The Art of
*u*MANUFACTURING

Micro – Device Manufacturing

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Business Development – Life Science and Microfluidics

3D/AG n|w Fachhochschule Nordwestschweiz FEMTOPRINT® 3D PRINTING FOR GLASS MICRODEVICES

Outline

FEMTOPRINT

1_The Company

2_The Technology

3_Capabilities

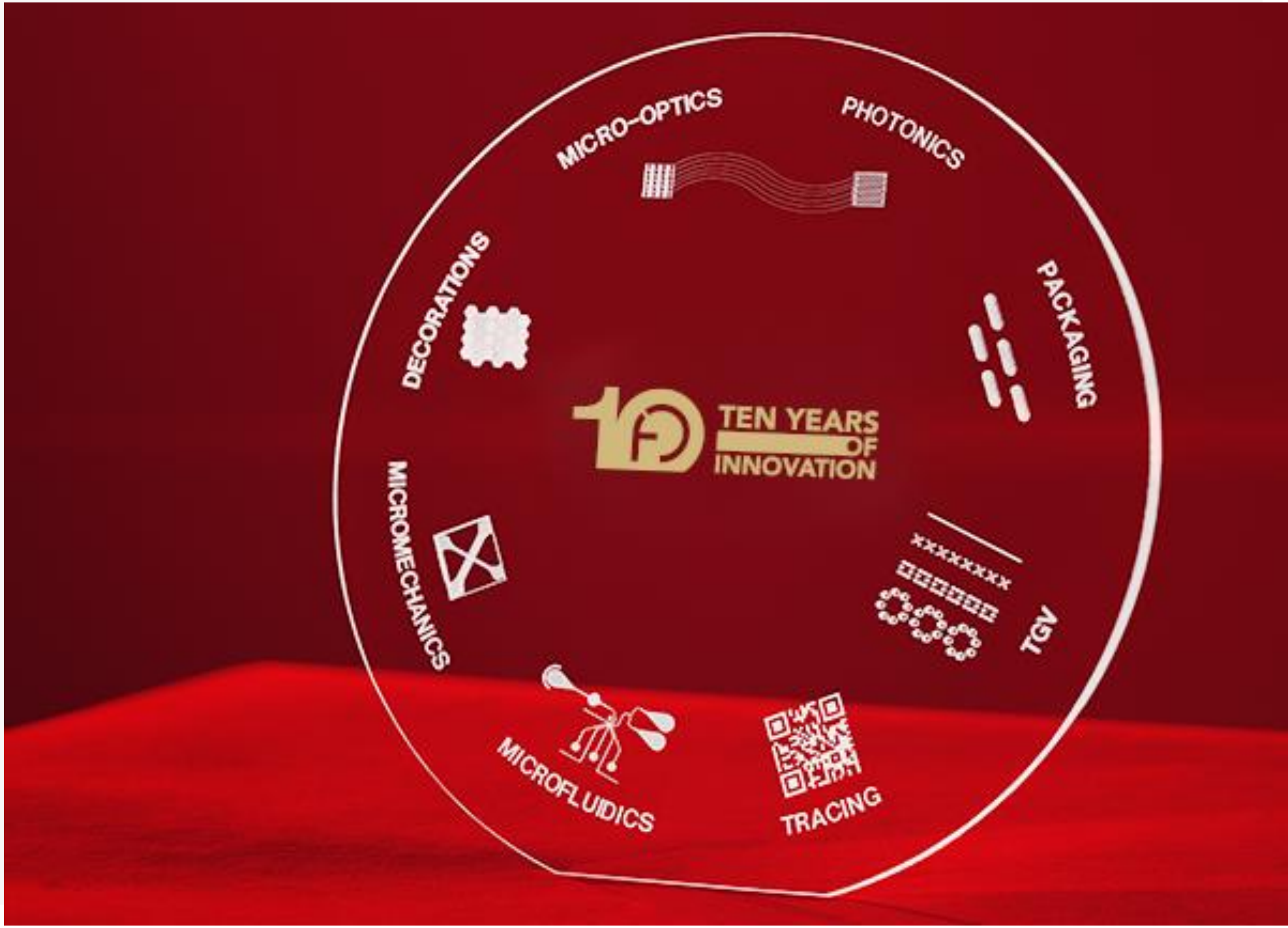
4_Applications/Markets

5_Glass Masters

AGENDA

The Company

01



FEMTOPRINT

FEMTOprint is a Swiss high-tech
Contract Development and Manufacturing Organization (CDMO)
specializing in
high-precision 3D laser microfabrication in glass

FOUNDED IN 2013

40+ TEAM MEMBERS

EXPORT TO 30+ COUNTRIES

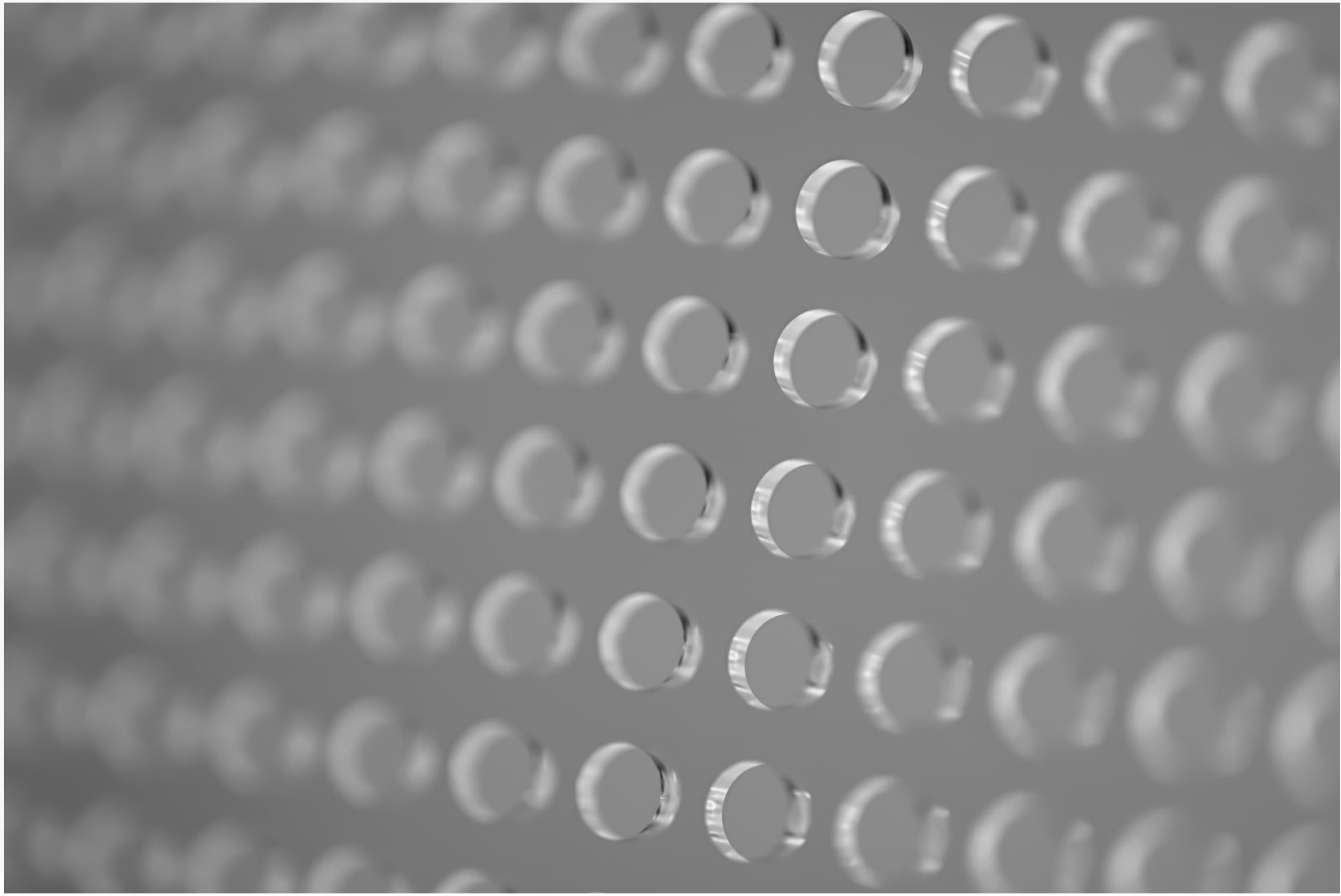
ISO 13485:2016
ISO 9001:2015

TEN YEARS OF INNOVATION

The Technology

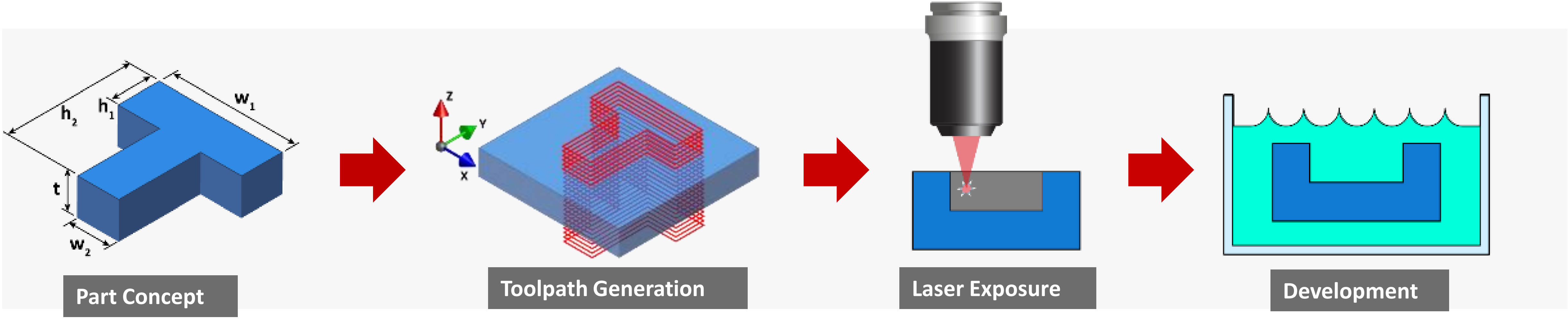
FEMTOPRINT®

02



The Technology

Laser Modification – Improved Etching



NOVELTY

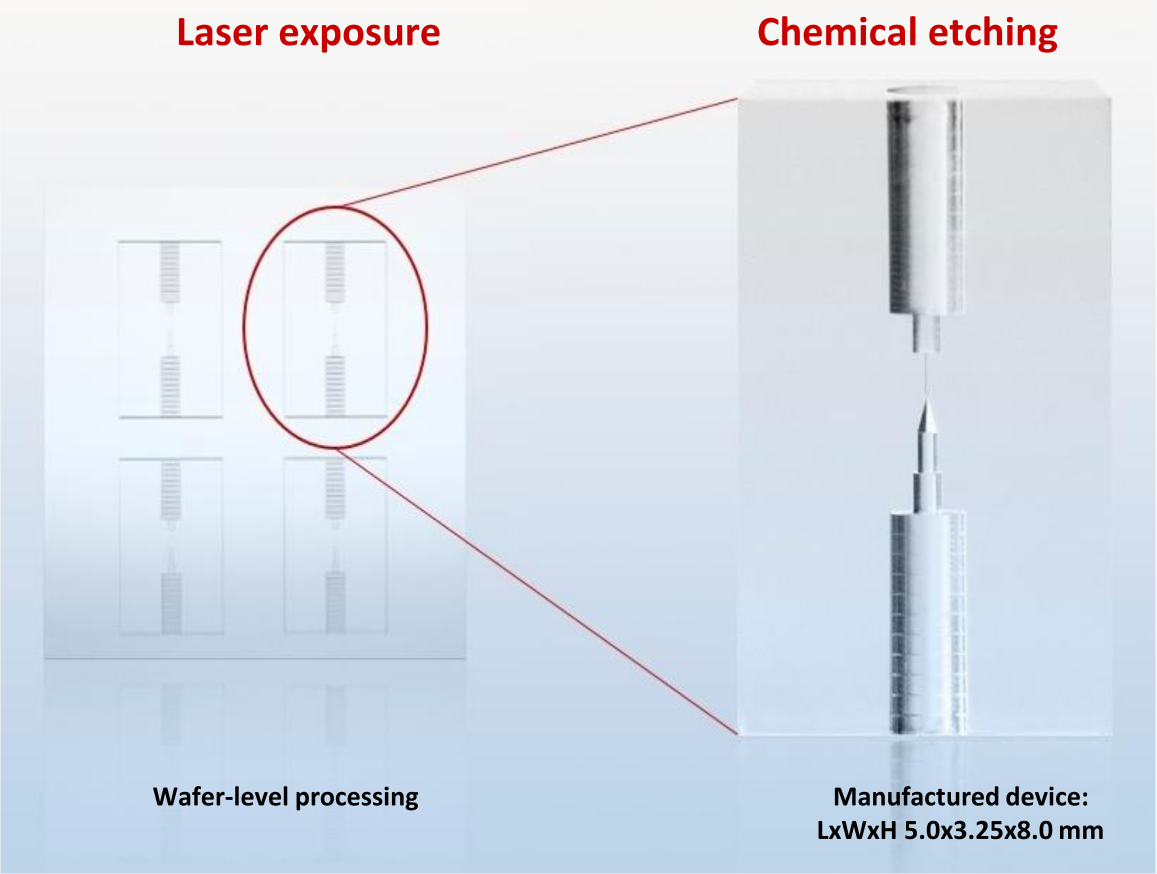
Subtractive laser 3D microfabrication technology based upon a 2-step process, whereas ultrafast laser exposure and wet etching development enable truly free-form surface/volume definition in **glass materials**.

ADVANTAGES

- Vertical sidewalls (<+/- 0.1°)
- 3D fabrication
- Monolithic integration
- No cleanroom required
- Maskless process
- Excellent surface quality

Benefits

- In-house unique capabilities of glass micro-processing in 3D, waveguides manufacturing, surface polishing, multi-material welding and ablation.
- Fast turnaround cycles in prototyping
- High geometrical accuracy and surface quality
- Integrated features in a monolithic approach, avoiding assembly and alignment tasks
- One-stop shop manufacturing foundry, delivering from single units up to volumes on wafer-level
- ISO 13485:2016 certified for medical devices.



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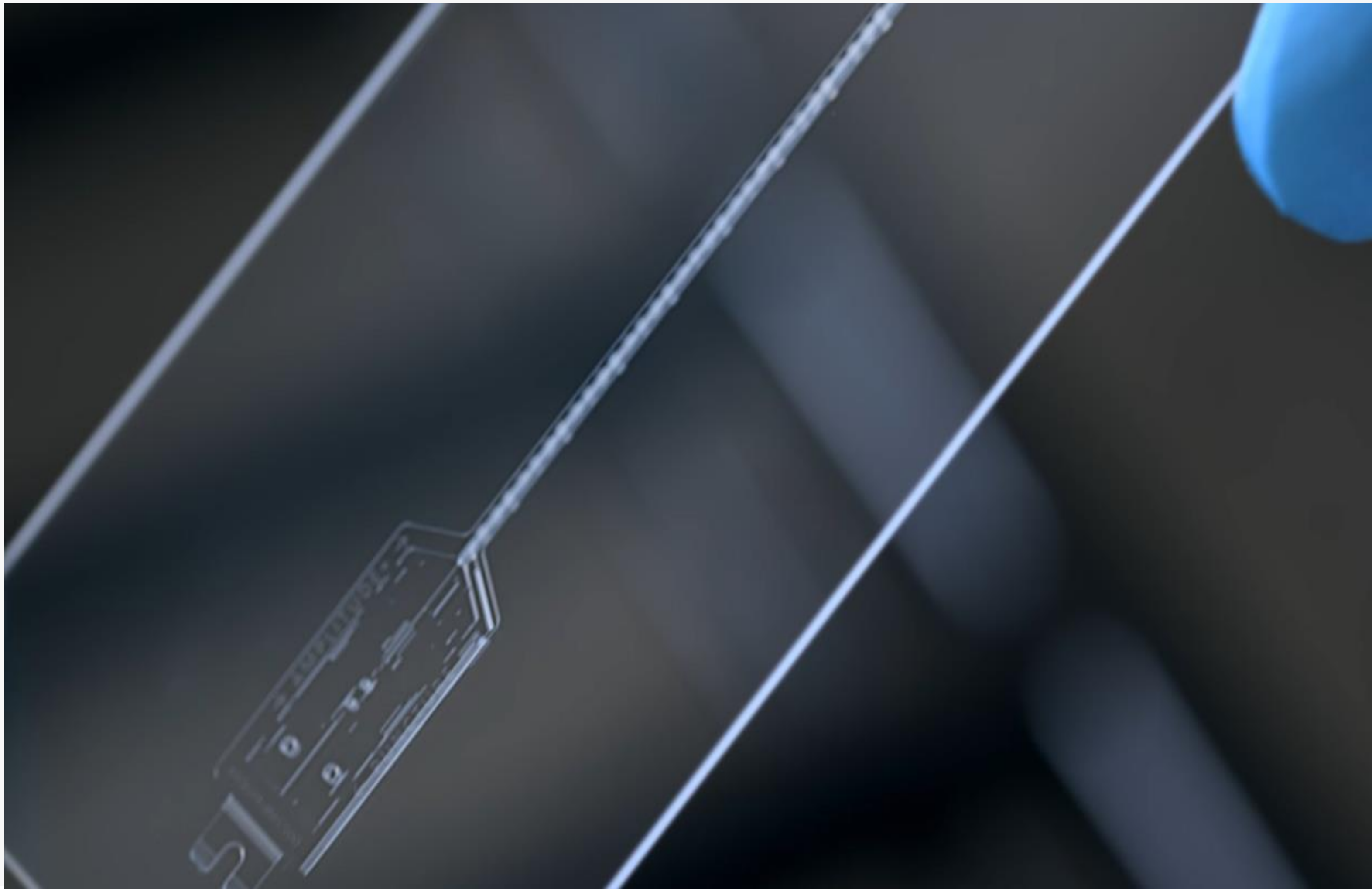
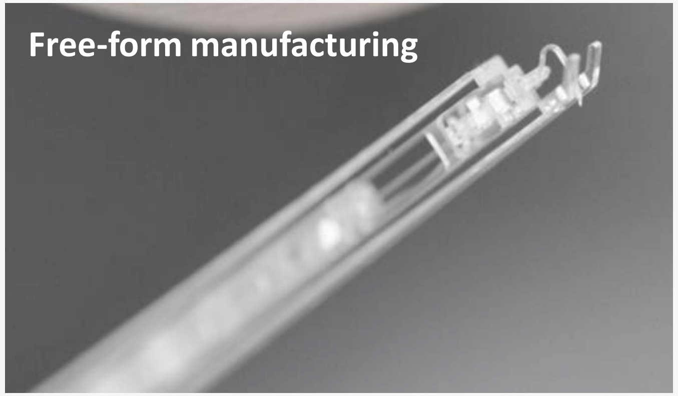
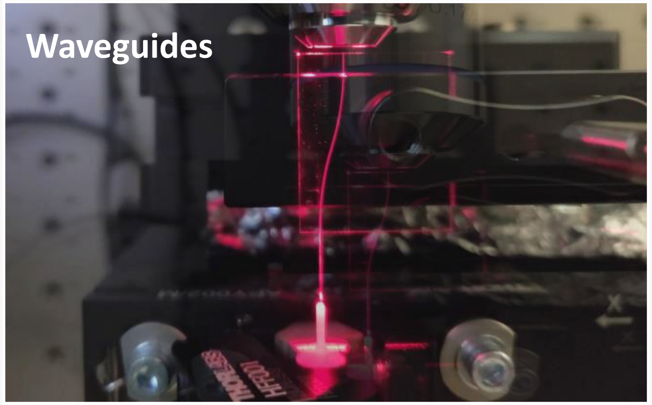
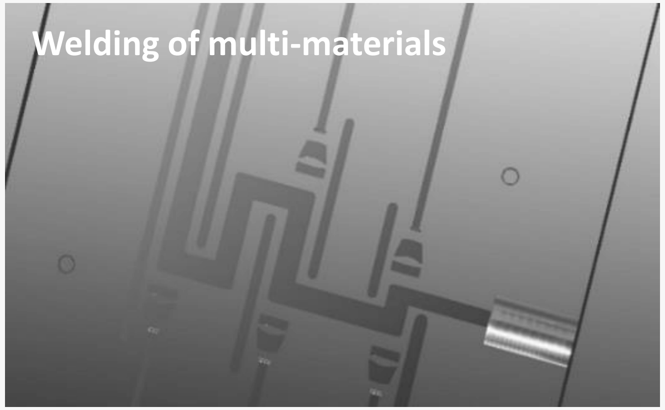
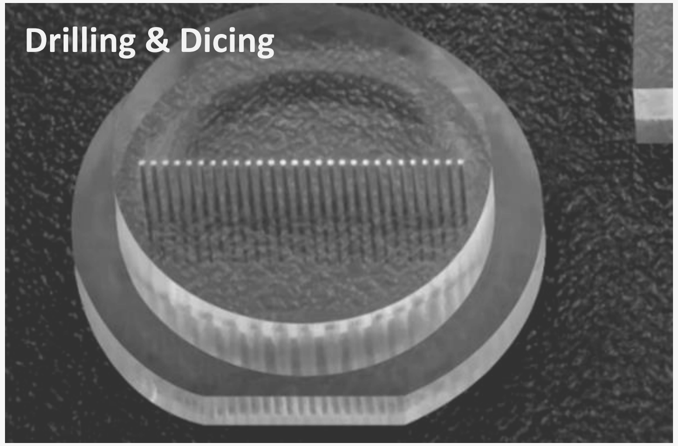


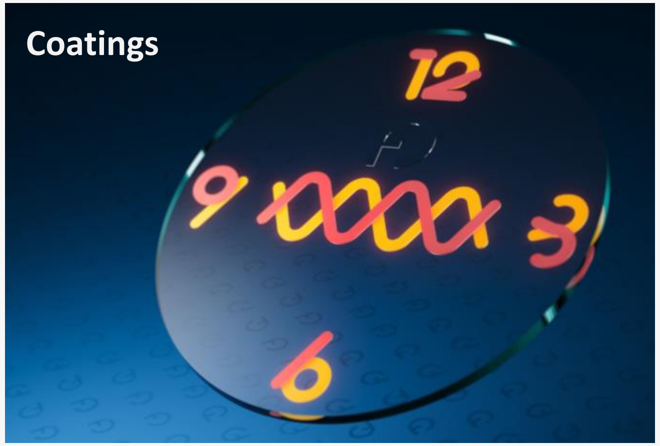
Core Competencies







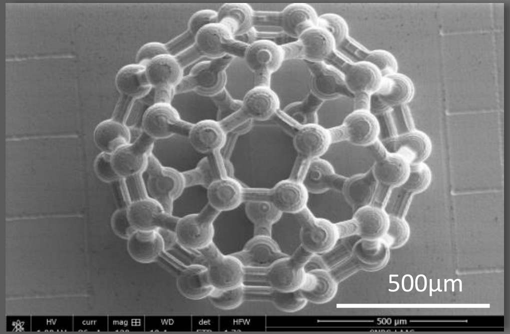


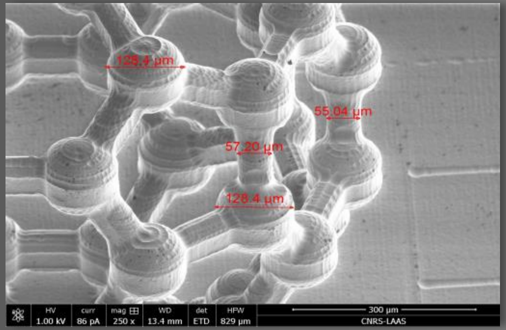


PERFORMANCES in SiO_2

RESOLUTION AND TOLERANCES

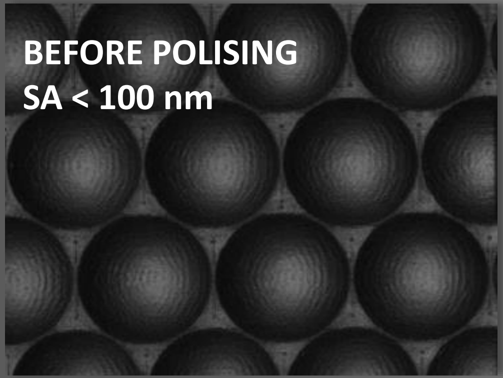
- Process resolution ~ 1 µm
- XY tolerances +/- 1 µm
- Z tolerance +/- 2 µm

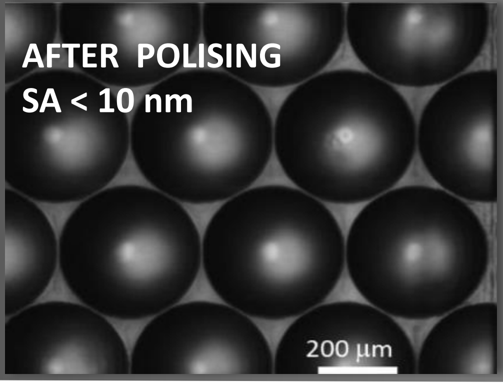




SURFACE QUALITY

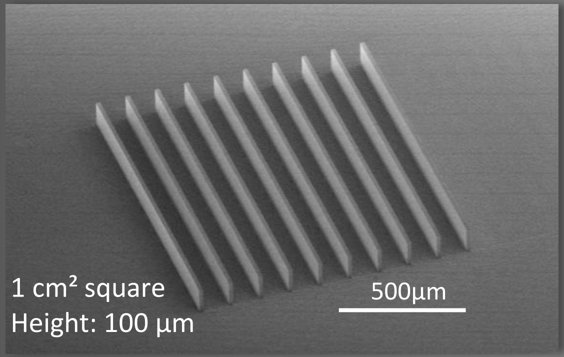
- Patterned surface *Sa* $\leq$ 100 nm
- Surface treatment *Sa* $\leq$ 10 nm

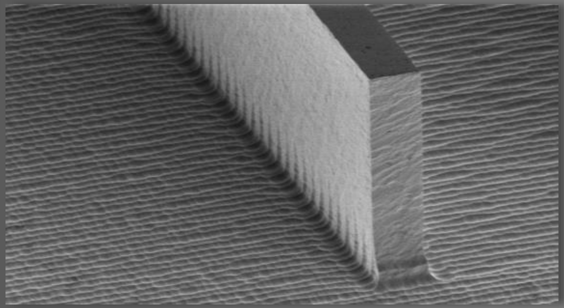




ASPECT RATIO

- Aspect ratio $\geq$ 1:500
- Sidewall deviation $\leq$ 0.1°
- Bulk height: up to 30 mm
- Working area up to 300 mm Ø





Application Areas & Industries

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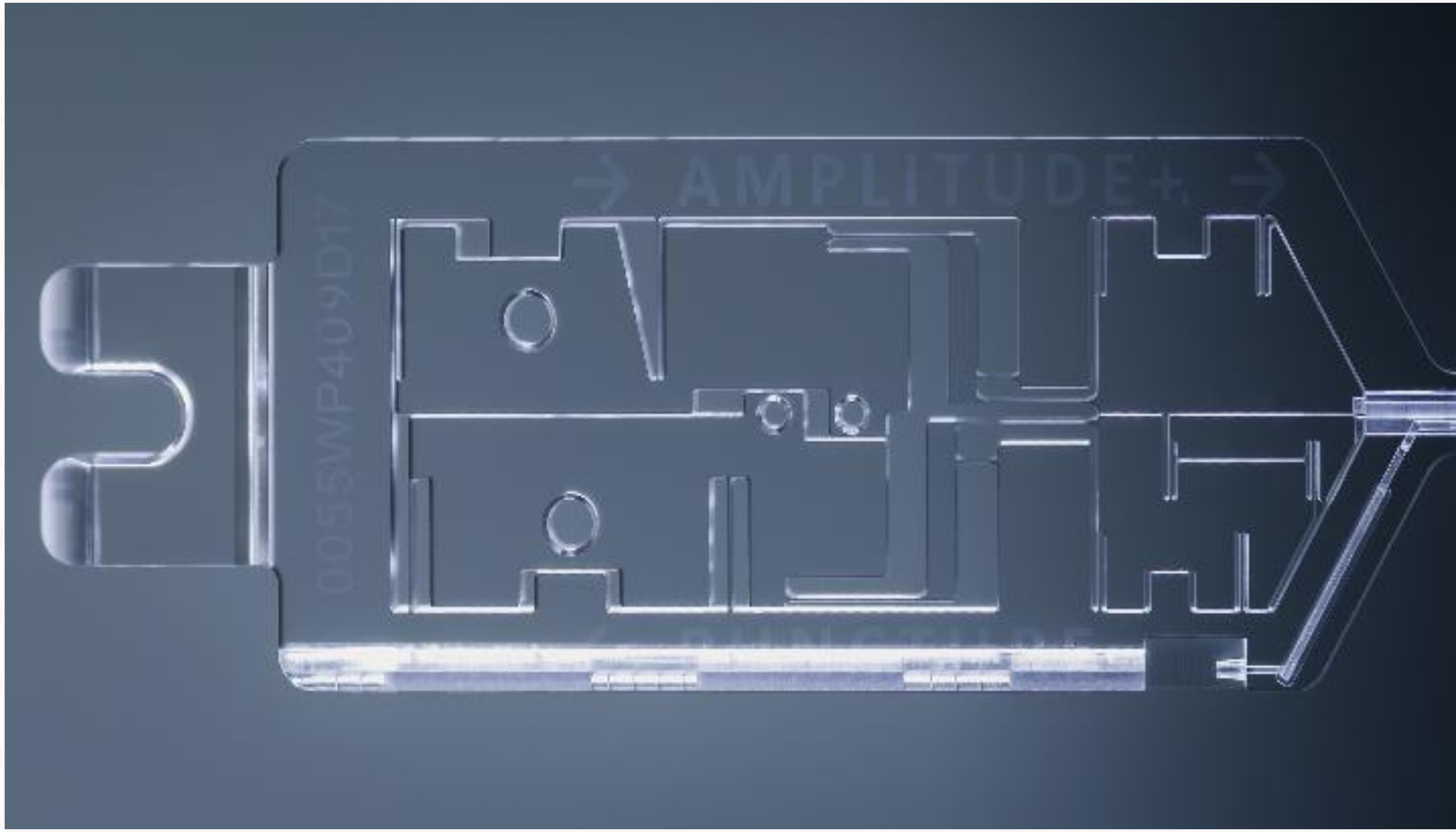
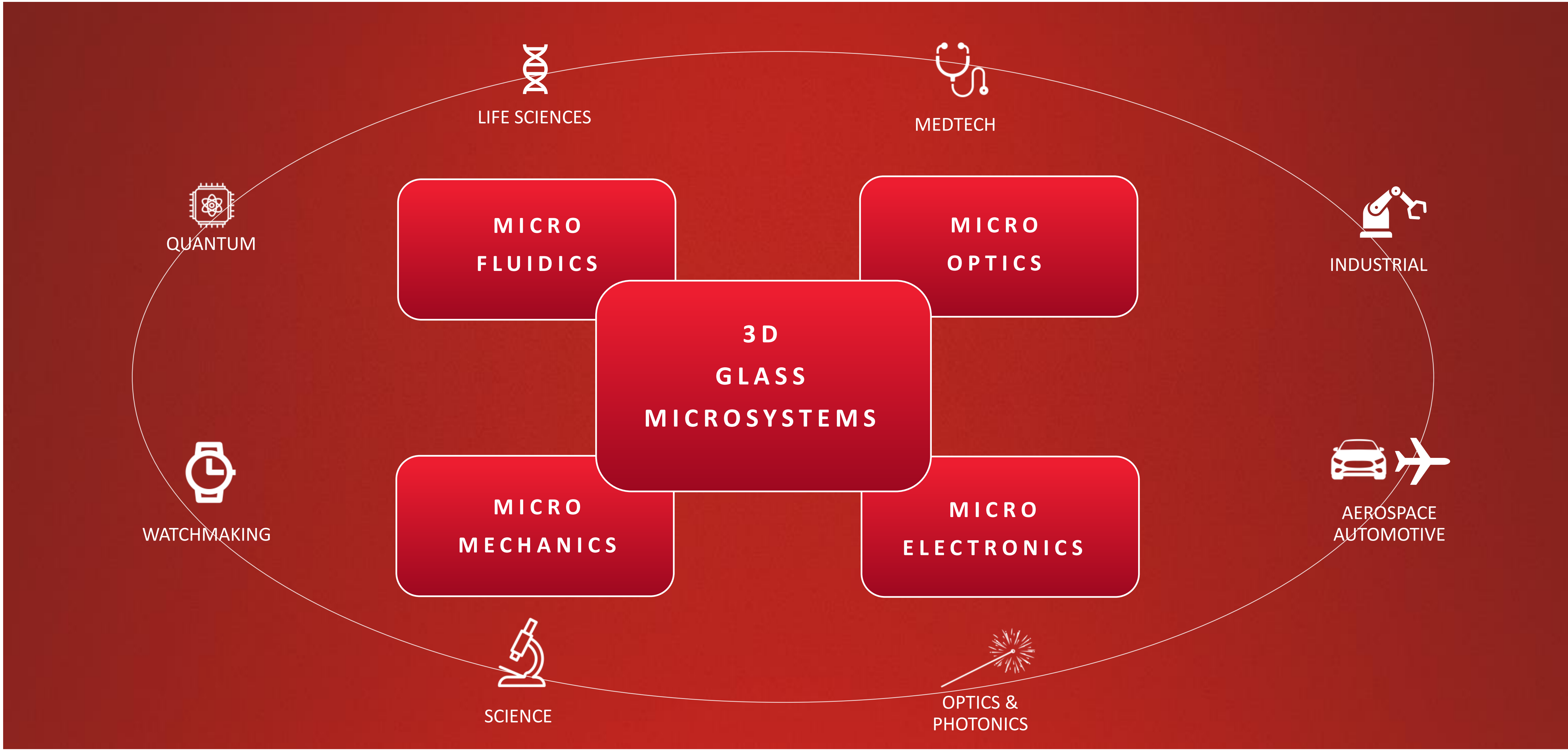


Application areas & industries



Glass Masters

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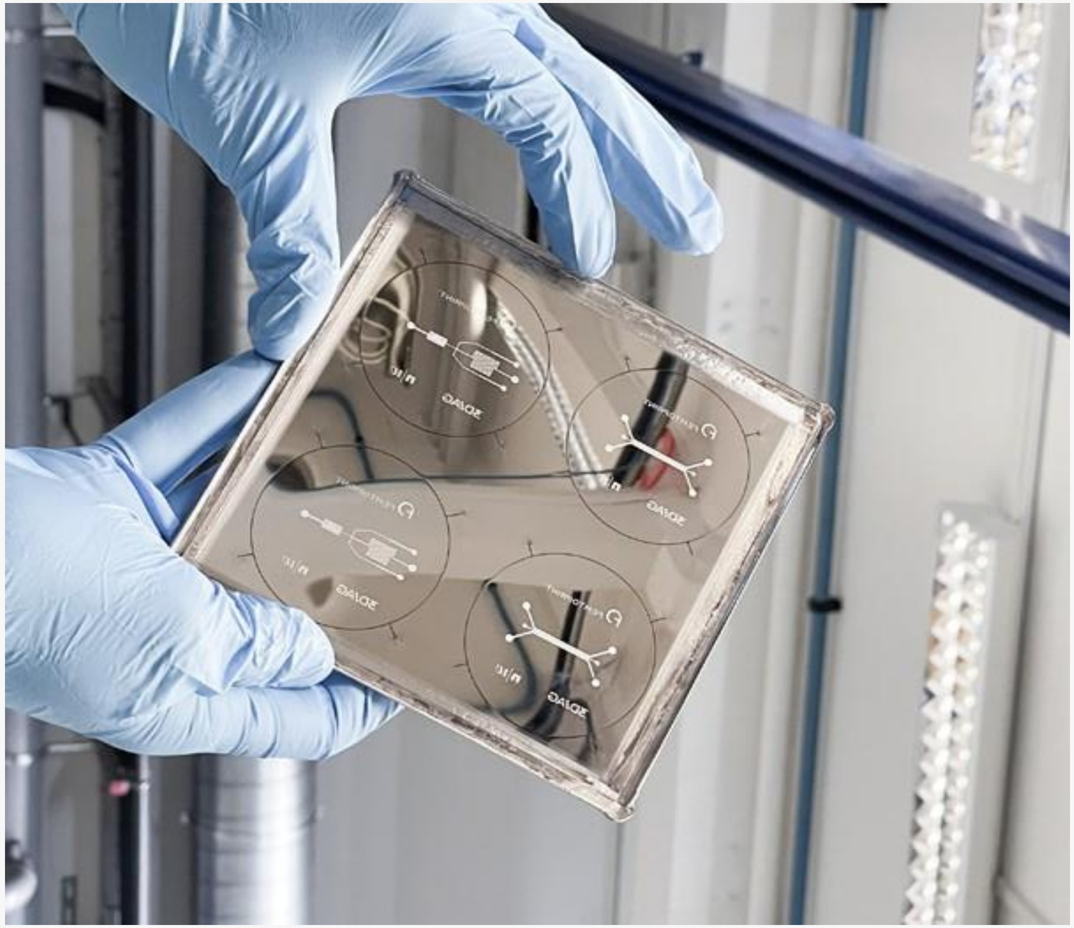


Micro – Device Manufacturing

*"A **collaborative journey t**hrough advanced technologies in glass laser micro-fabrication, electroforming, and injection moulding"*

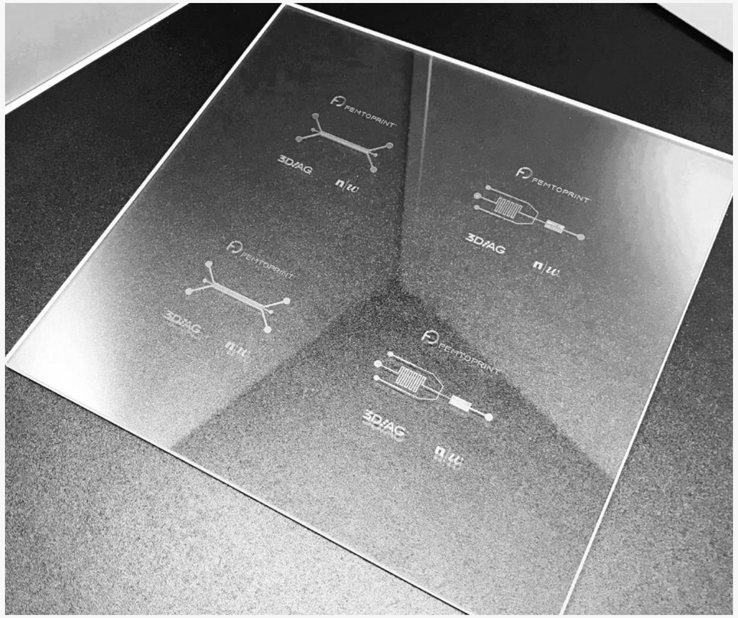
FEMTOPRINT

Micro – Device Manufacturing

The process begins with precision glass etching to create a glass master (FEMTOPrint).

Subsequently, a nickel shim was created via an electroforming process to create a tool for injection moulding (3D AG).

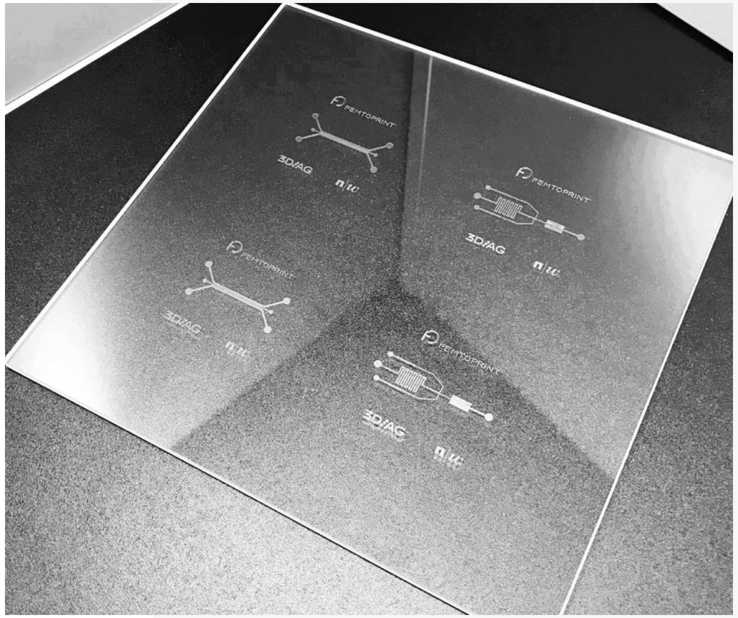
This tool was successfully employed in various injection moulding techniques resulting in a few thousands polymer parts with microfluidic features (FHNW).

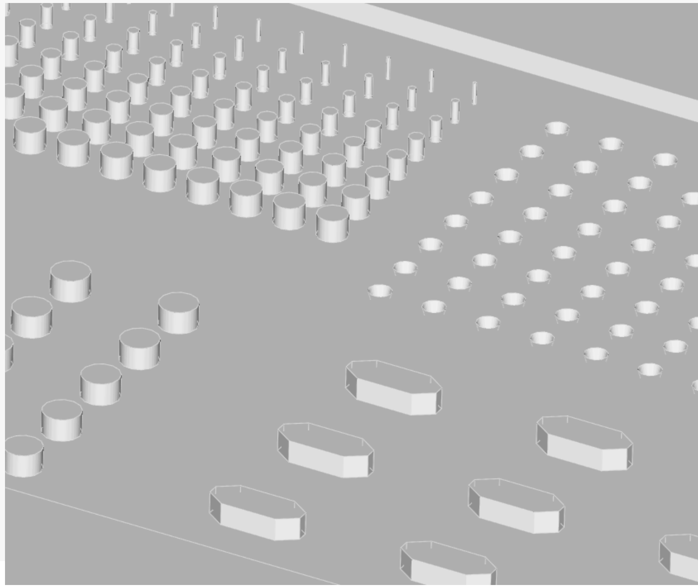


Advanced Laser Writing Process for Master Fabrication

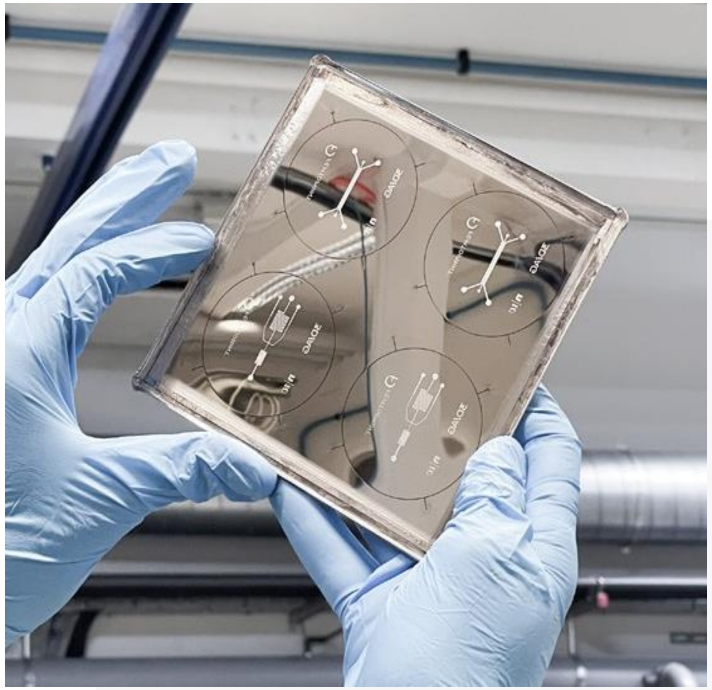
Revolutionizing Microfluidic Fabrication with 3D Master Production.

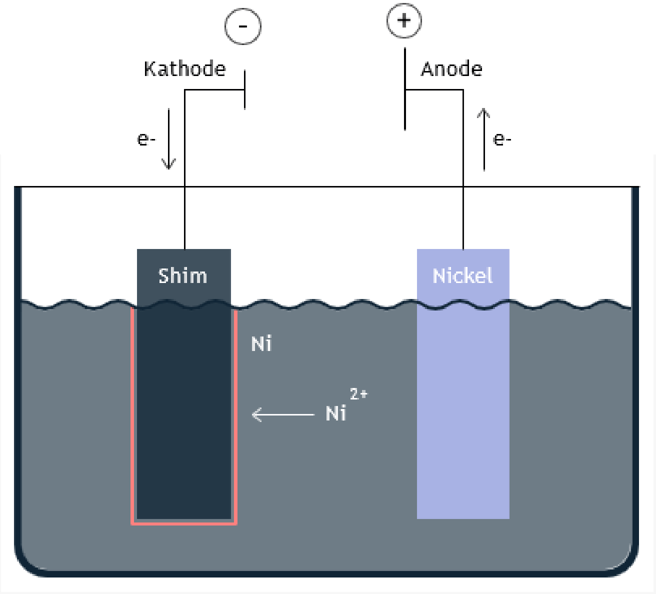
- Design Freedom:
  - Multi-depth channels, slopes, funnels, holes, pillars and other shapes can be produced in a single exposure step.
  - The introduction of sidewall draft angles of 3 to 5 degrees facilitates demolding.
  - The tolerances approach 1 um in XY and 2 um in Z, alongside exception repeatability.
- Prototyping in glass in parallel
- Maskless process for faster iterative designs





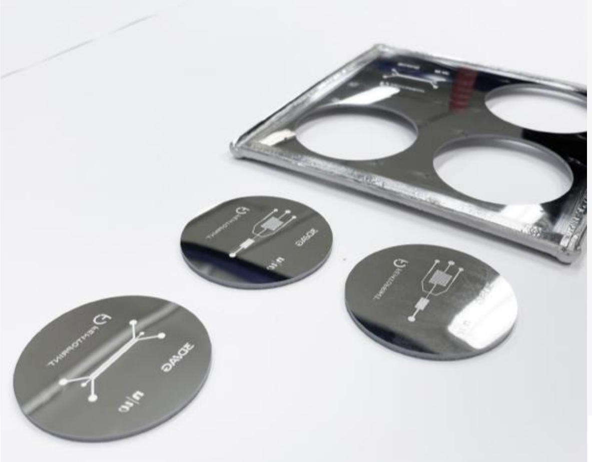
Electroforming Shims by 3D AG





Mould Preparation

- The electrodeposition of nickel with the ability to transfer intricate structures with nanometer precision to create nickel shims
- Produces a relatively thick layer of metal (50 um to 4000 um), which can be separated to create an exact replica of the original structure.
- Allows the production of multiple copies from a single master template, reducing costs and lead times.



Injection Moulding by FHNW

Replication of Microfluidic Shims

- Successfully moulded microfluidic designs that were fabricated by FEMTOprint in Glass and transferred to Nickel Shims by 3D AG
- Utilized with different process variants: isothermal, variothermal, with/without compression stroke.
- Achieved very good replication in COC, COP, and PMMA.

About the Authors

Dr. Marek Krehel CTO at 3D AG

Dr. Marek Krehel, an Optical Engineer, joined 3D AG in 2017 and has been serving as the Chief Technology Officer since September 2022. He earned his doctoral degree in Engineering from ETH Zurich in 2014, focusing on Polymeric Optical Fiber for biomedical sensing at Empa. Following his doctorate, he worked as a Senior Research Associate at Luzern University of Applied Sciences, specializing in light redirection systems from 2014 to 2017. Prior to this, he contributed to Philips Research in Eindhoven, characterizing scattering systems in light-guiding applications. Dr. Krehel obtained his master's degree in this field from Wroclaw University of Technology.

Dr. Andrea Lovera CTO at FEMTOPrint

Andrea earned a PhD in Photonics from the Swiss Federal Institute of Technology of Lausanne in 2014, where he conducted pioneering research on surface plasmon biosensors for cancer detection. He then joined FEMTOprint as a Field Engineer, contributing to technology maturation, business model evolution,
and company expansion, gaining experience in laser glass processing. Since 2017, Andrea has led the Engineering department and served as CTO, overseeing the company's technical development and strategic evolution as member of the strategic board. In September 2023, he co-founded AxCellerate, a company offering a pioneering service for drug discovery based on 3D glass devices, where he is also active as CTO.

Prof. Dr. Per Magnus Kristiansen
Head of the Institute of Polymer Nanotechnology FHNW

Prof. Dr. Per Magnus Kristiansen studied Materials Engineering at ETH Zürich, where he also earned his PhD in the Polymer Technology group in 2004.
In the following five years, he worked for Ciba Specialty Chemicals,
initially focusing on the market introduction of novel clarifiers and research on supramolecular additives. From 2007, he was part of the Automotive Application Technologies team, serving clients along the entire value chain. In 2009, he joined the FHNW University of Applied Sciences and Arts Northwestern Switzerland as a Professor in Polymer Engineering and Nanotechnology. Since 2016, he has been the Head of the Institute of Polymer Nanotechnology (INKA) at FHNW, where he also served as Deputy Head from 2011 to 2016.

Thank you!

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