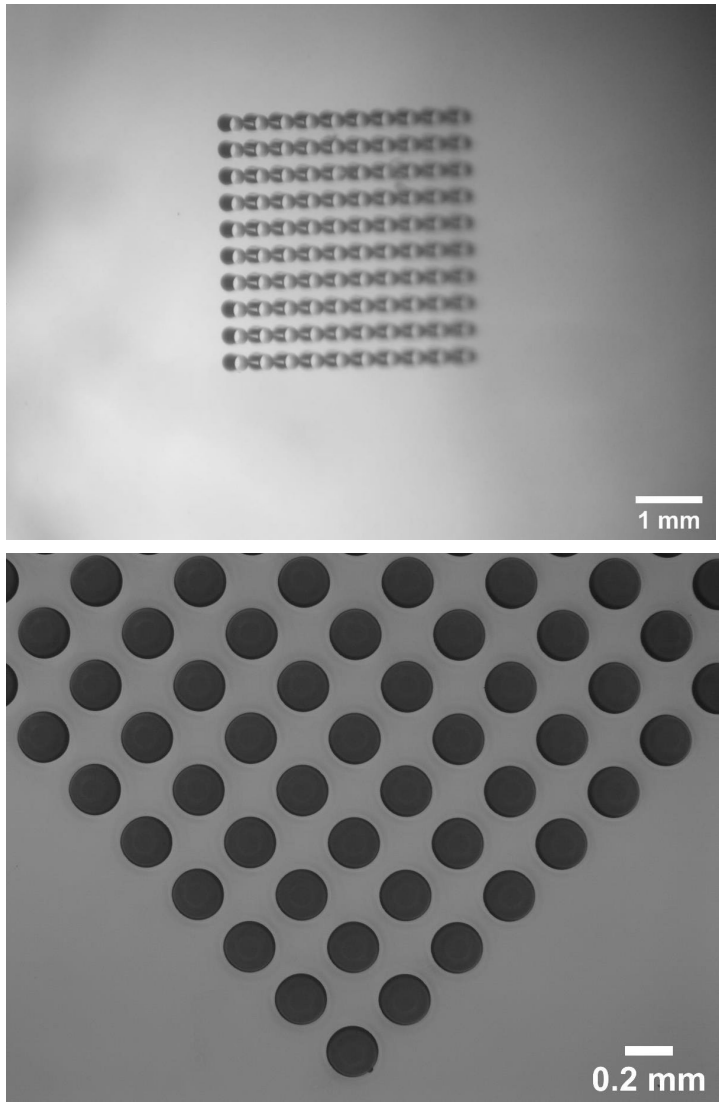
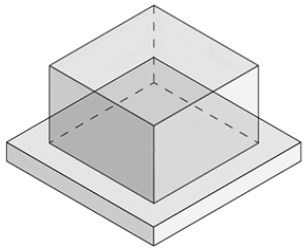
SELECTIVE LASER ETCHING : A PROVEN PROCESS, BUT WHAT'S NEXT?



SLE method in TGV, diam. **0.2 mm x 0.5 mm depth made by Femtika** with **Jasper Micro laser from Fluence**

SLE PROCESS:

- Ultra-High Precision: Ideal for intricate, high-density via structures.
- Complex Geometries: Capable of creating curved or irregular vias.
- Material Flexibility: Can handle a variety of substrates, providing versatility in applications.



SLE LIMITATIONS:

- Material Limitations: Not all glass types are compatible.
- Chemical Etching Complications: Strong chemicals like hydrofluoric acid are needed after laser irradiation, posing safety risks and requiring strict handling protocols.
- High Equipment Costs: SLE systems are costly, limiting accessibility for smaller budgets.
- Laser Tuning Challenges: Precise adjustments of laser settings is crucial to avoid incomplete modifications or excessive damage.

femtika

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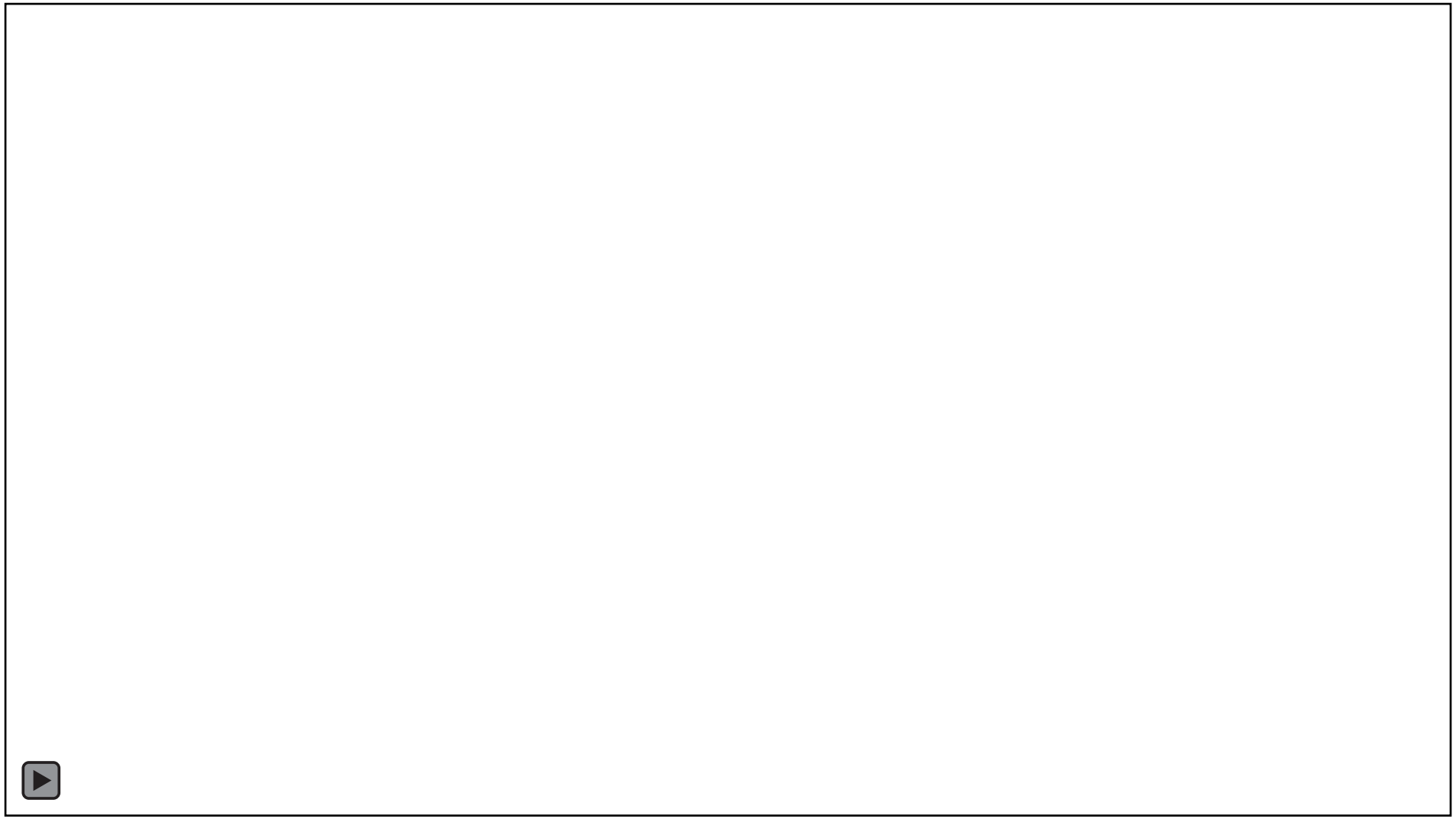
Cheap and Simple Alterntives ?

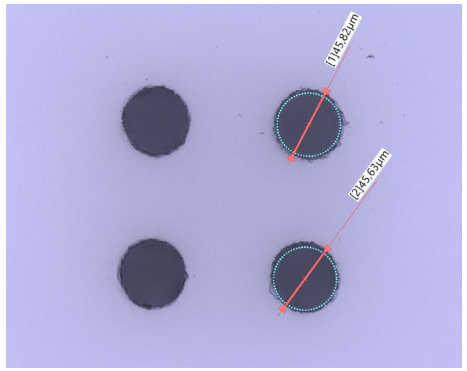


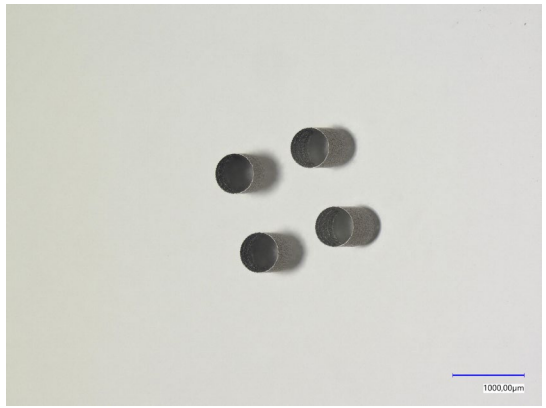
Sequential Through Glass Hole: A Competitive Alternative

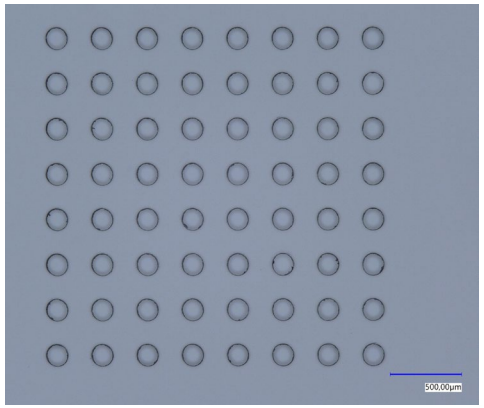
STH Overview:

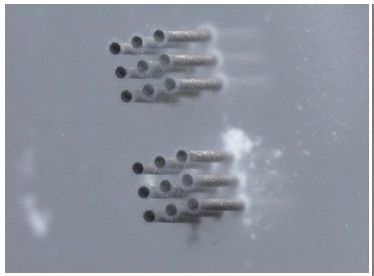
- The process of drilling holes is done in a sequential manner, where each via is created in a step-by-step manner, allowing for precise control over the depth and diameter of each via (vertical interconnects).
- Each pulse drills through the glass, and multiple passes can be made to achieve the desired depth, creating uniform and clean vias.
- Material Compatibility: Effective for a variety of glass types, including and traditional glass substrates. Ideal for applications requiring high dielectric strength and thermal stability.
- Design Flexibility: Suitable for creating simple or complex via structures, including high aspect ratio holes. Can accommodate varying via sizes and layouts depending on design requirements.
- Reduced Thermal Impact: The minimal heat-affected zone ensures that the glass remains structurally sound, preserving optical clarity and mechanical properties.
- Scalability: The STH method can be scaled to produce larger volumes of vias while maintaining accuracy and uniformity.

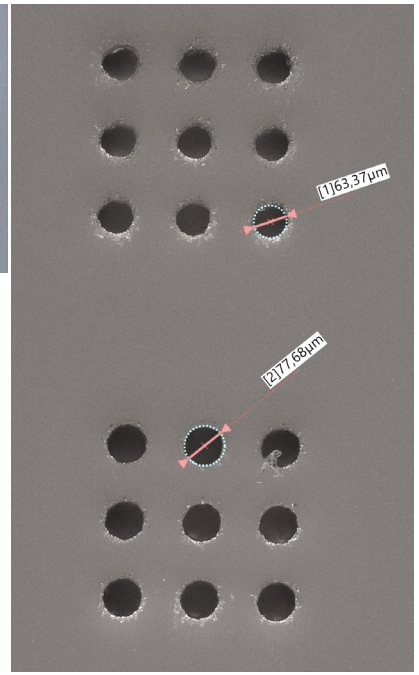
MICROMACHINING OF TGV FOR CHIP MANUFACTURING AND PACKAGING











1.1 BK7 Schott
Aspect ratio 1: 17
Debris easy to remove in an ultrasonic bath

- High-speed drilling without taper
- High repeatability, no microcracks
- 20:1 aspect ratio without wet etching
- Flexible profile of the holes
- Bk7 1.1 mm thick.

  Hole diameter down to 40 um.

processing speed of 0.5 mm thick, 50 µm diameter up to

15 holes/min

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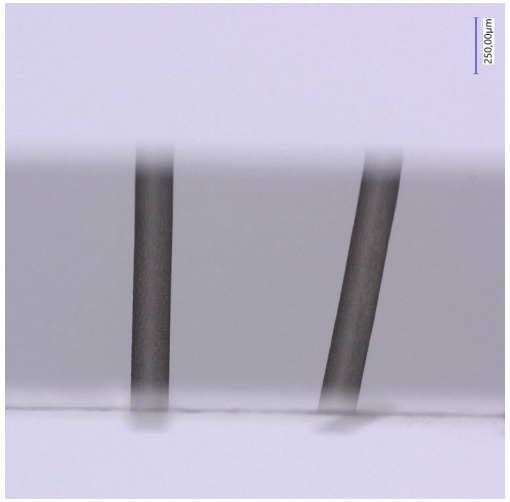
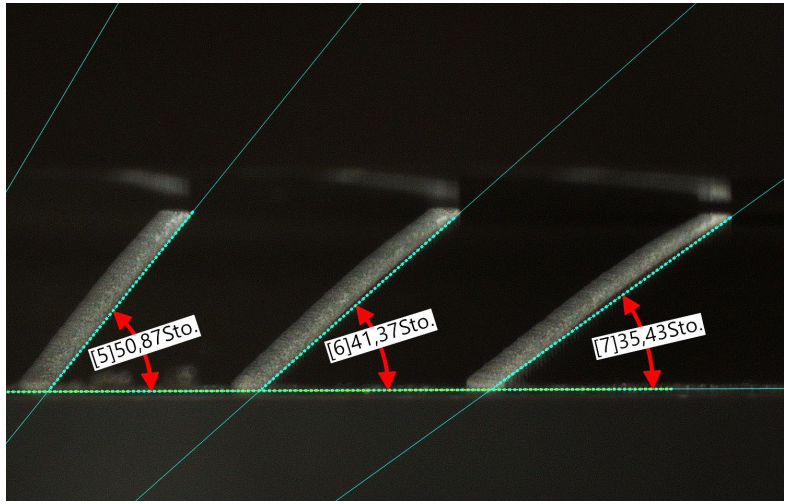
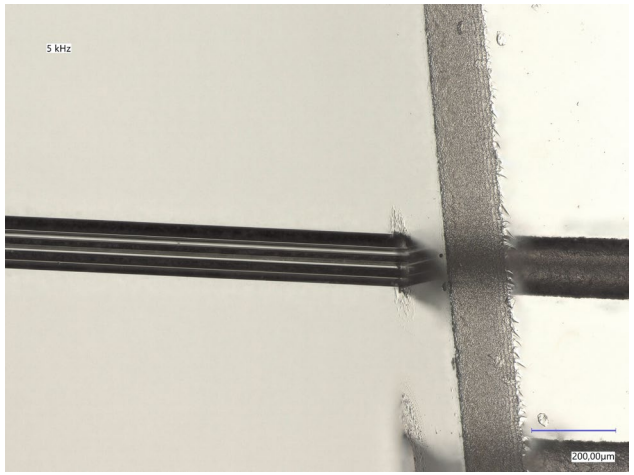
MICROMACHINING OF TGV FOR CHIP MANUFACTURING AND PACKAGING







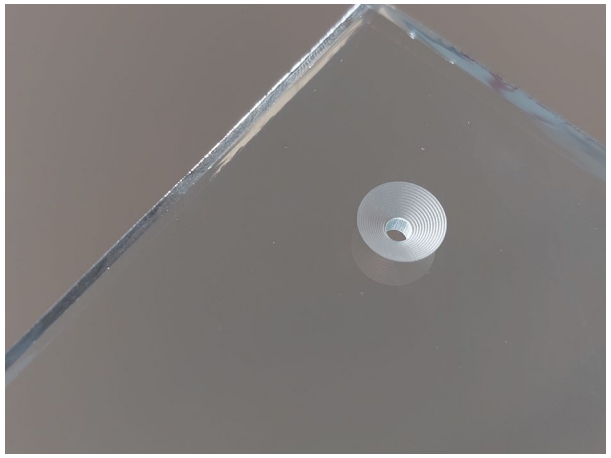
- **Tilted vias with 126um in diameter**
- **Tilt up to 55 deg**

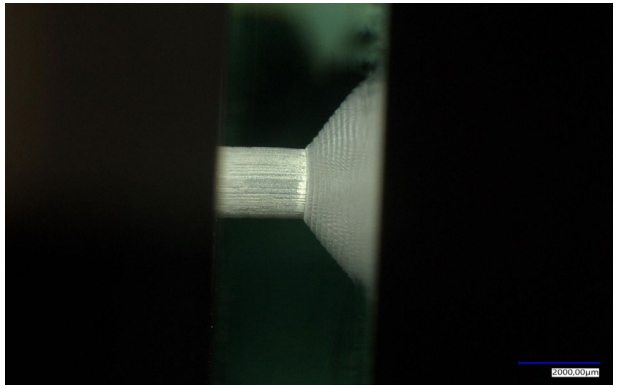
SERVE SEVERAL IMPORTANT PURPOSES:

- ENHANCE ELECTRICAL PERFORMANCE BY REDUCING PARASITIC CAPACITANCE AND INDUCTANCE
- ENABLING DENSER PACKING OF COMPONENTS AND BETTER ROUTING OF ELECTRICAL CONNECTIONS.
- CAN IMPROVE THE MECHANICAL STABILITY OF THE CONNECTIONS, HELPING TO MITIGATE STRESS AND POTENTIAL CRACKING IN THE GLASS SUBSTRATE DURING MANUFACTURING AND OPERATION.

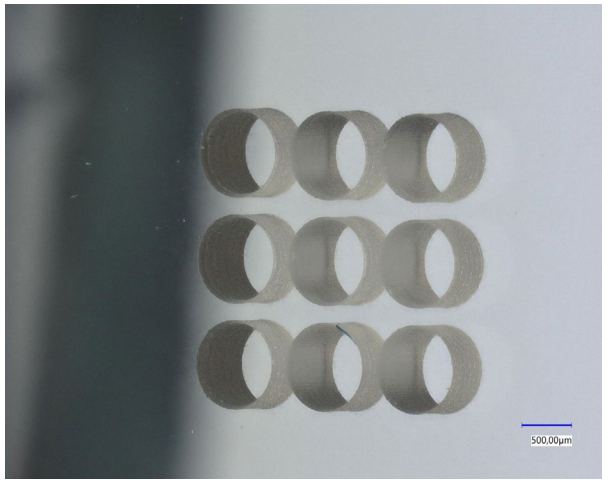
Optical fiber inside the via

THICK GLASS IS A CHALLANGE ?





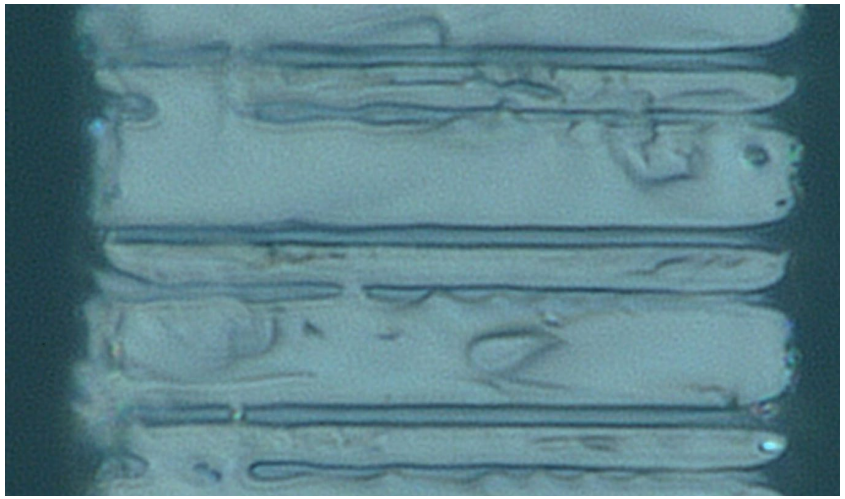
- Soda Lime 4 mm Glass thickness
- Front/rear side ablation and nonlinear absorption
- High repeatability, no microcracks
- Macroscopic hole with cone
- Made with max, available removal rate
- Flexible profile of the holes

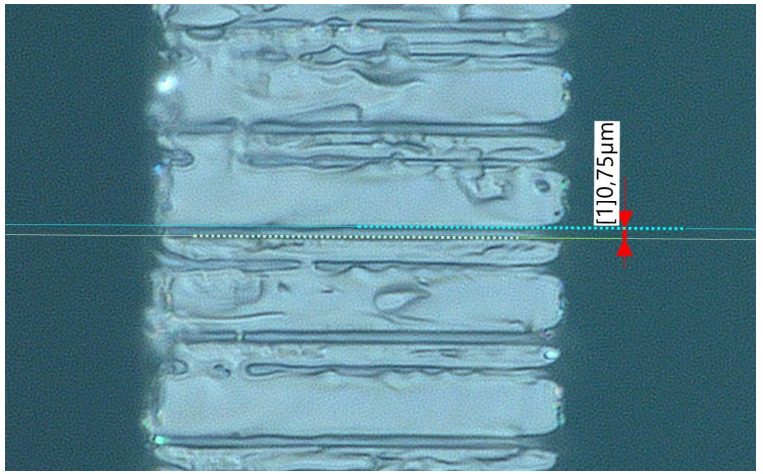


REMOVAL RATE OF SODA LIME GLASS BY ABLATION IS

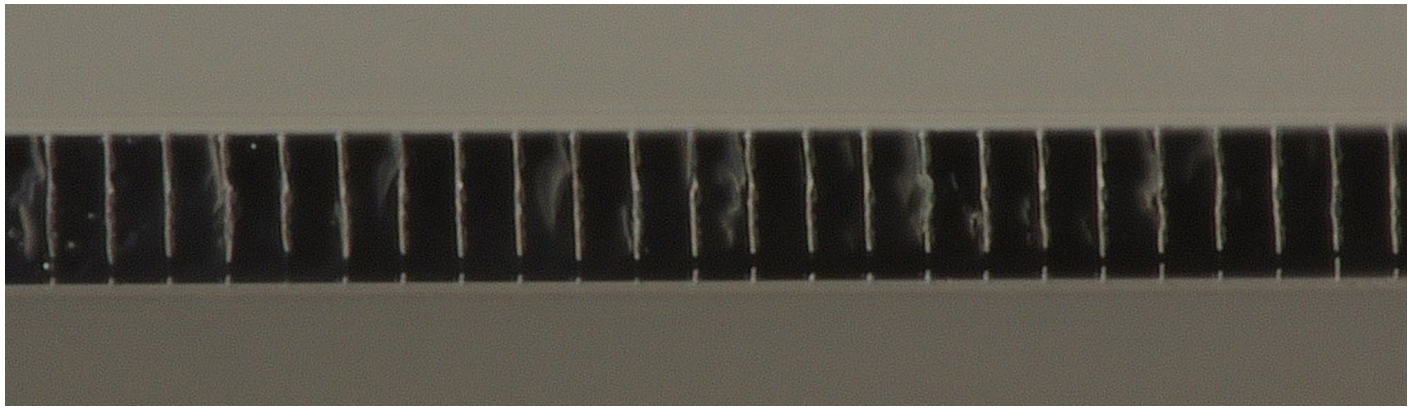
33 mm³/min (USING JASPER X0-30 W LASER)

SUBMICRON HOLES IN UTG





- UTG Glass **30 um** thick
- Non-diffracting beam usage
- No cracks
- No need burst mode
- Hole diameter down to **0,75 µm**
- Aspect ratio 1:40



SERVE SEVERAL IMPORTANT PURPOSES:

-WEIGHT REDUCTION: LIGHTER DEVICES ENHANCE PORTABILITY AND USABILITY.

-SPACE EFFICIENCY: ALLOWS FOR HIGHER COMPONENT DENSITY AND COMPACT DESIGNS.

PowerPhotonic
Enhancing Beam Performance

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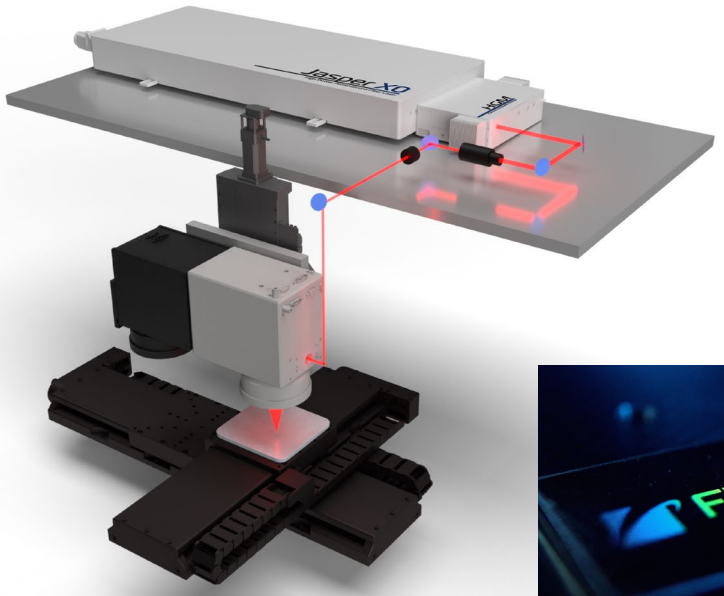
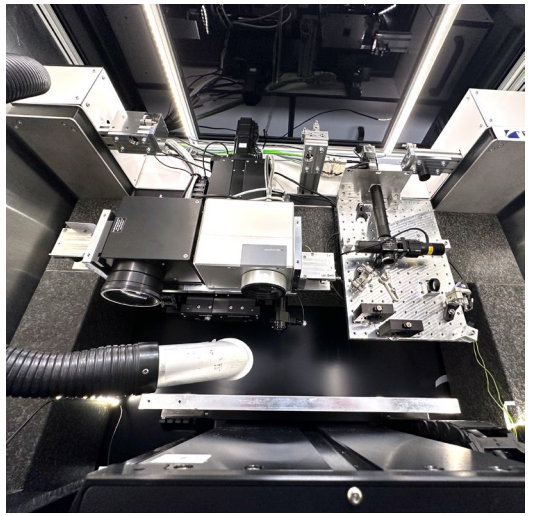
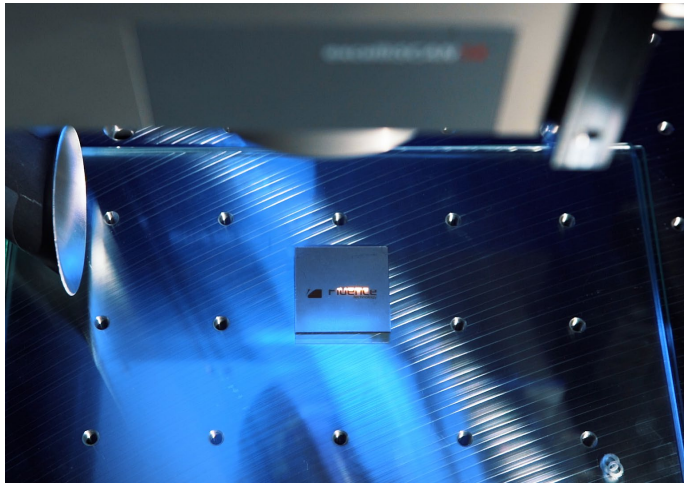
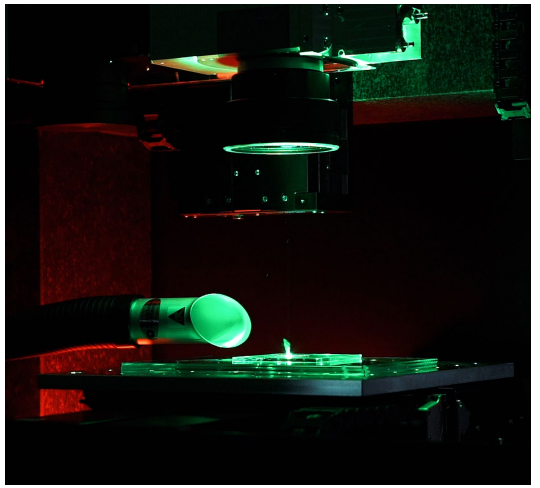
Ultrafast Laser Application Laboratory

The micromachining station is comprised of positioning stages, galvoscanners, and various fixed and beam-shaping optics. At the ULAL's heart is Fluence's Jasper X0-30 femtosecond fiber laser, which offers three wavelengths, pulse duration tuning from 250 fs to 10 ps, and different temporal pulse structures.









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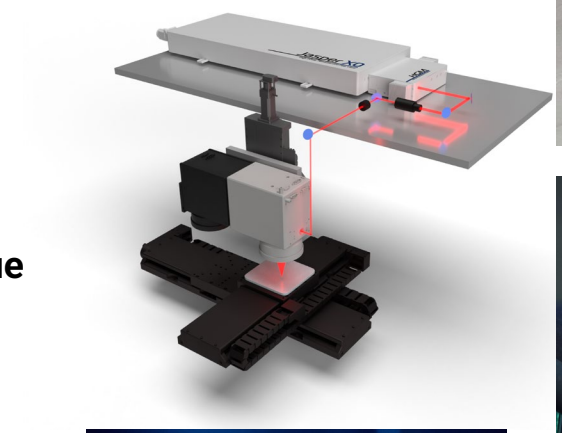
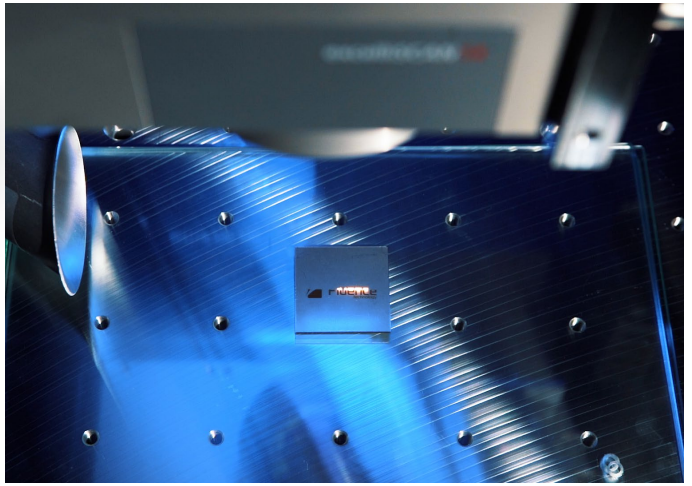
ULTRAFAST LASER APPLICATION LABORATORY

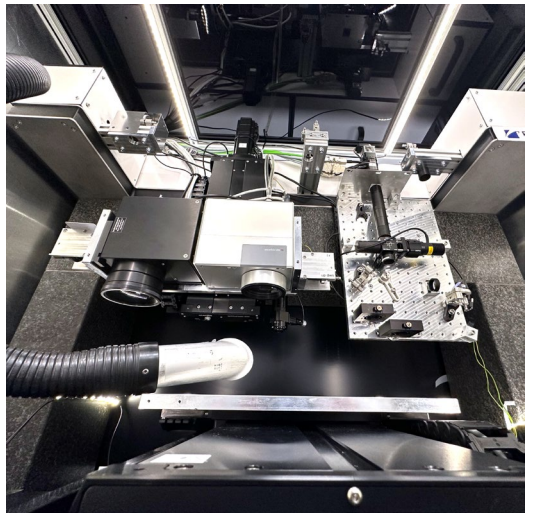
The Fluence Ultrafast Laser Application Laboratory (ULAL), a new facility in Wrocław. The laboratory is equipped with a top-class, high-precision automated micromachining station based on high-power femtosecond lasers.

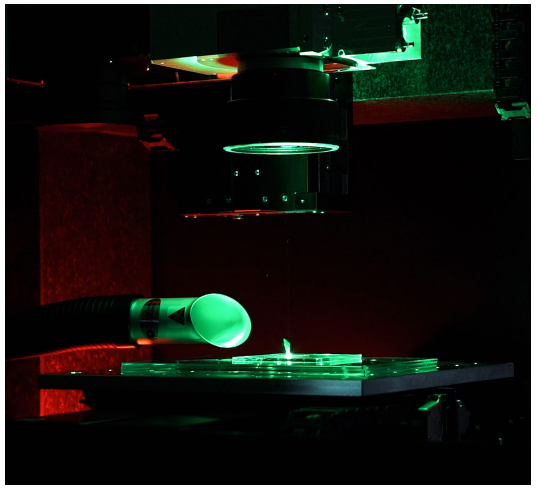
MAIN GOALS:

- Feasibility study
- Demonstrations
- Microprocessing services
- Laser process design
- New micromachining technique – RnD
- Research









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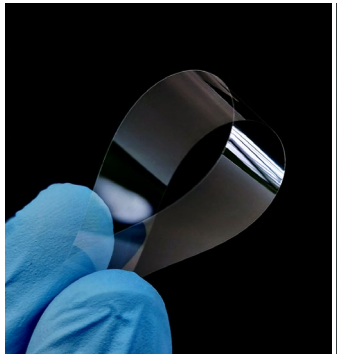
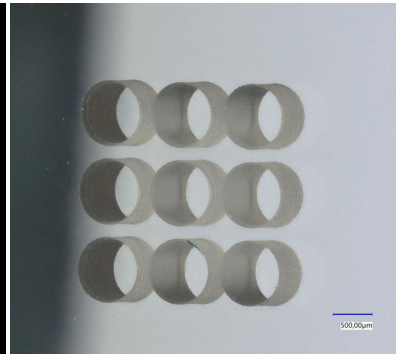
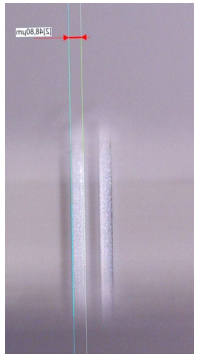
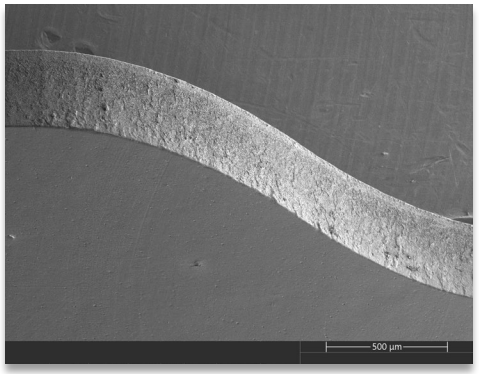
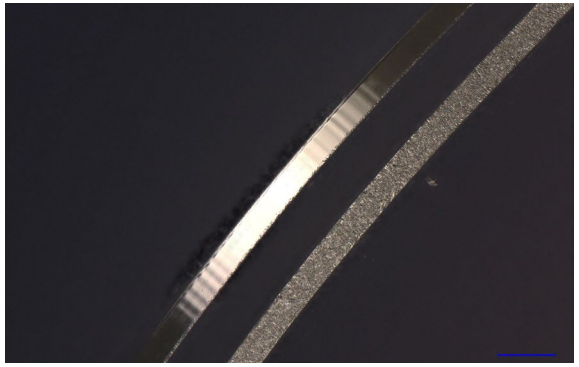
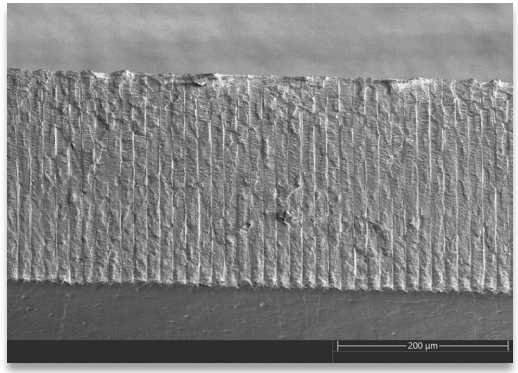
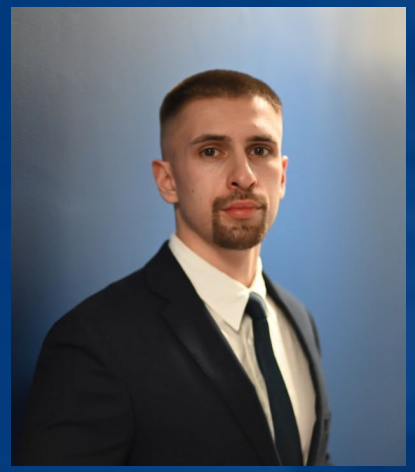
CONCLUSIONS

- ✓ **Simplified Manufacturing:** No Chemical Etching Needed: Streamlines fabrication and reduces safety hazards.Well-controlled shape with positive/negative taper.
- ✓ **Design Flexibility:** Controlled Shapes: Achieves positive/negative taper and dual/single chamfers in a single step.Tilted vias with aspect ratio 1:10, straight vias 1:20.
- ✓ **Optimized Via Performance:** Tilted vias can achieve an aspect ratio of 1:10, while straight vias reach 1:20, offering robust interconnection solutions tailored to specific application needs.
- ✓ **Material Advantages:** Glass is preferable due to its superior optical properties and mechanical benefits, making it ideal for advanced electronic applications.
- ✓ **Precision Requirements:** Achieving short pulse durations and high beam quality is essential for ensuring perfect contrast and precision in the etching process.



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European Funds
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