

Selective structuring of thick SU-8 layers on dielectric substrates by femtosecond ablation for medical applications

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Overview

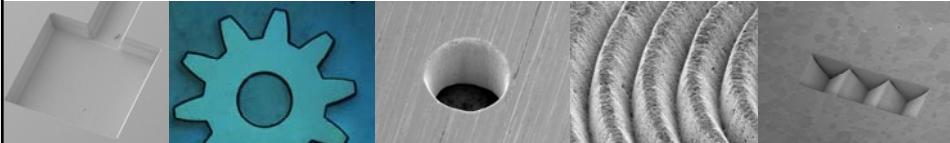
- **Introduction and motivation**
- **Experimental**
 - Material systems
 - Ultra-short pulse laser system
 - Selective ablation
 - Determination of ablation thresholds and process window
- **Results**
 - Protective layer
 - Flank angle and edge roughness
 - Selective laser ablation
 - SU-8 on soda-lime glass
 - SU-8 on fused silica
 - Problems
- **Summary and conclusion**

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Josef-Ressel-Center for material processing with ultrashort pulsed lasers

a cooperation of
HighQLaser / Spectra-Physics and the **Vorarlberg University of Applied Sciences**

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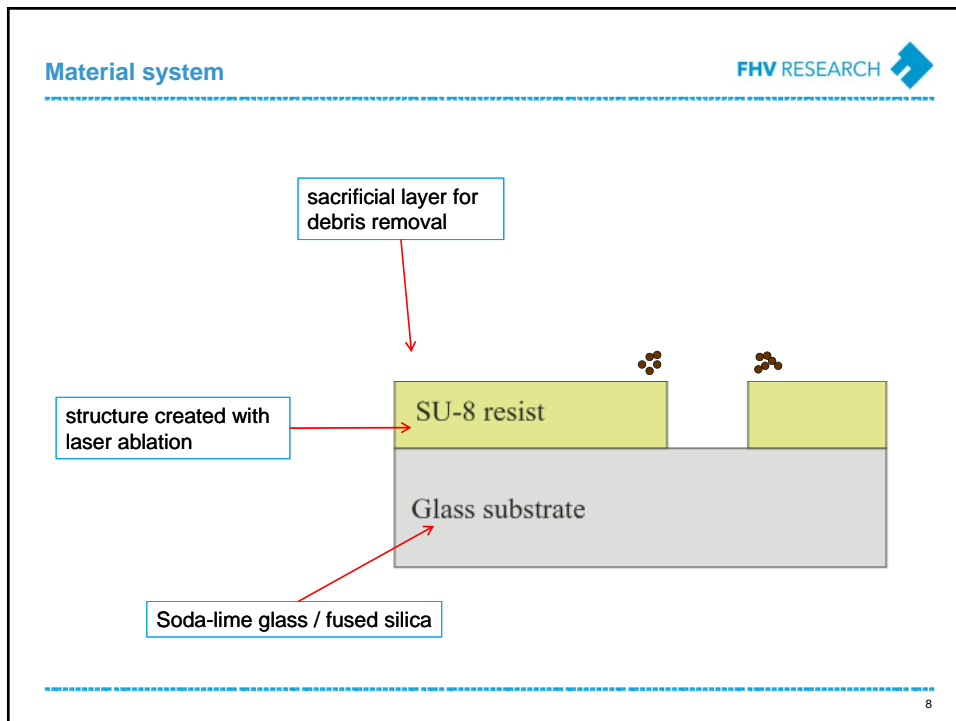
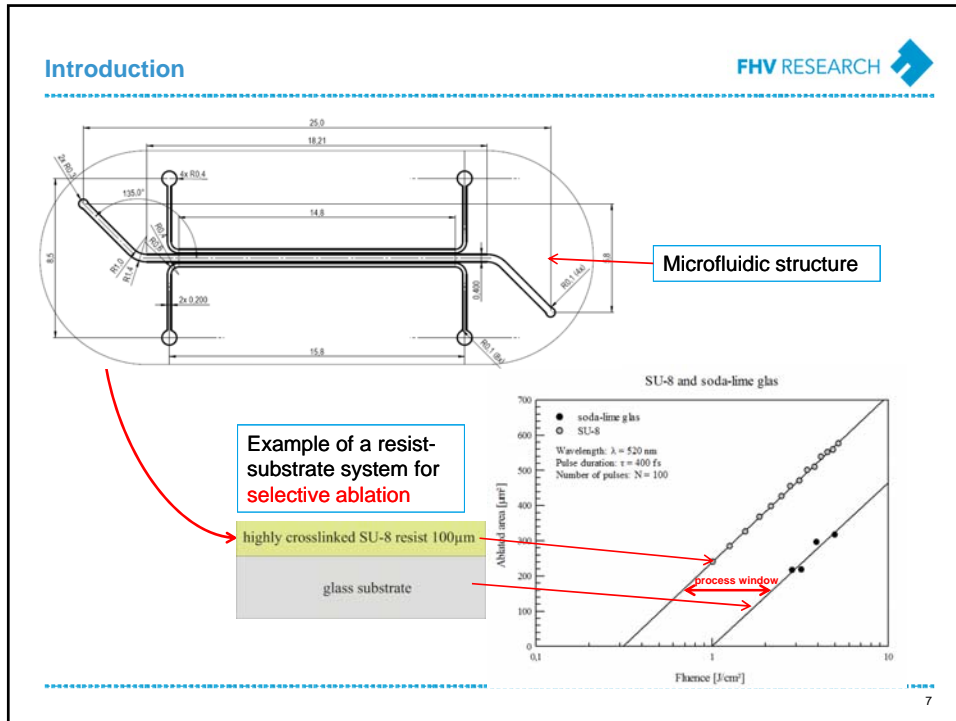
5 Years Project

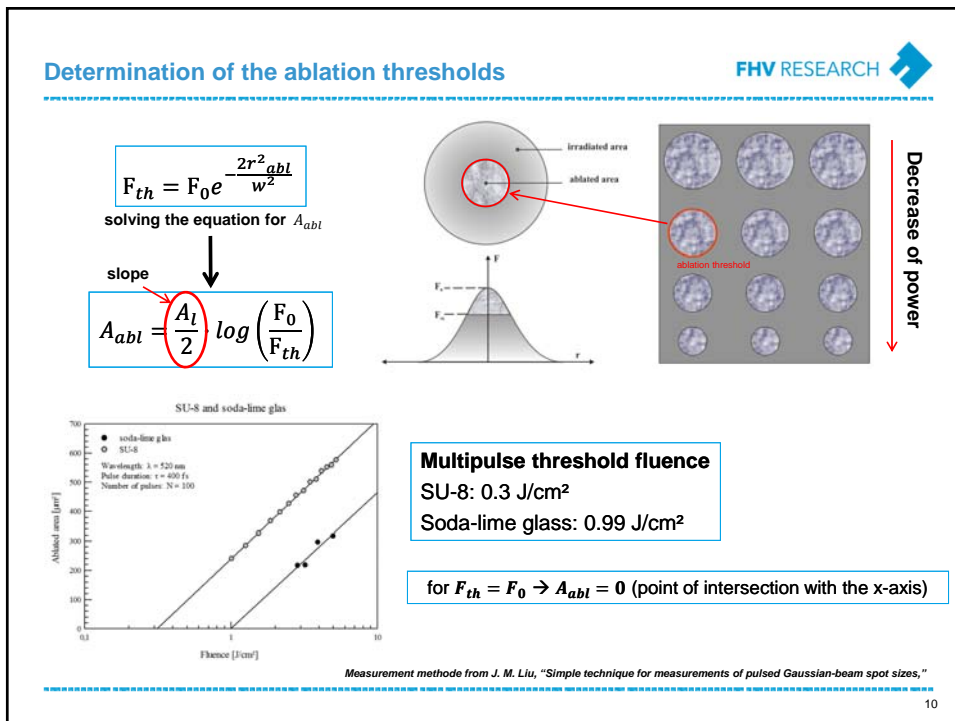
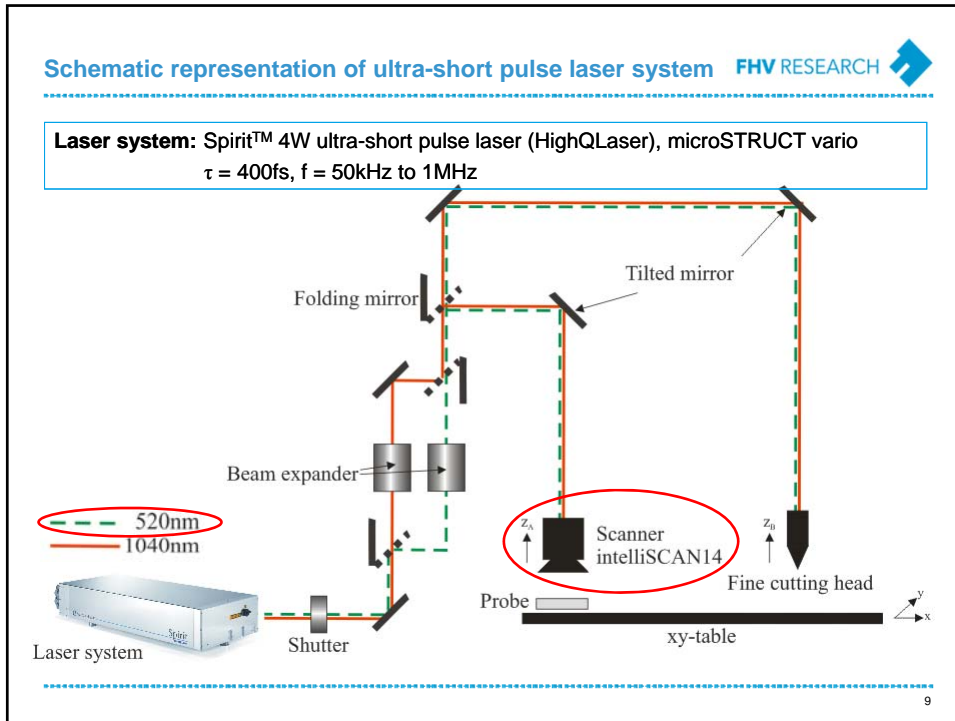
Funded by the Austrian Federal Ministry of Economy, Family and Youth and the National Foundation for Research, Technology and Development

Focus on


- physical mechanisms of laser ablation (material removal) with ultrashort laser pulses
- possible applications
- materials and material systems, respectively, which are considered as promising for future microsystems

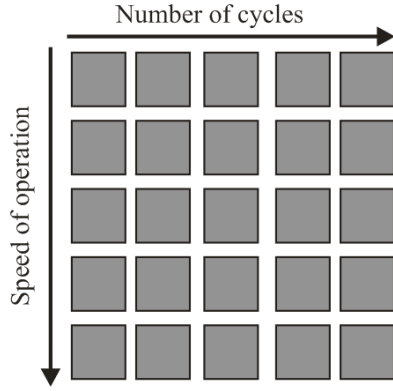






Determination of process window

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Test pattern:

- Structure quality
- Realizable range of flank angle
- Edge roughness

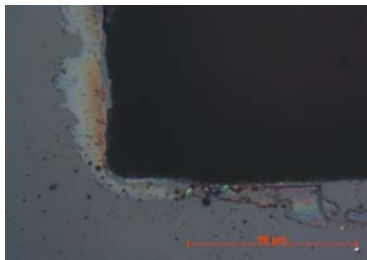
Parameter	Value	Unit
Repetition rate	200 - 500	kHz
Fluence	0.3 - 0.8	J/cm ²
Hatch distance	1 - 5	µm
Speed of operation	200 - 500	mm/s

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Protective layer

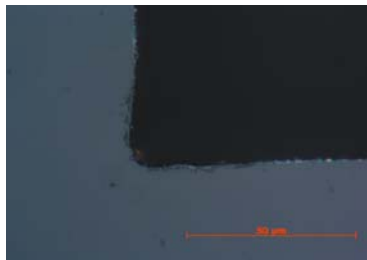
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Without protective layer

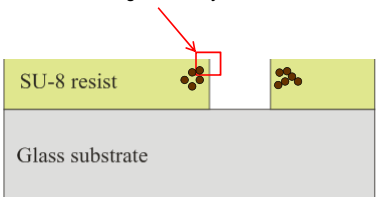


Structure created with laser ablation, edge damage caused by the debris

With protective layer

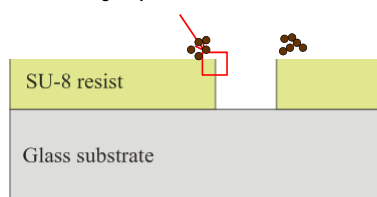


Structure created with laser ablation after removing the photoresist with acetone



SU-8 resist

Glass substrate

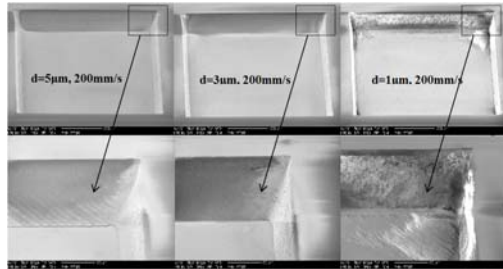


SU-8 resist

Glass substrate

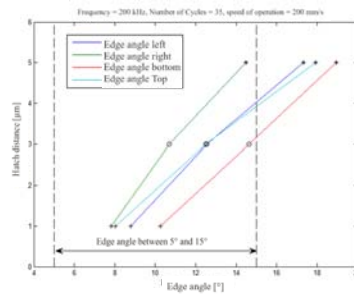
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Flank angle and edge roughness



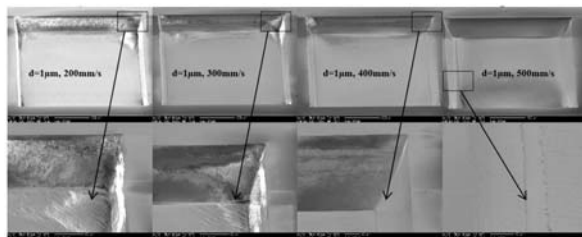
Dependence on hatch distance:

- Flank angle becomes steeper, the lower the hatch distance is
- Edge roughness increases with smaller hatch distance



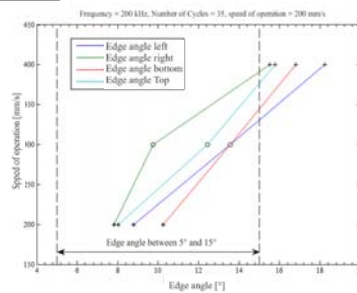
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Flank angle and edge roughness



Dependence on speed of operation:

- Flank angle becomes flatter, the more the speed of operation increases
- Edge quality is better at increasing speed of operation



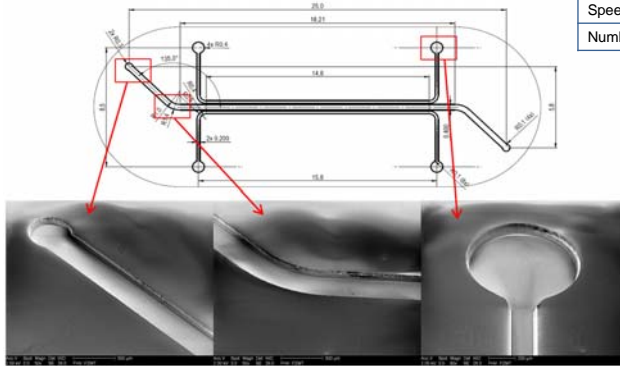
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Results: SU-8 on soda-lime glass



Microfluidic structure ablated into SU-8 on soda-lime glass with following parameters:

Parameter	Value	Unit
Repetition rate	500	kHz
Fluence	0.3	J/cm ²
Hatch distance	1	µm
Speed of operation	500	mm/s
Number of cycles	75	-



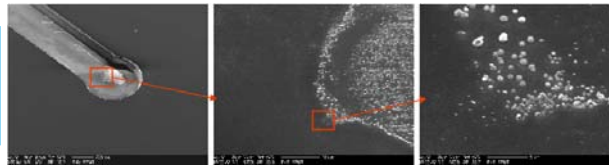
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Problems



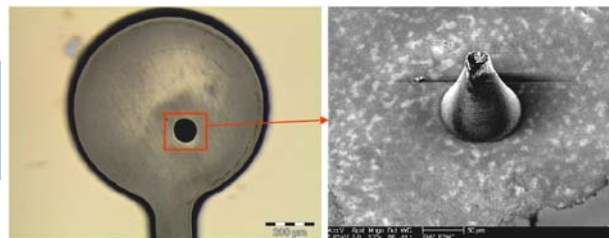
Roughening of the glass substrate

→ Use a substrate with a higher threshold fluence



SU-8 remains after laser ablation

→ Improve covering of the SU-8

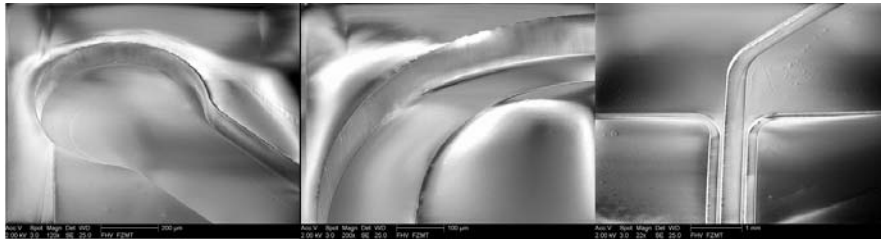


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Results: SU-8 on fused silica

Microfluidic structure ablated into SU-8 on fused silica with following parameters:

Parameter	Value	Unit
Repetition rate	500	kHz
Fluence	0.88	J/cm ²
Hatch distance	1	μm
Speed of operation	500	mm/s
Number of cycles	35	-



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Summary and conclusion

Laser ablation of a microfluidic structure with femtosecond laser:

- SU-8 on soda-lime glass:
 - Fluence: 0.3 J/cm²
 - Problems with roughening of the substrate and SU-8 remains
 - Long processing time compared to second material system
- SU-8 on fused silica:
 - Fluence: 0.88 J/cm²
 - No artifacts, no damage of the substrate
 - Short processing time because it can be worked with an approx. three times higher fluence

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Acknowledgements



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Thank you for your attention