Spark Assisted Chemical Engraving (SACE)

An innovative technology with high potential for industry

L.A. Hof, R. Wüthrich

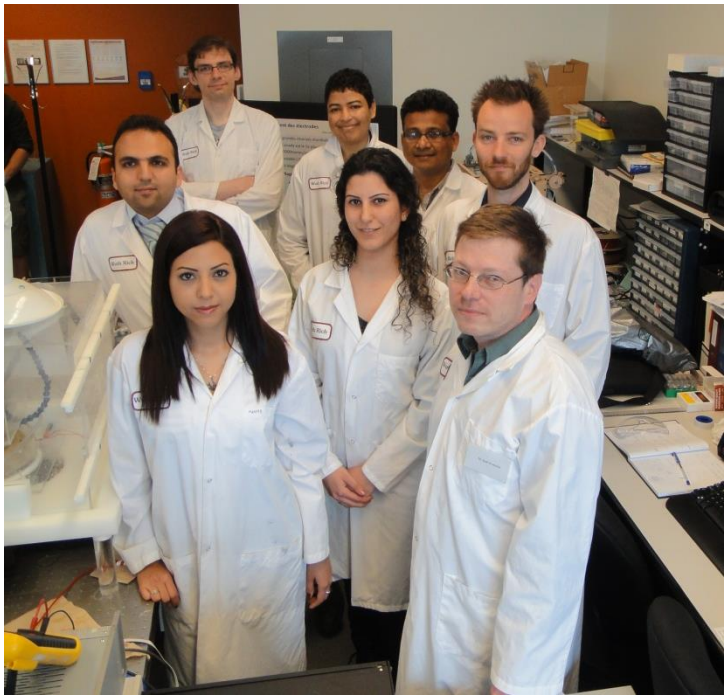
Electrochemical Green Engineering Group

Department of Mechanical and Industrial Engineering

Concordia University

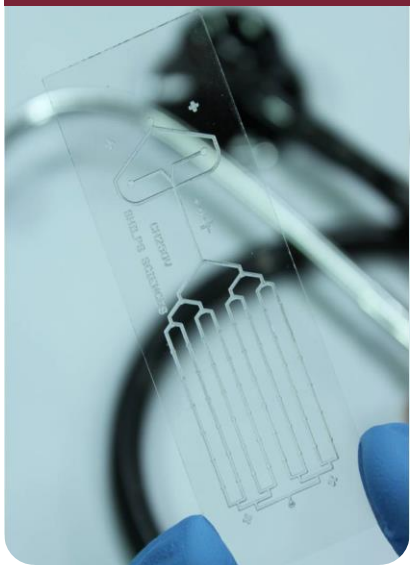
Our Mission

Develop green advanced manufacturing technologies meeting the demand of the fourth industrial revolution



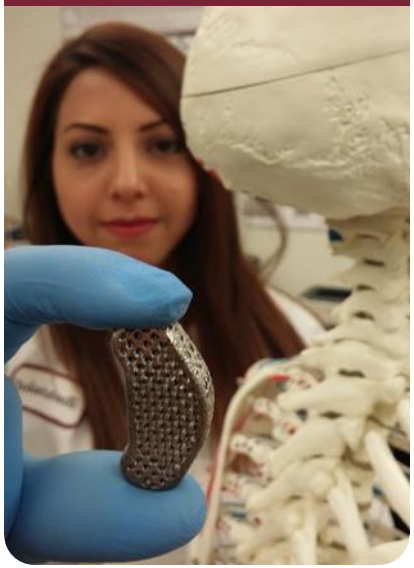
Our Expertise

Glass Machining



- Lab-on-Chip
- Multilayer chips
- Micro- to Macro-world interfaces

Post-Processing

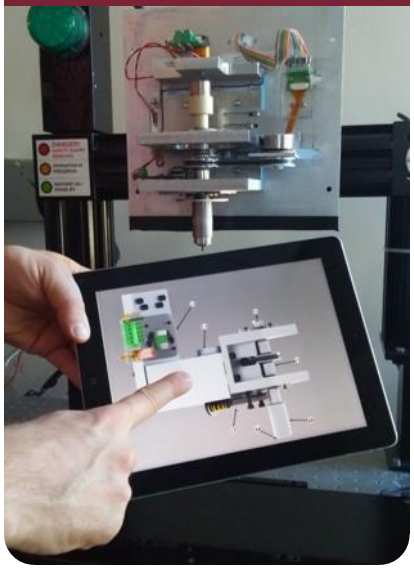


- Multiscale electro-polishing
- Down to Ra of 50nm
- Broad range of materials including Titanium

Coating

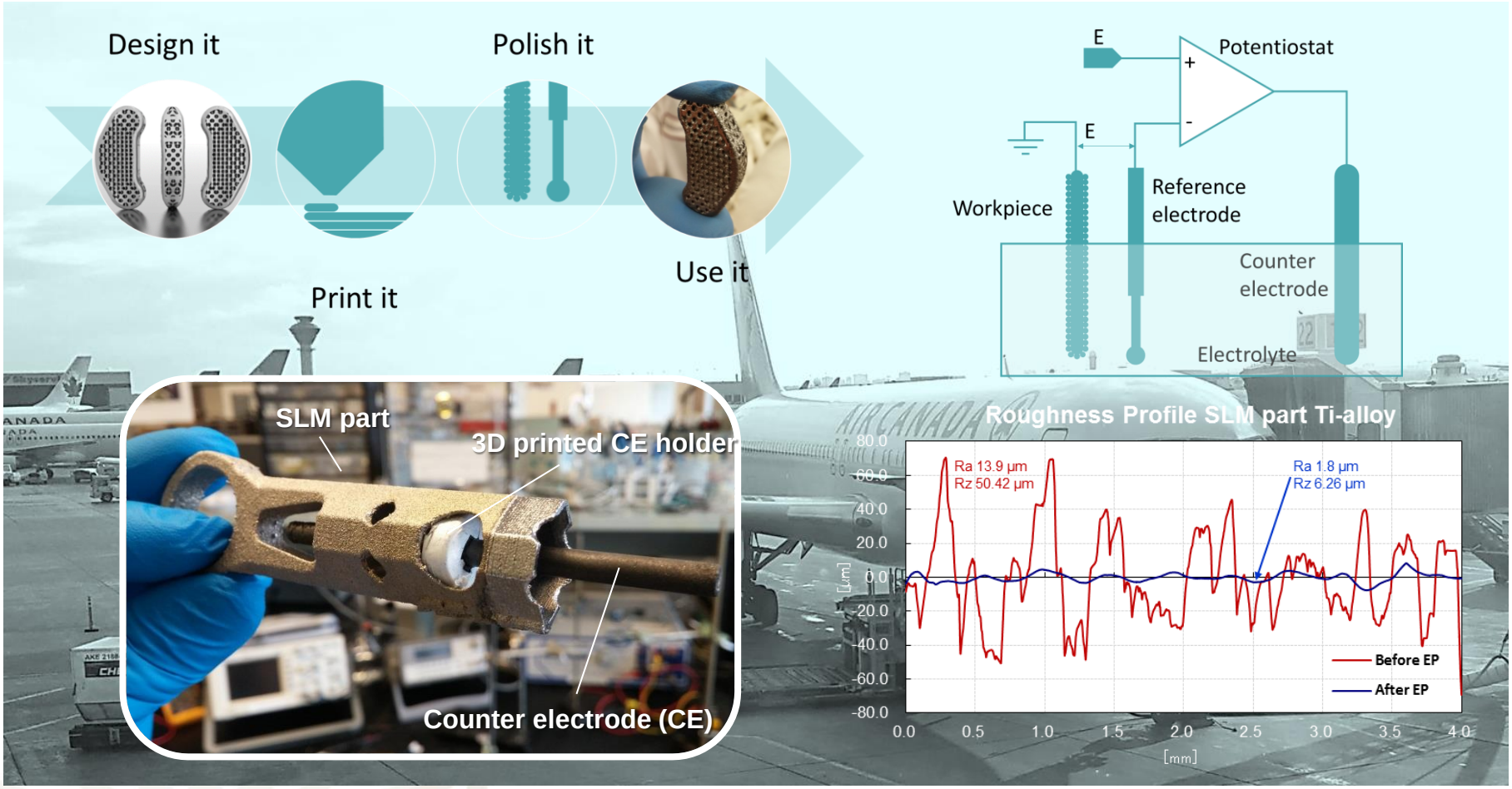
- Complex parts
- Wide range of substrate materials
- Tuning surface wettability

Industry 4.0

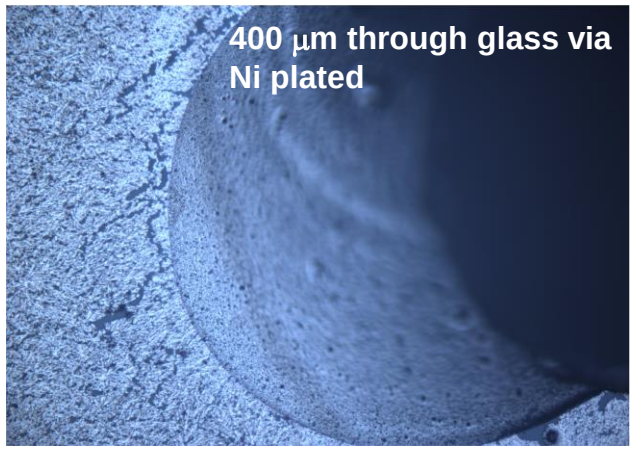


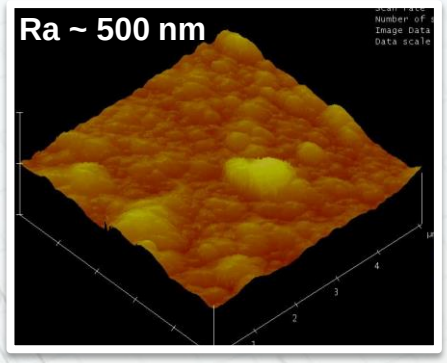
- Batch Size 1 production
- Internet of Things (IoT)
- Ultra low-cost tooling

Electropolishing

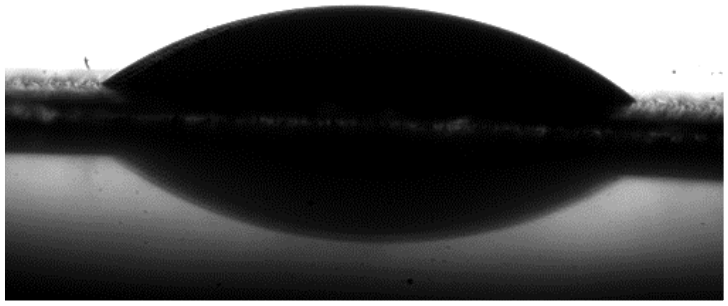


Room Temperature Nanocoating

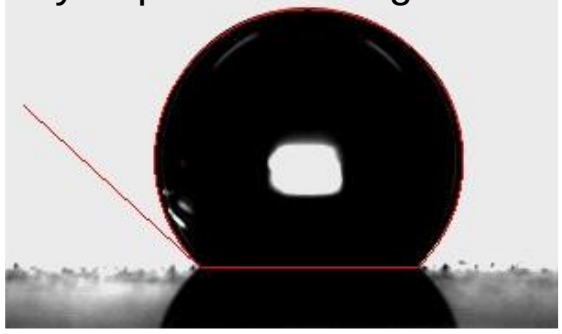




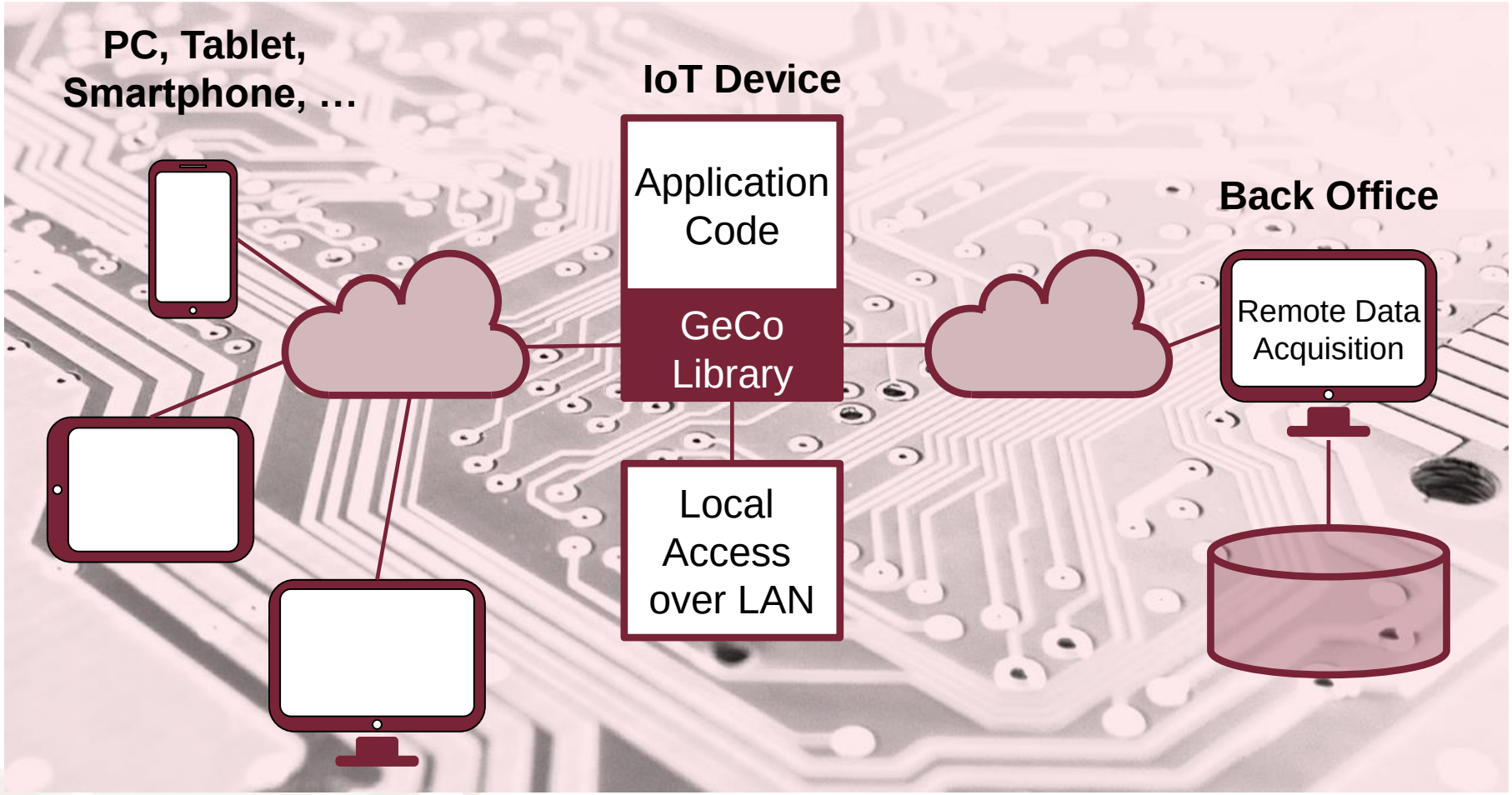
Hydrophilic coating



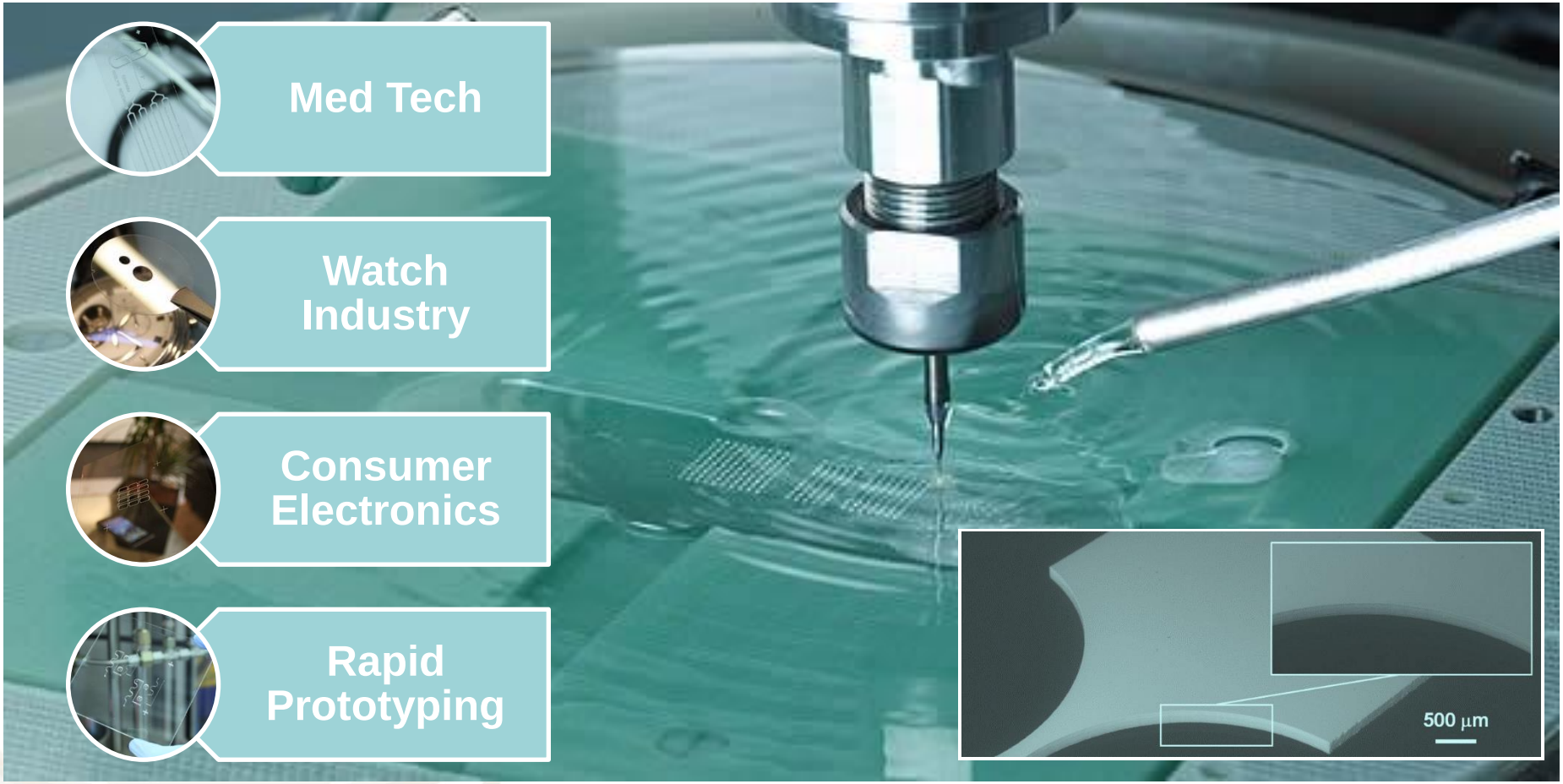
Hydrophobic coating



Internet of Things

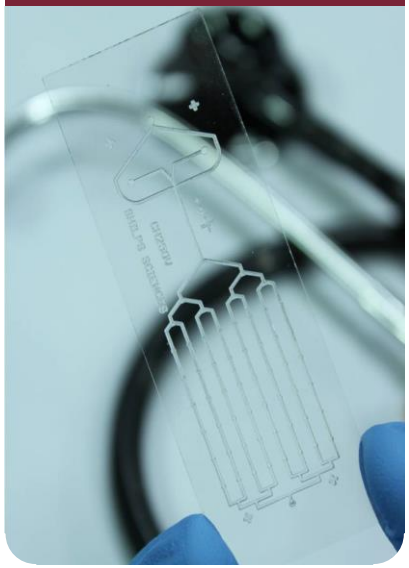


Glass Micromachining



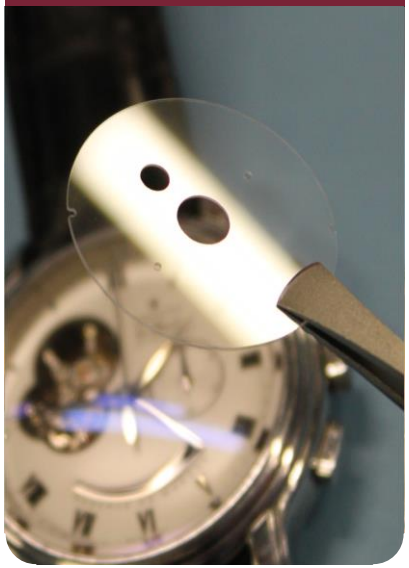
Applications

MedTech



- Lab-On-Chip
- Multilayer chips
- Micro- to Macro-world interfaces
- Micro-cutting

Watch Industry

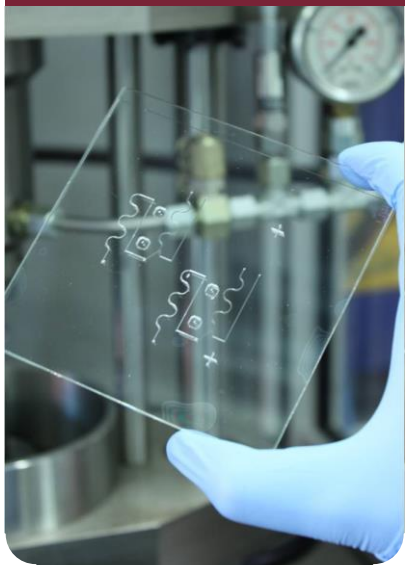


- Watchglass cutting
- Inner parts
- Anti-counterfeiting marks
- Localized glass strengthening

Consumer Electronics

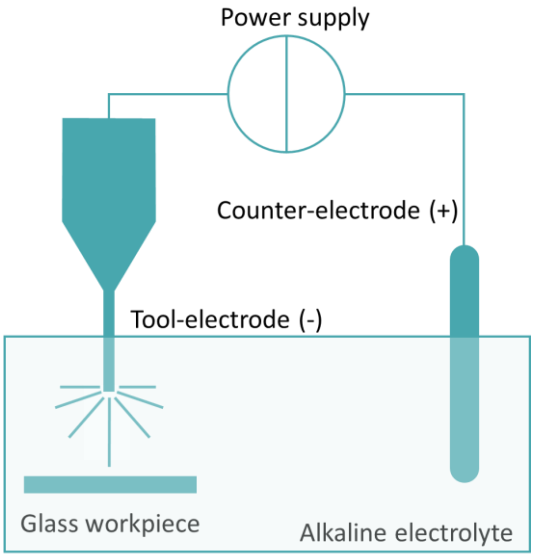
- Drilling for Trough Glass Vias
- Micro-cutting of glass including thin (<300μm)
- Micro-cutting of hardened glass

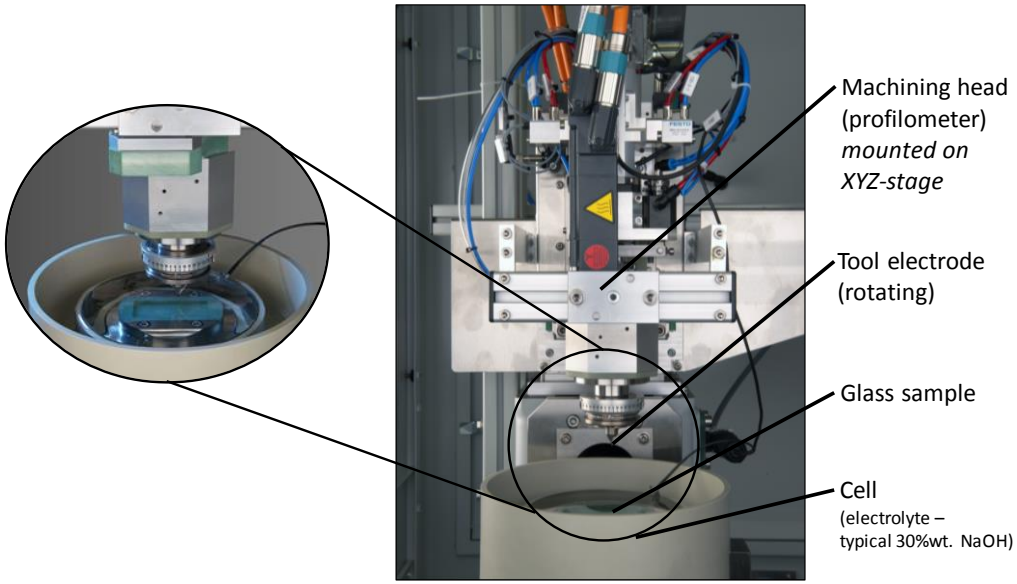
Rapid Prototyping

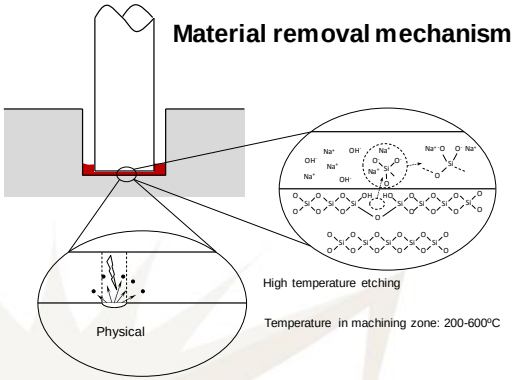


- Industrial R&D
- Fundamental Research
- Surface engineering
- Batch Size 1 production

SACE Principle







- Chemical etching of glass by OH radicals
- Thermally catalysed
- Local flushing of electrolyte and heating of work-piece determines machining speed and quality
- Reaction:
  $SiO_2 + 2NaOH \rightarrow Na_2SiO_3 + H_2O$

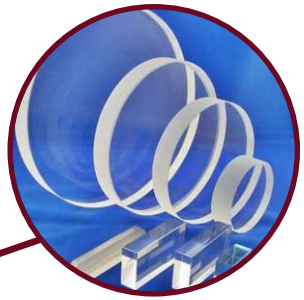
Machinable materials

Silicon oxide based materials

Glass

- Pyrex
- Mempax
- BF33
- D263T
- AF32
- B270
- …

Quartz

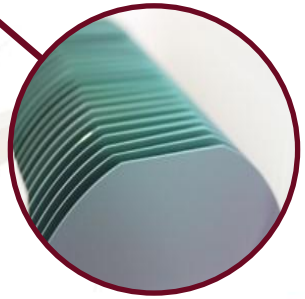


Tempered Glass

- Corning Gorilla
- AGC Dragontrail
- Schott Xensation

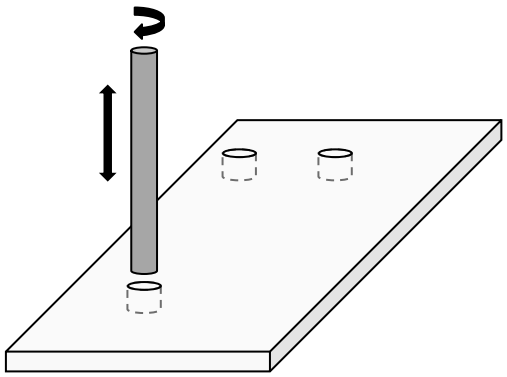
Vitreous enamel

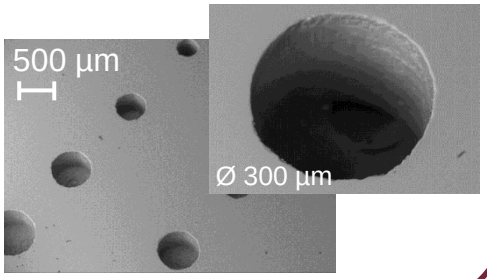
Silicon



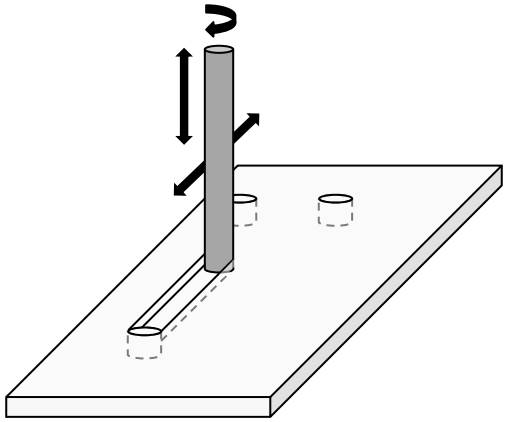
Flexible Machining

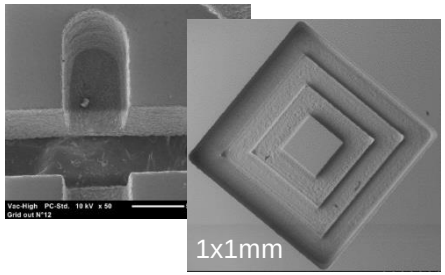
Drilling



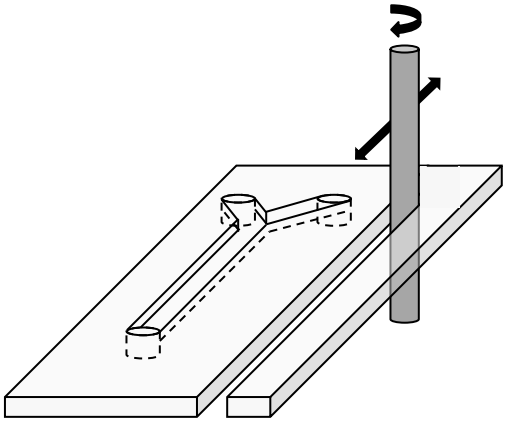


Milling





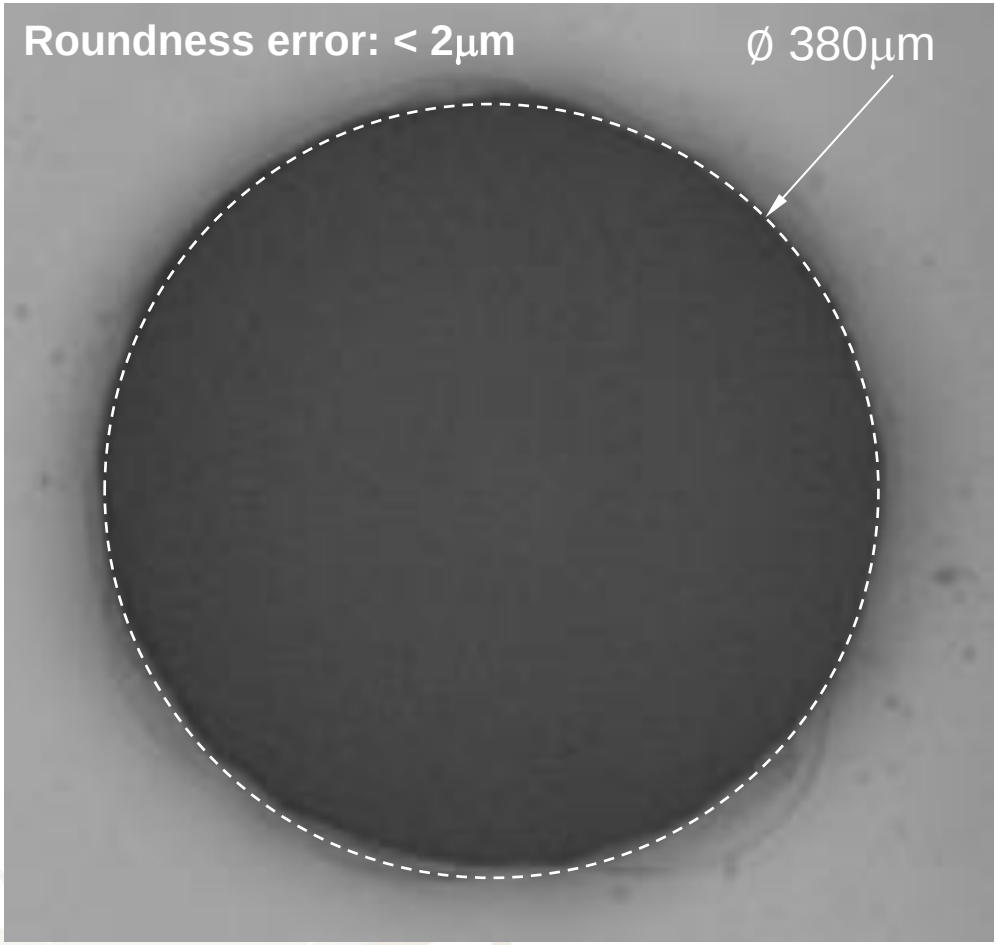
Cutting

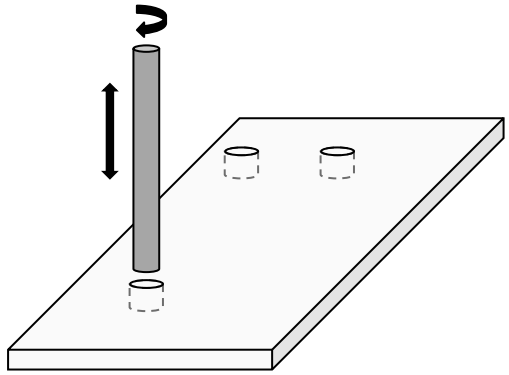


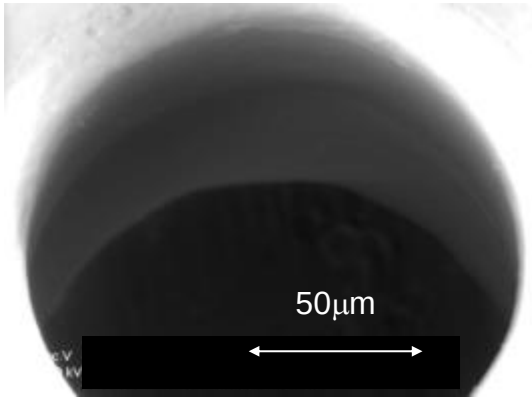
Machining Specifications

Drilling	• 150 µm < Ø < ∞ • 0 < depth < several mm • 1-5 s down to 700 µm • vertical to tapered holes (0 to 90°) • aspect ratio 1:10
Milling	• 20 mm/min at 200 µm depth of cut • several mm deep • tolerances on channel width: 5 % • aspect ratio 1:10
Micro-cutting	• 10 - 20 mm/min • depth: 4 - 5 mm
Polishing	• Very rough to very smooth surfaces are possible

Micro-drilling of glass

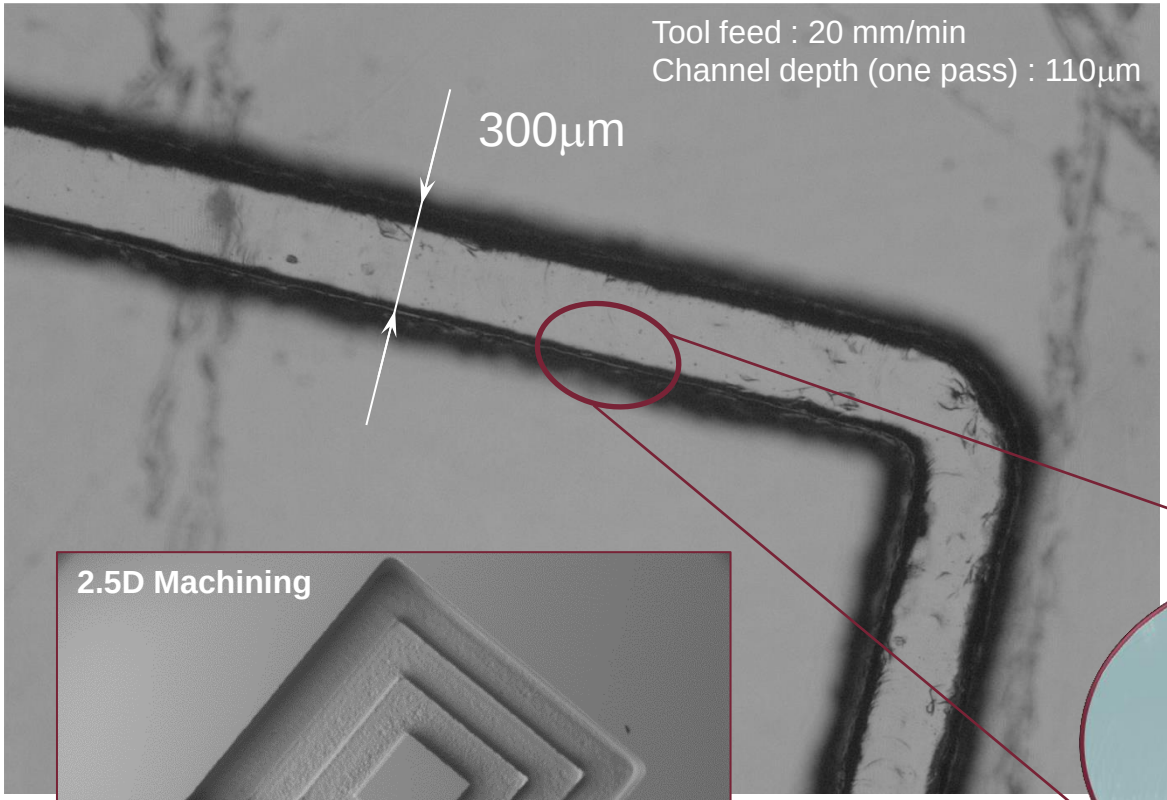


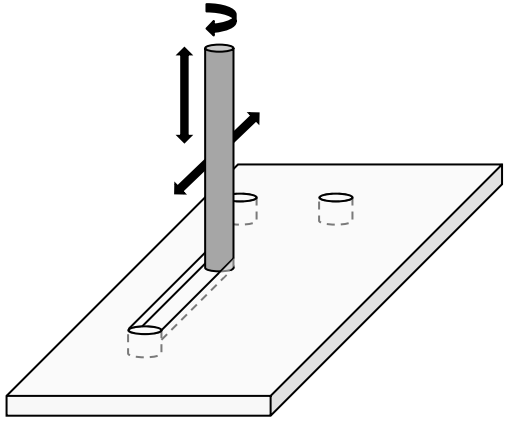


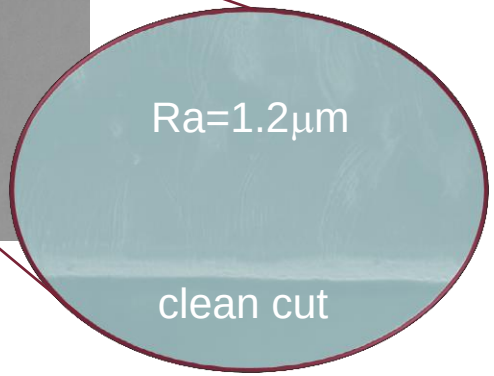


1mm deep
1:5

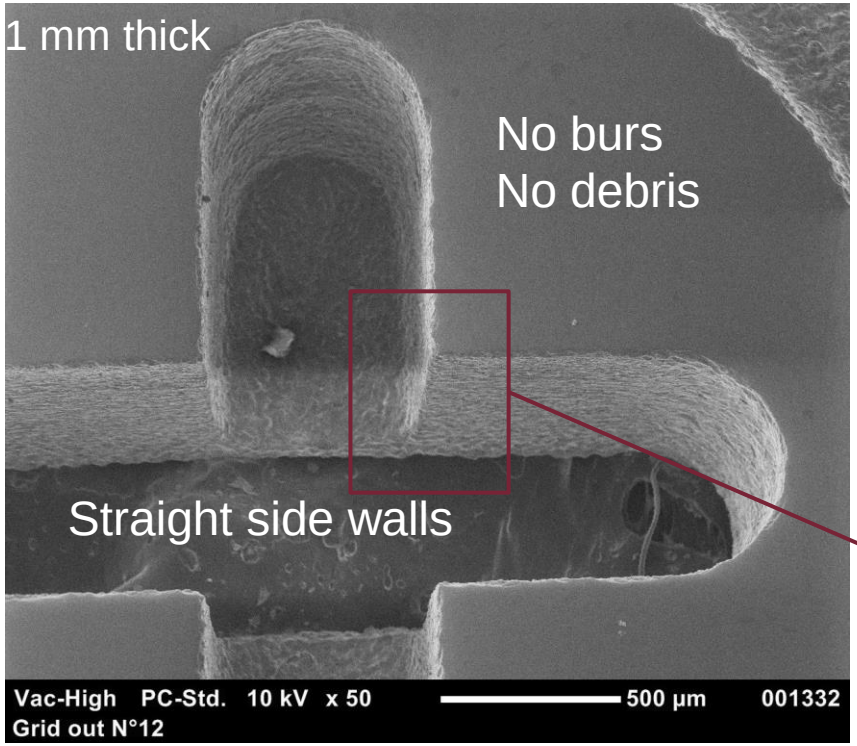
Micro-milling of glass

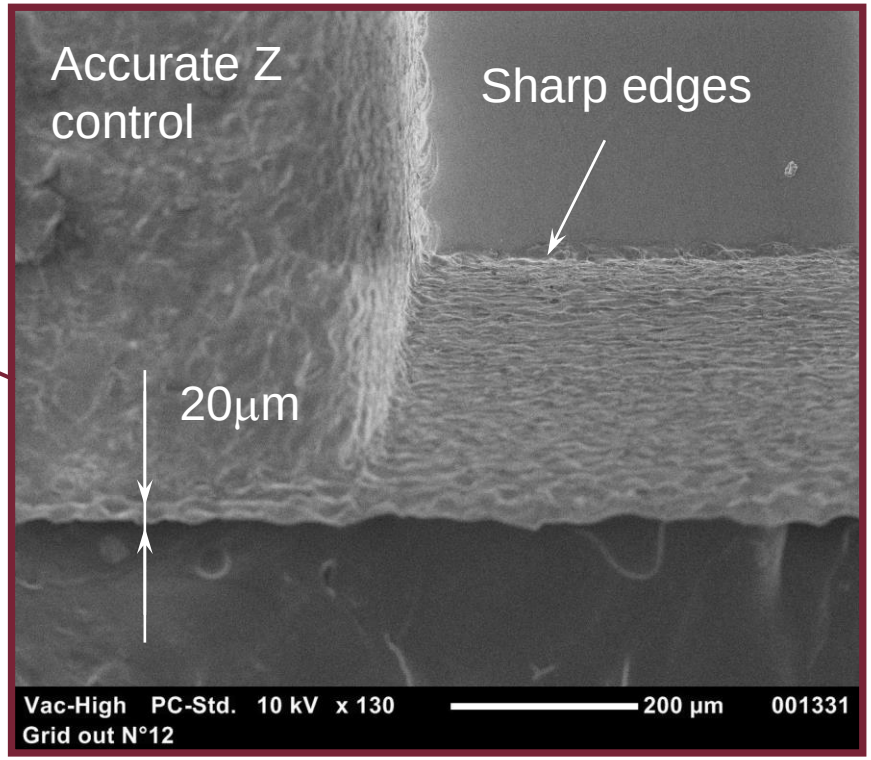






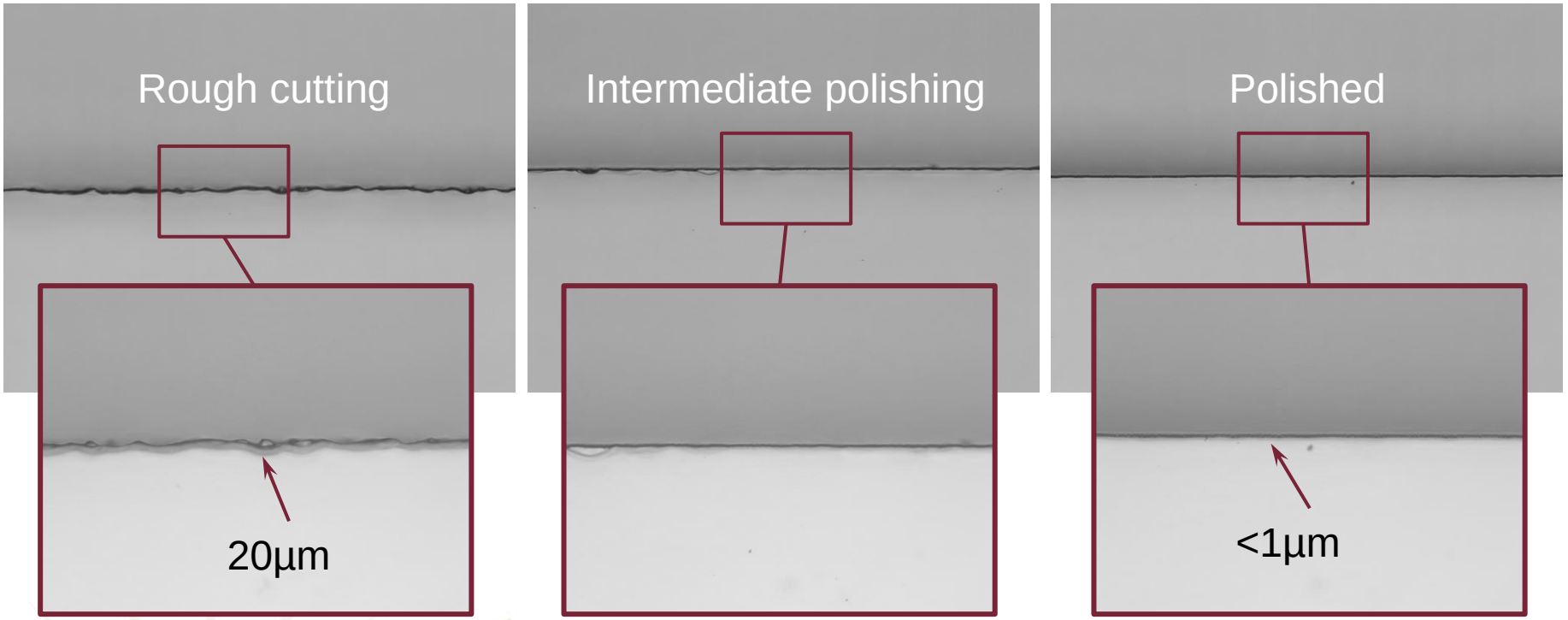
2.5D machining of glass



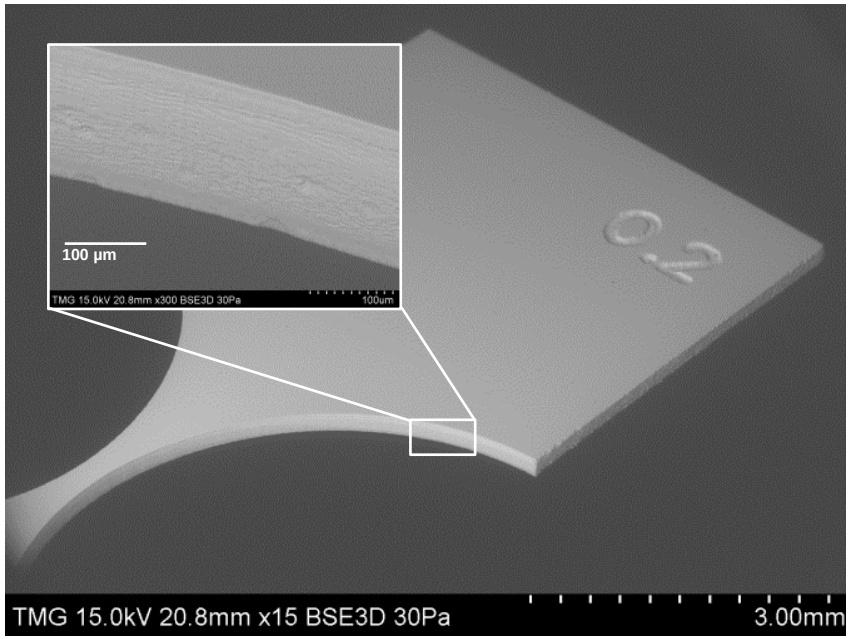


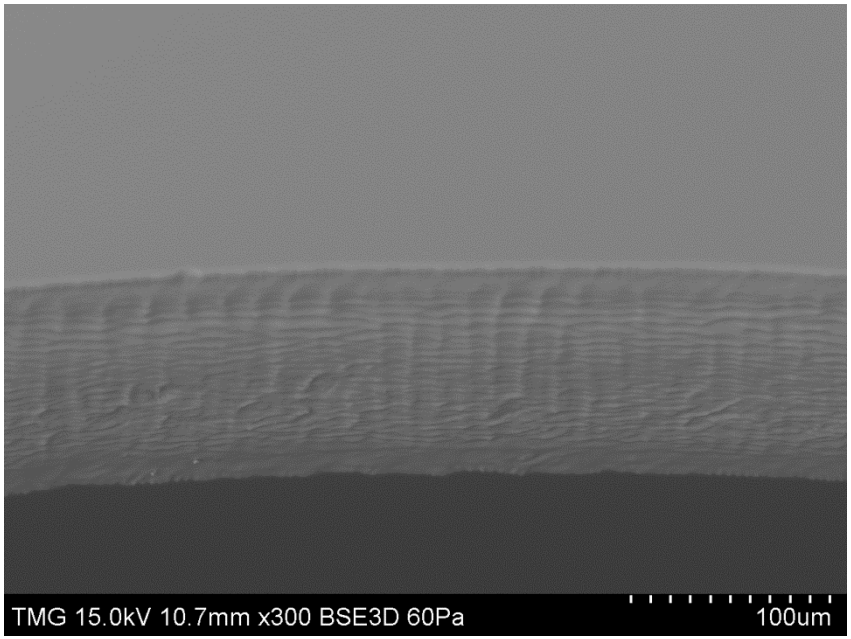
SACE polishing (SACP)

Glass thickness: 500 μm

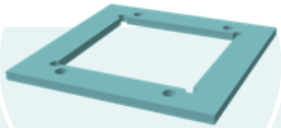


SACE polishing (SACP)





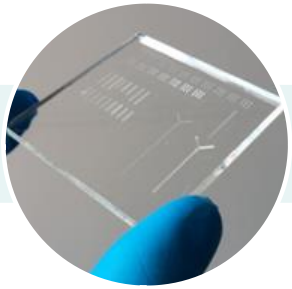
Idea-to-realization



Design tooling

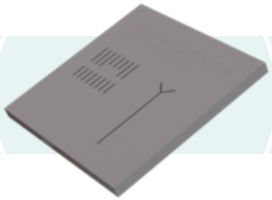
Print tooling

- ✓ Ultra-customized parts
- ✓ Low batch size fabrication
- ✓ Industry 4.0 compatible



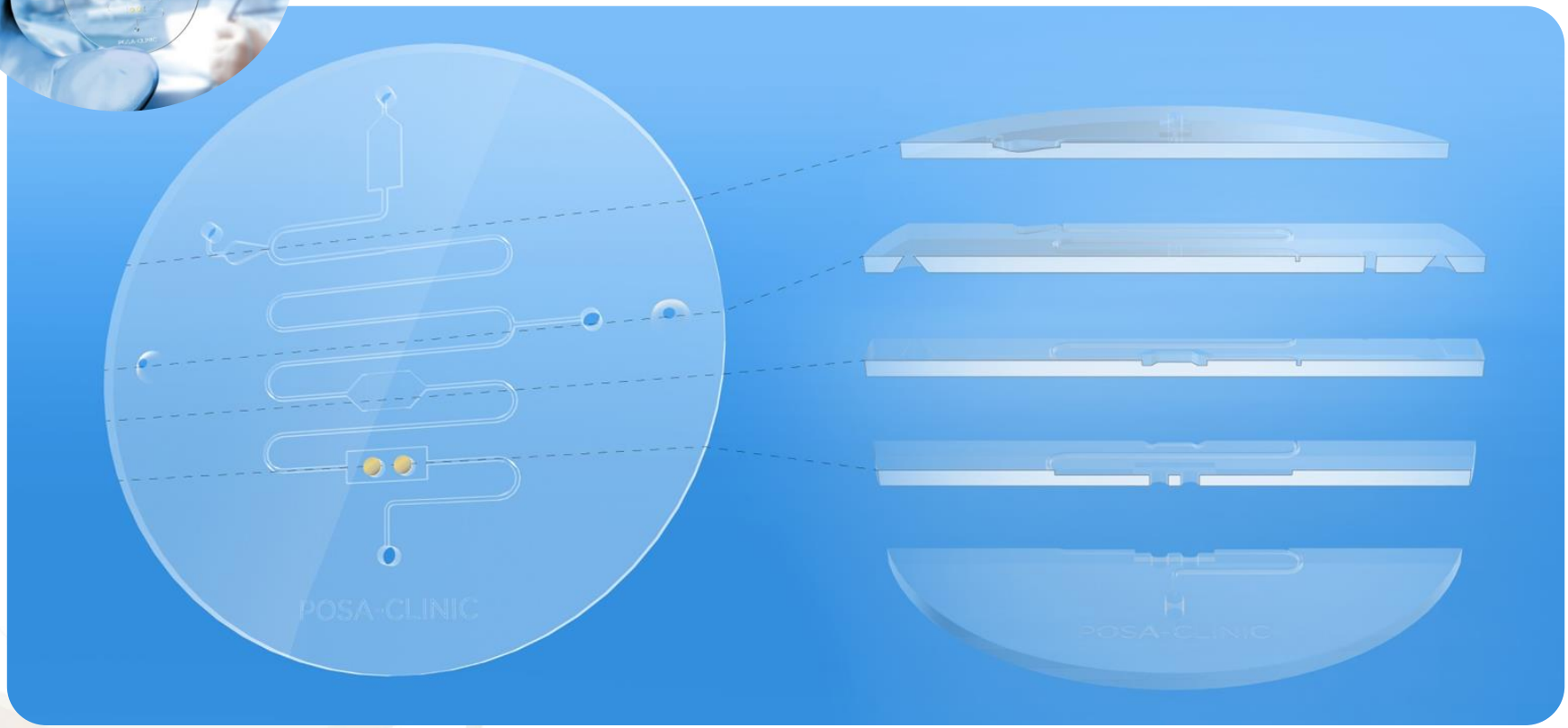
Machine glass

Design part

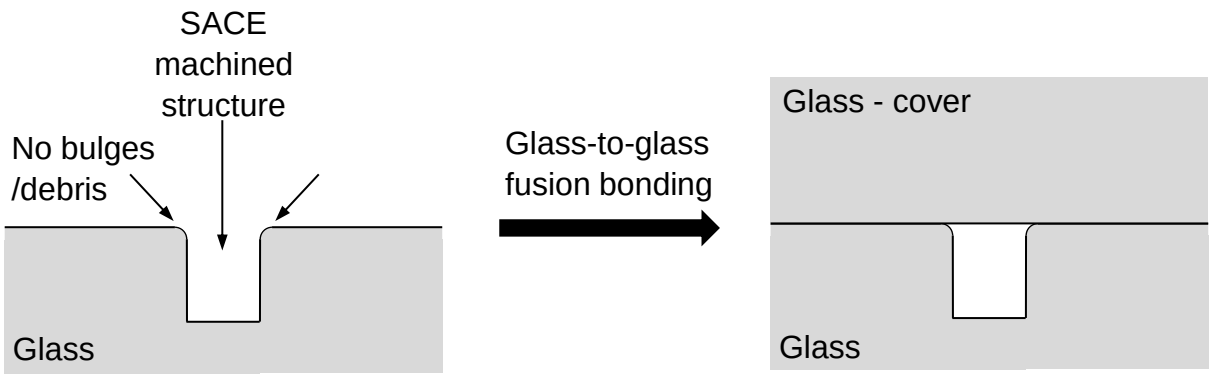


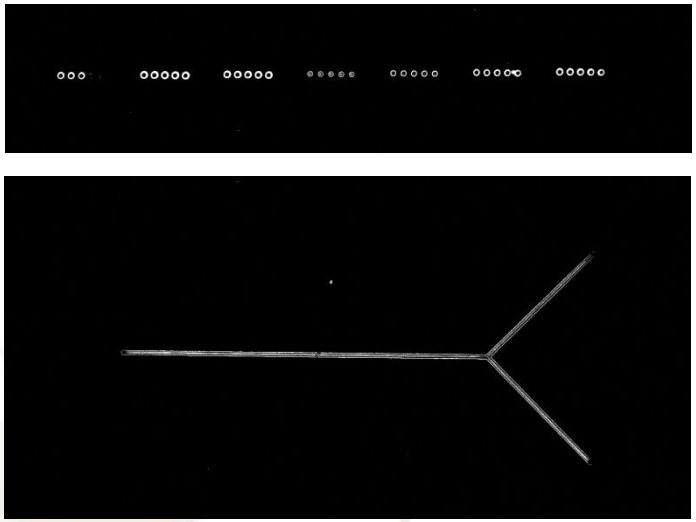
- ▪ Low forces (~ 5 mN) exerted on workpiece during SACE machining
  → custom tooling can be 3D printed with ABS (= corrosive resistant)
- ✓ No need for extra fixtures
- ✓ No disturbing of local electrolyte flow → high machining quality

Microfluidic for Medical Applications



Direct glass-to-glass bonding

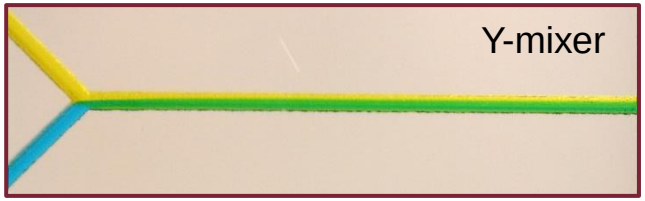




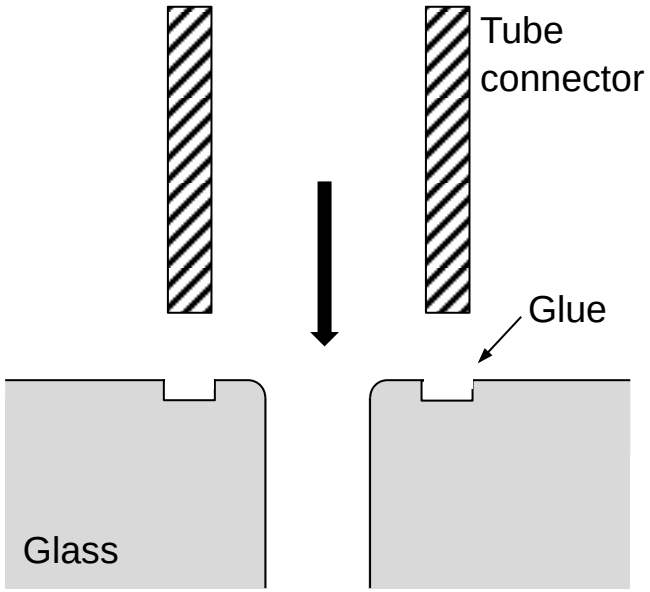
Acoustic Microscope *(Sonoscan®)*

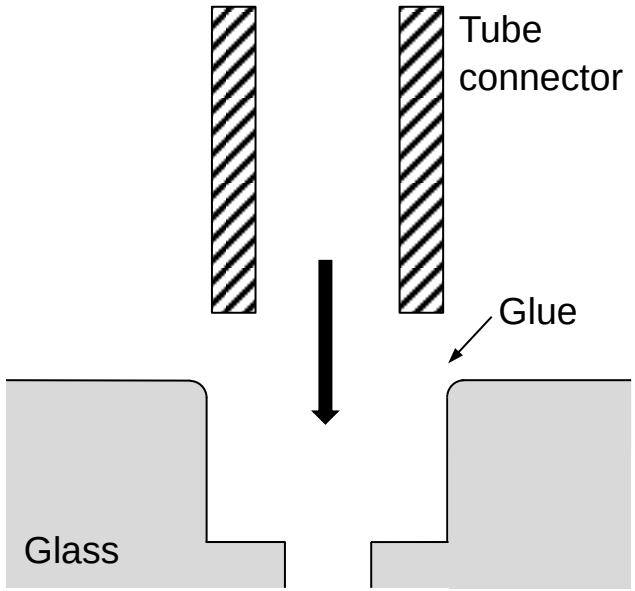
- Non-destructive testing
- Monitoring defects (e.g. voids, cracks)

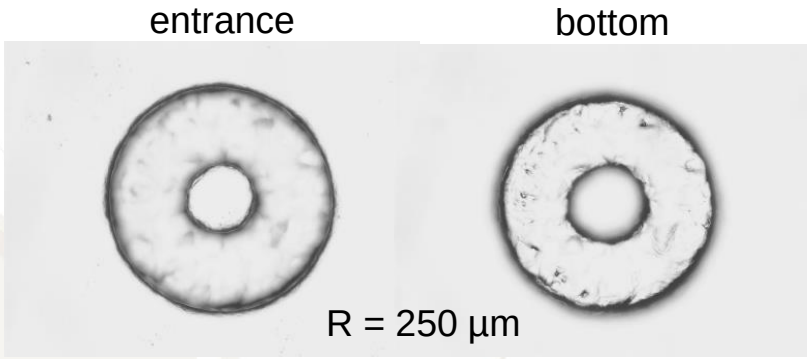
→ ***No defects***

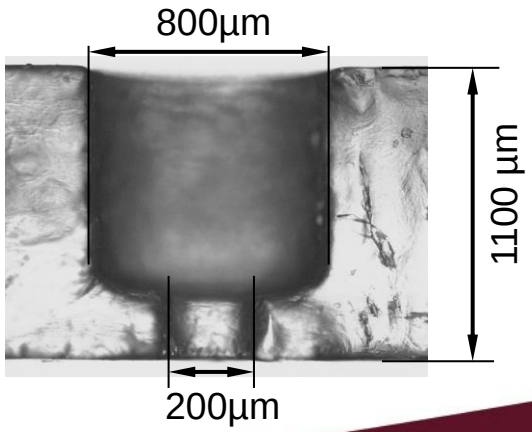


Microfluidic Connection



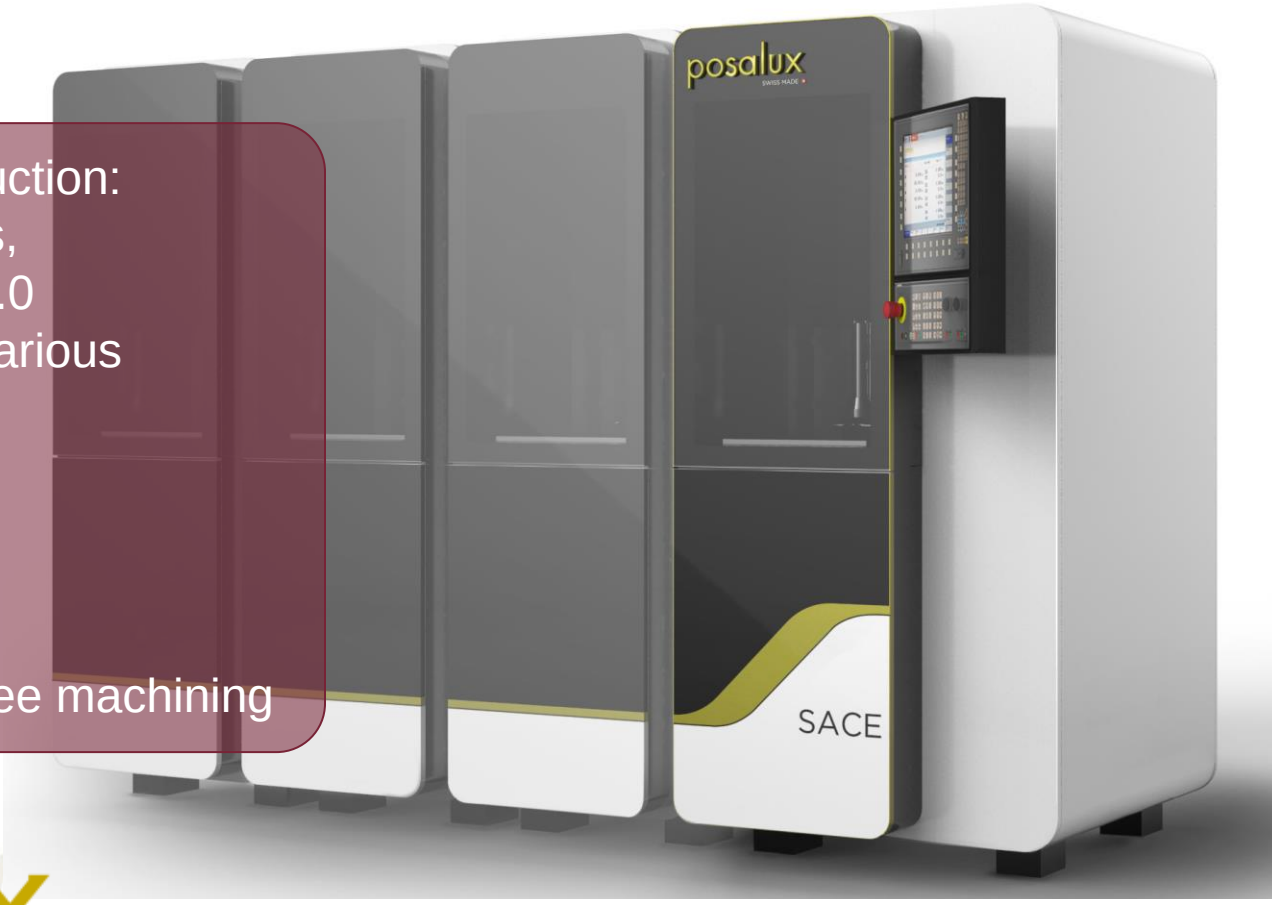






Industrial Production

- Mass and flexible production: prototyping small series, batch size-1, industry 4.0
- Modular concept with various number of heads
- Clean-room compatible
- Mask free process
- No tooling costs
- 2.5 D machining
- Burr and micro-crack free machining



posalux
SWISS MADE

Current industrial partners

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SWISS MADE

FlowJEM
Polymer Microfluidic Technology

micronit
MICROFLUIDICS
15th Anniversary

PASSIVE ACTION

RÉSEAU QUÉBEC 3D

AXIS
PROTOTYPES

Shilps Sciences

TERRAGON
Environmental Technologies Inc.

Machine Tool Systems Inc.

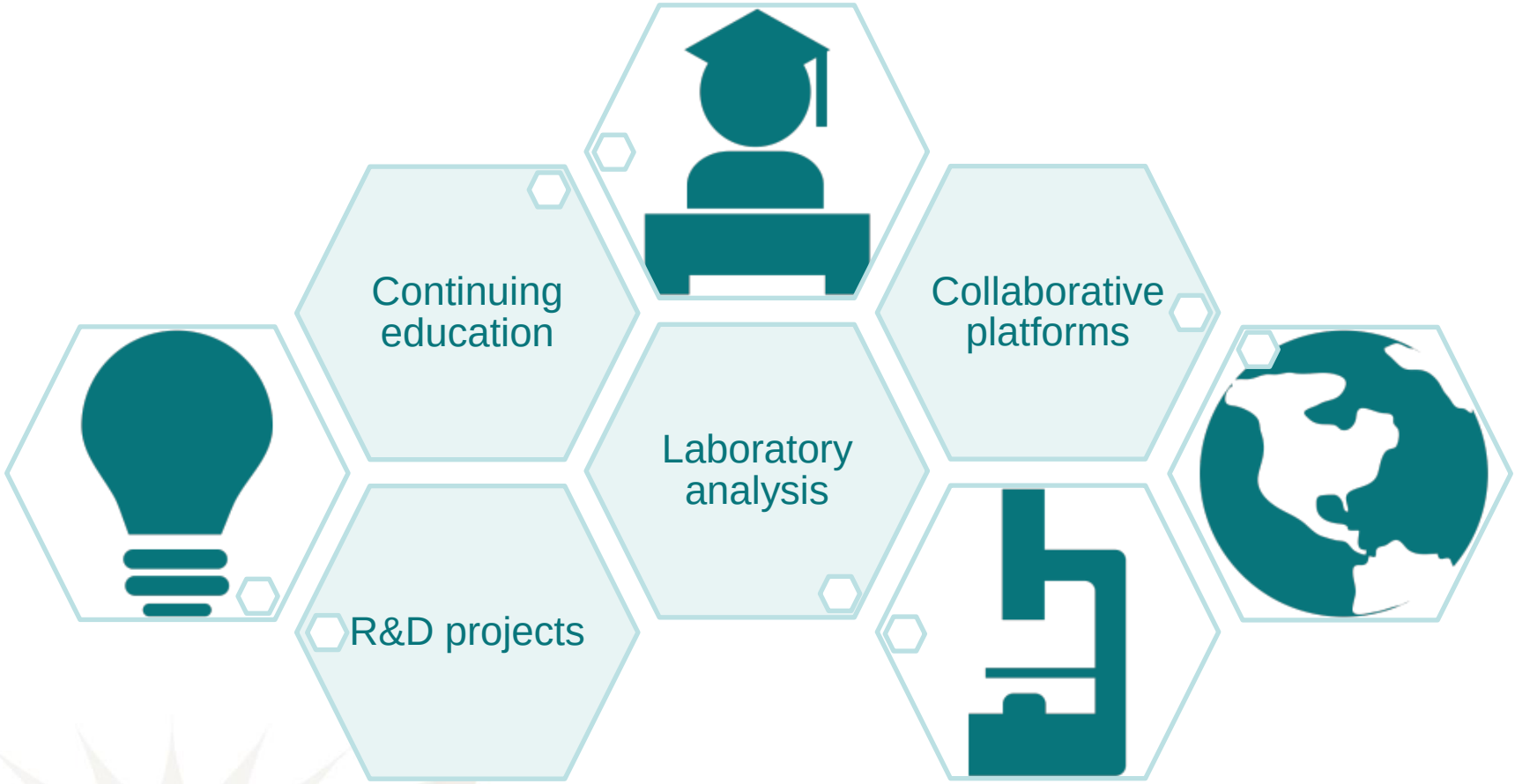
ALPHACASTING

Arts & Techniques

AGC ASAHI GLASS

Université Concordia University

What we offer



THANK YOU

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