FACULTY OF ENGINEERING AND ARCHITECTURE

NAMIFAB UGENT
EXPERTISE CENTRE FOR NANO-AND MICROFABRICATION

NAMIFAB UGENT

dr. ir. Thomas Vervust

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OVERVIEW

→ Introducing NaMiFab UGent

→ Use case examples

→ NaMiFab expertise

→ Collaboration with NaMiFab

→ Contact information

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INTRODUCING NAMIFAB UGENT

NaMiFab UGent:

→ Is an **expertise center for Nano-and Microfabrication**.

→ We structure and combine different materials at nano- and microscale.

→ We design and fabricate various components and systems.

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Cleanroom

Tech Lane Ghent

Science Park - Campus A

Technologiepark-Zwijnaarde 914 – 926
9052 Ghent

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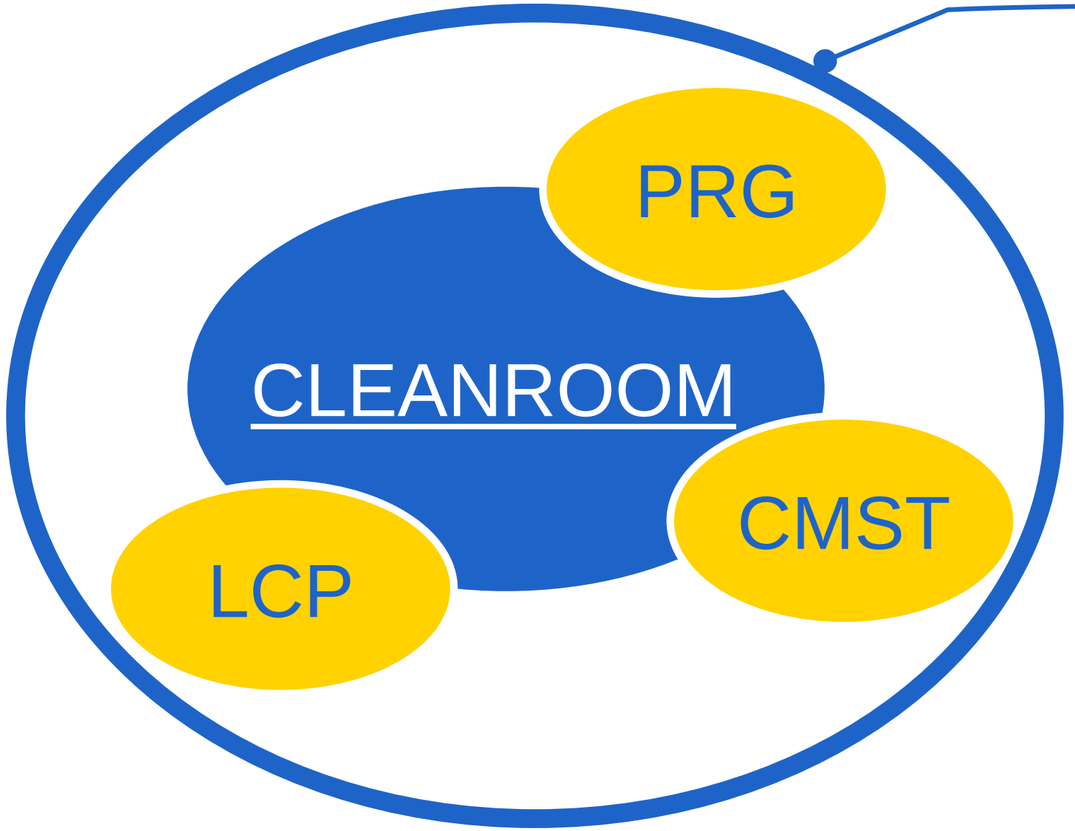
NaMiFab UGent



Expertise Centre for Nano- and Microfabrication

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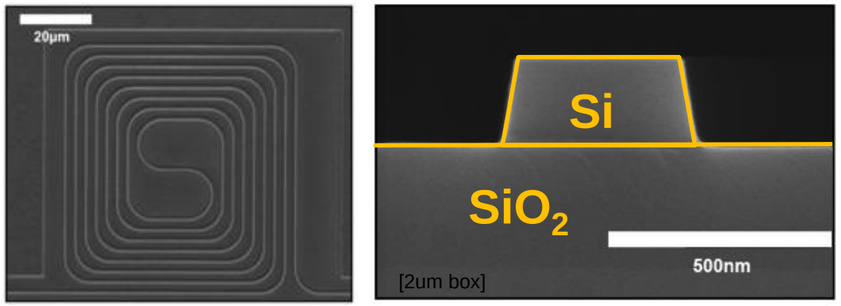
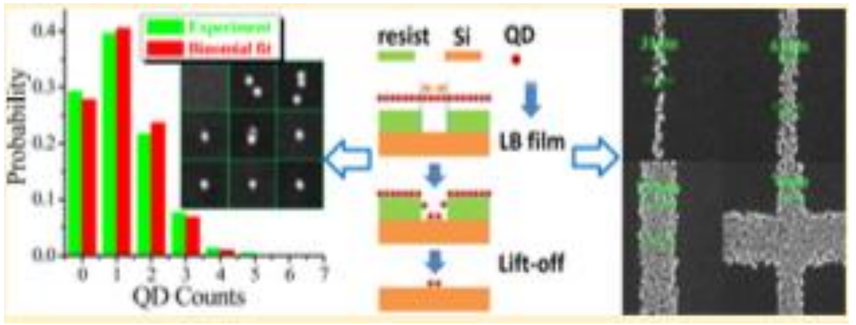
PRG: Photonics Research Group
CMST: Centre for Microsystems Technology
LCP: Liquid Crystals and Photonics Group

PRG - TECHNOLOGY PLATFORMS

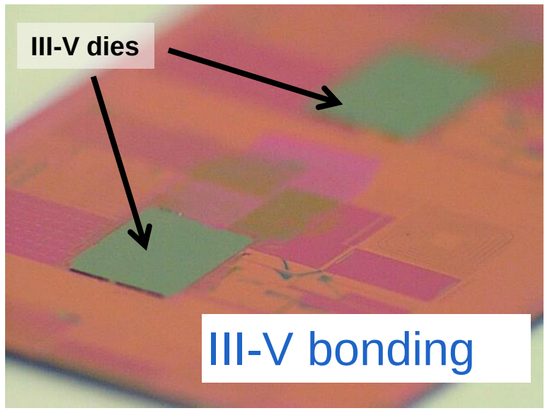
Silicon & SiN Waveguides



High resolution imaging (SEM, FIB)

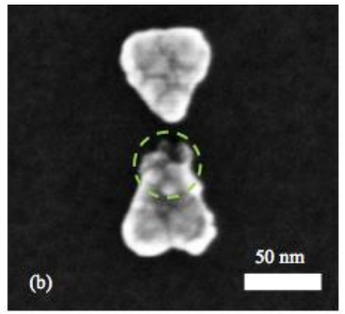


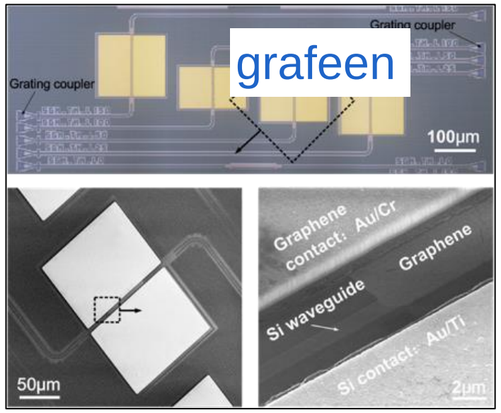
Integration with new materials



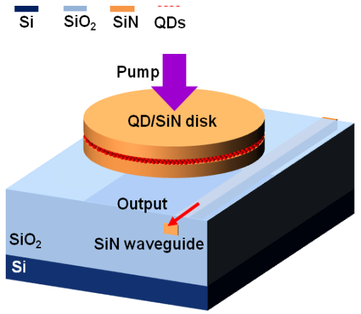
Photonic Integrated Chips

High resolution patterning (EBEAM)





Colloidal QDOTS



High resolution structures

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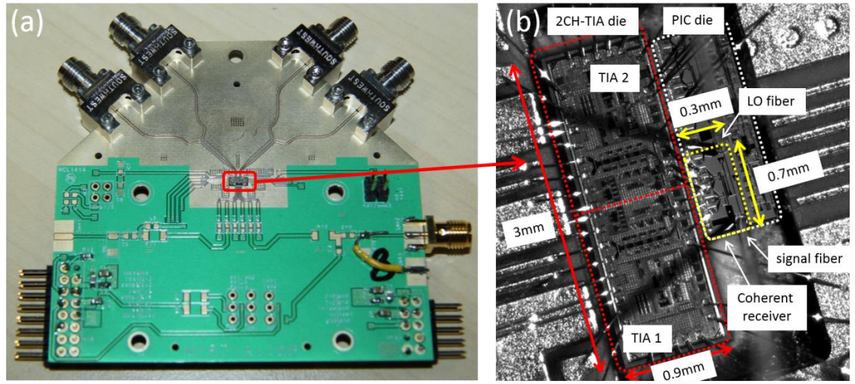
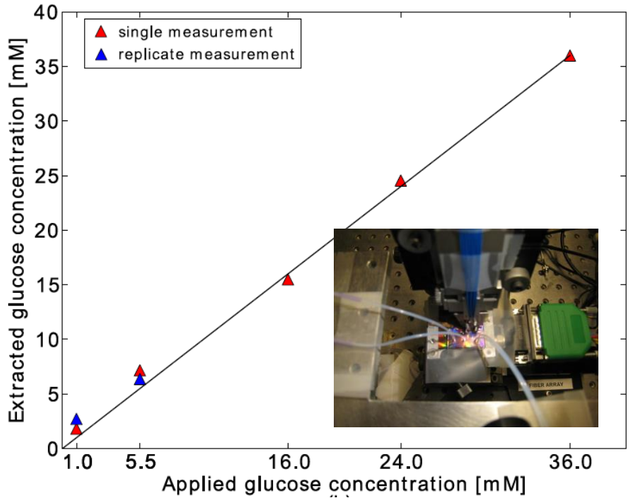
PRG - APPLICATION EXAMPLES

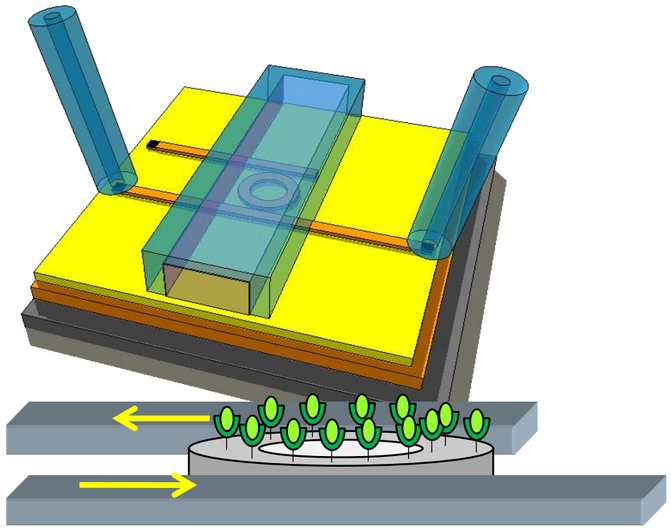


High-speed opto-electronic transceivers



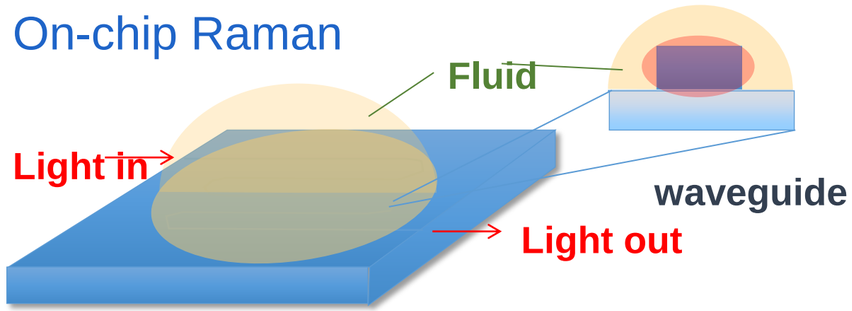
On-chip spectroscopy

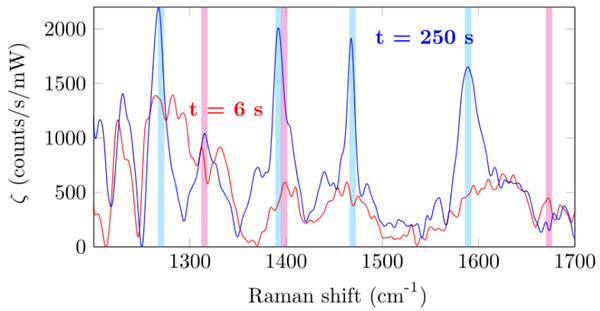
- Glucose detection
- Gas-sensing
- …



Biosensing (e.g. detection of Tuberculosis)

On-chip Raman





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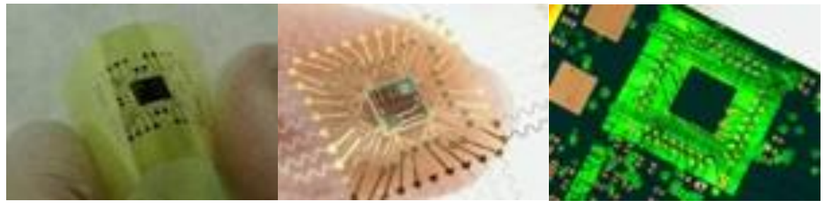
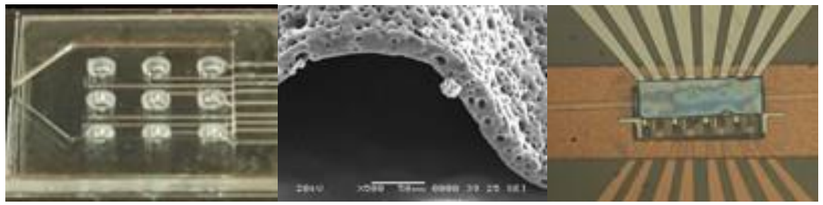
CMST - TECHNOLOGY PLATFORMS



Electronic packaging

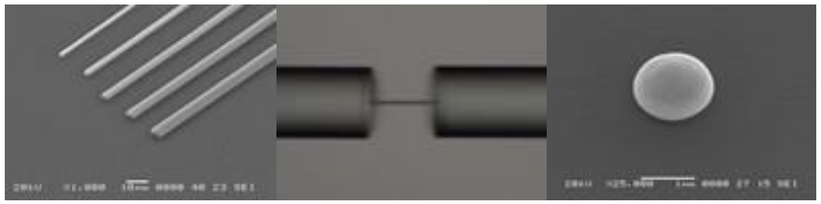


Polymer processing - microfluidics

Micro systems

ASIC design

Stretchable interconnect



Polymer photonics and laser technology

Electro-optical devices and displays

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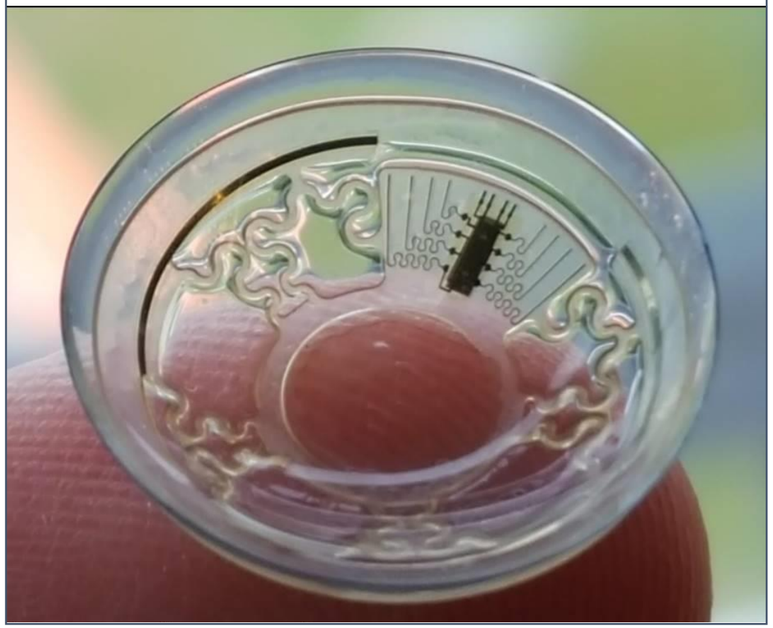
CMST - APPLICATION EXAMPLES

Smart contact lens

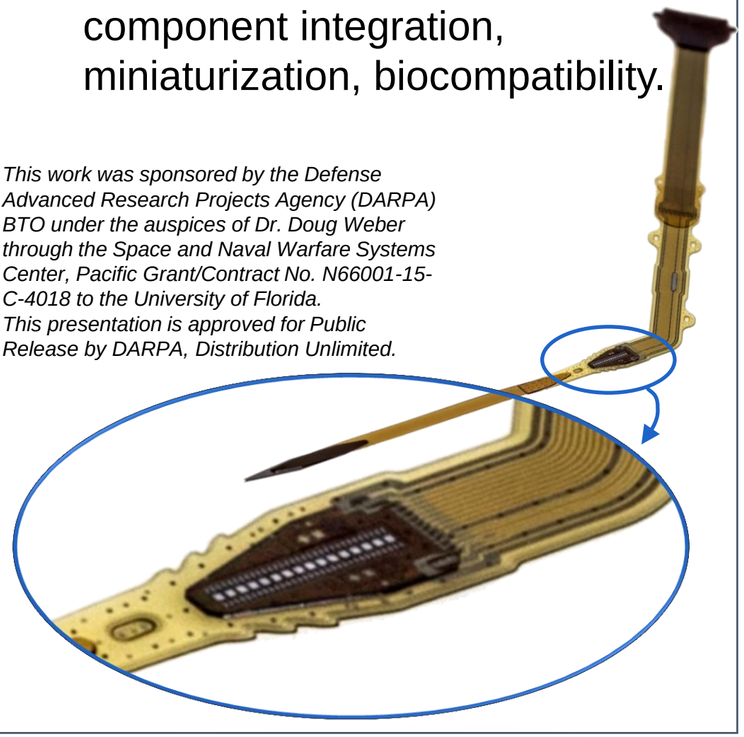
- Electronic platform with sensors, controller, communication, electro-optic switching, battery…
- Applications: artificial iris, presbyopia correction, sensing..



Implantable PNS probe

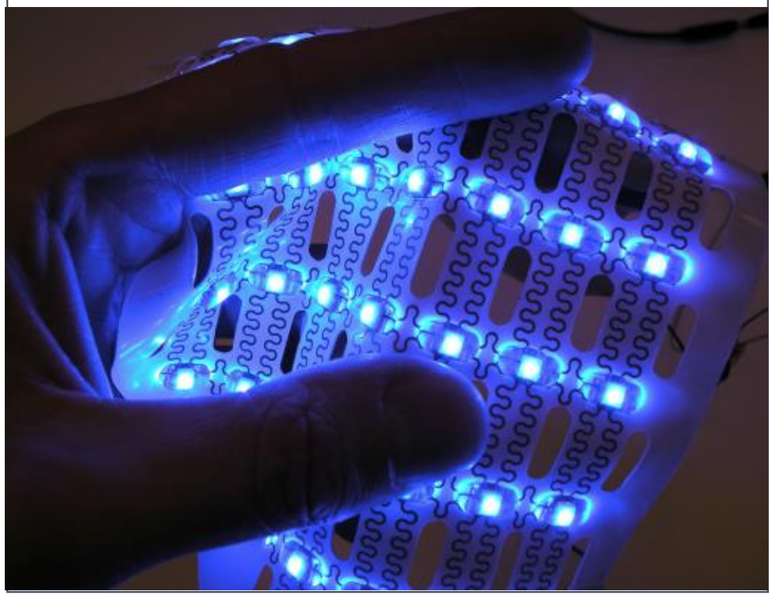
- Implantable peripheral recording and stimulation system for closed-loop sensory control of prostheses
- Technology for electronic component integration, miniaturization, biocompatibility.

This work was sponsored by the Defense Advanced Research Projects Agency (DARPA) BTO under the auspices of Dr. Doug Weber through the Space and Naval Warfare Systems Center, Pacific Grant/Contract No. N66001-15-C-4018 to the University of Florida.
This presentation is approved for Public Release by DARPA, Distribution Unlimited.

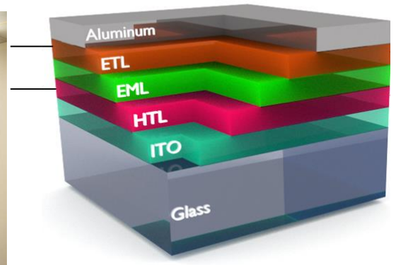


Stretchable light source

- Technology for stretchable interconnections in polymer and component mounting
- Applications: luminaires, RSI pain relief bandage...



LCP - TECHNOLOGY PLATFORMS



Organic layer deposition and OLEDs

Micro systems

Atomic layer deposition

LCD assembly

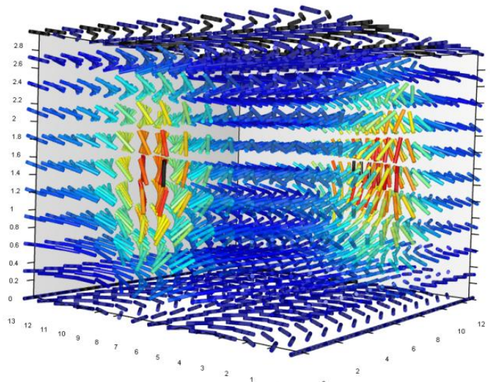
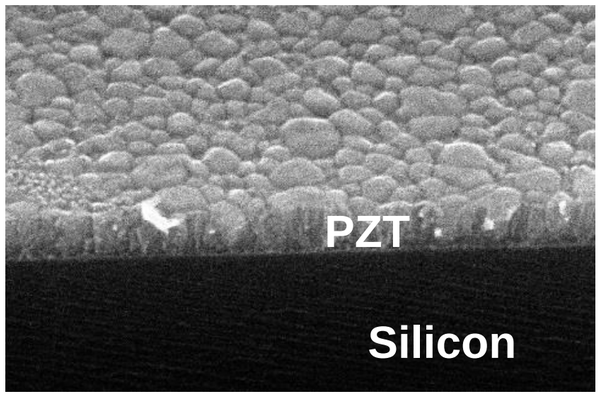


Photo-alignment of LCDs



Sol Gel of PZT

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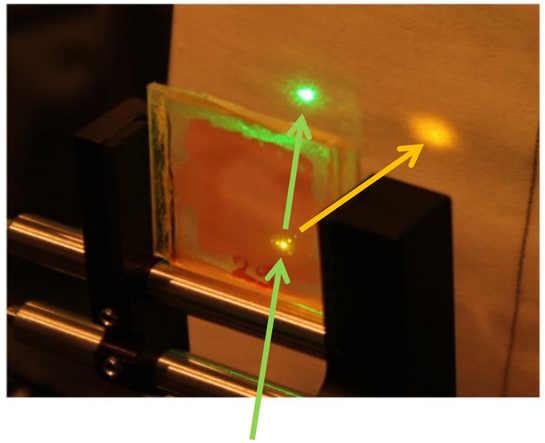
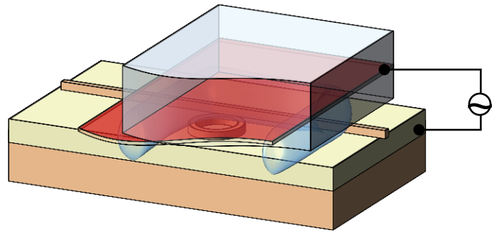
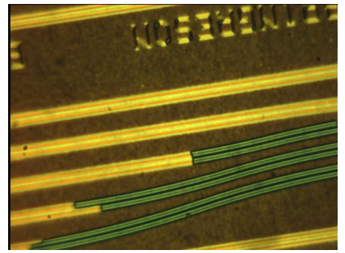
LCP - APPLICATION EXAMPLES



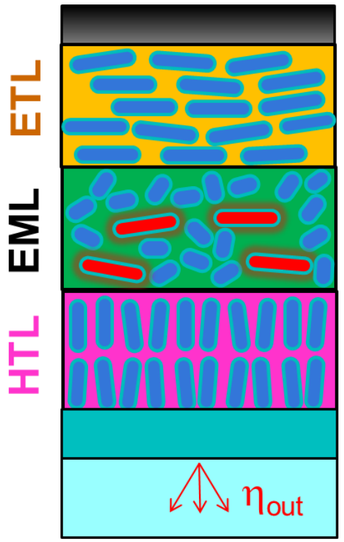
Tunable liquid crystal lasers

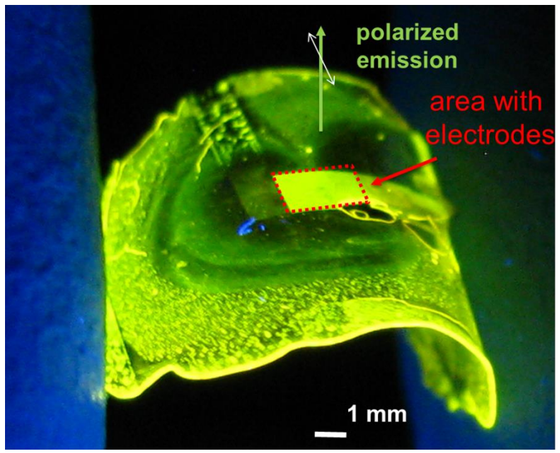
Tunable ring resonators with LC



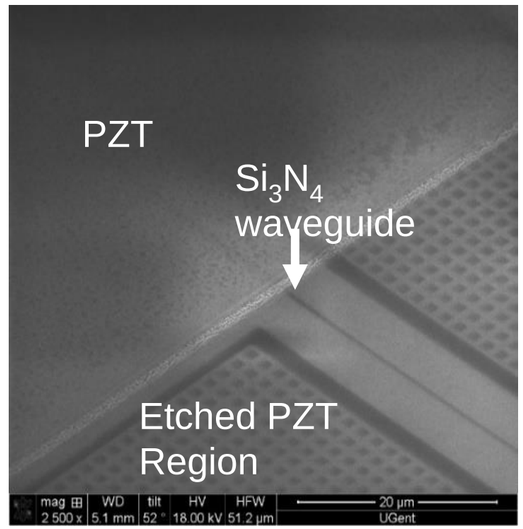


Anisotropic OLED devices





Polarized light emitter



High speed PZT modulators

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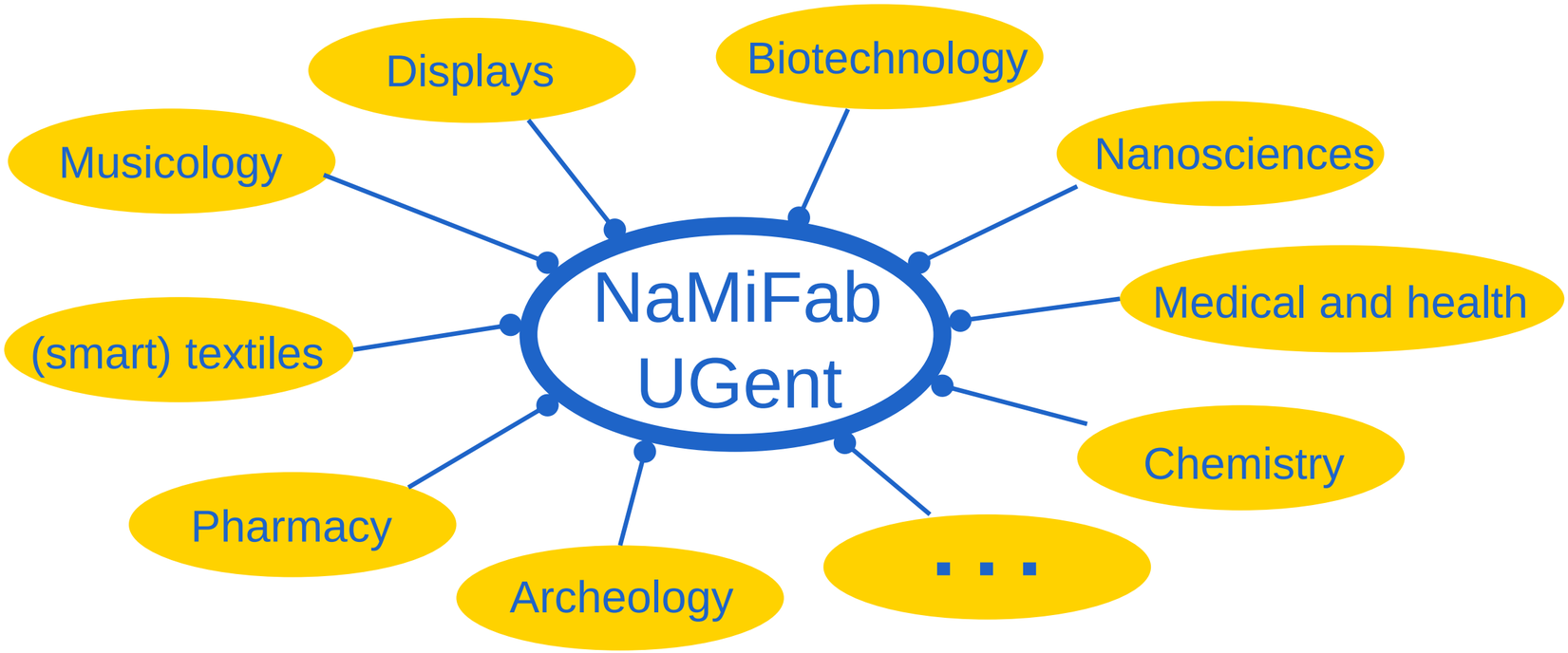

Our mission

Open up state of the art test and research infrastructure for the entire UGent research community, working in diverse domains.

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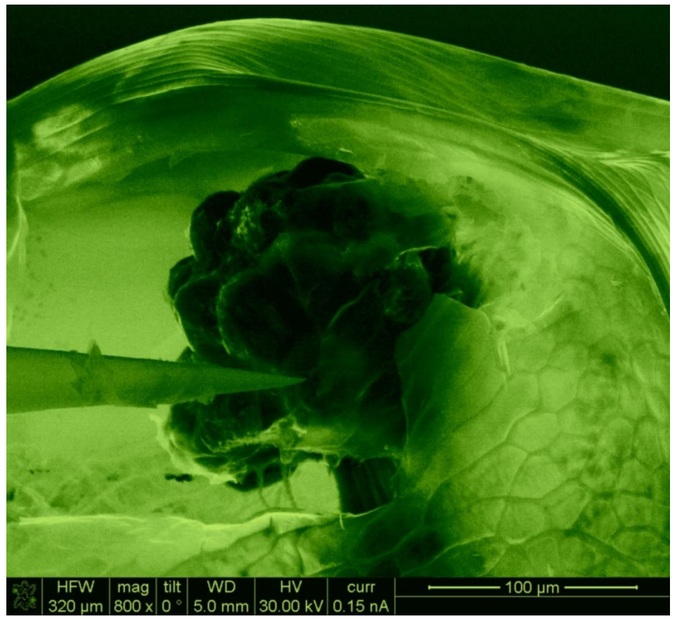
USE CASE EXAMPLES

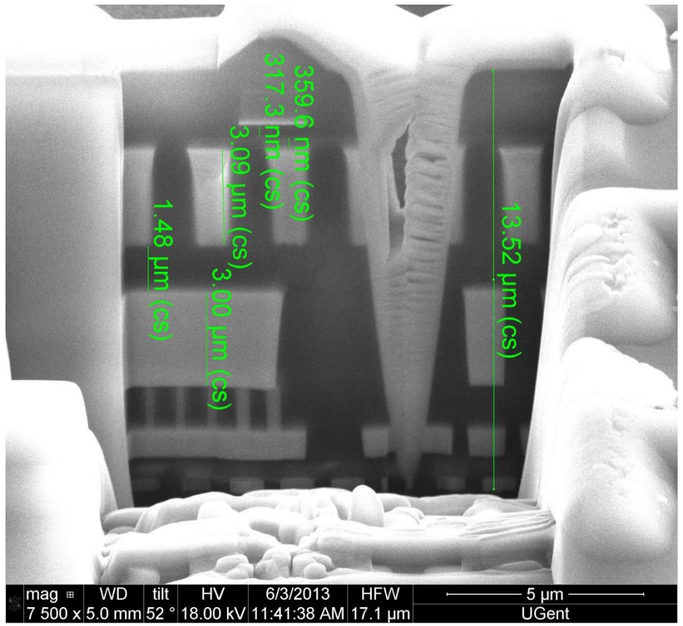
High-Resolution Imaging using Electron Microscopy and Focussed Ion Beam Cross-Sections

→ Nanometer resolution imaging with Electron Microscope

→ Focussed Ion Beam allows to make local cuts to see “into” material



Nanoprobe needle inserted in eye of Daphnia (water flea)



Reverse engineering and correcting mistakes in electronic ICs

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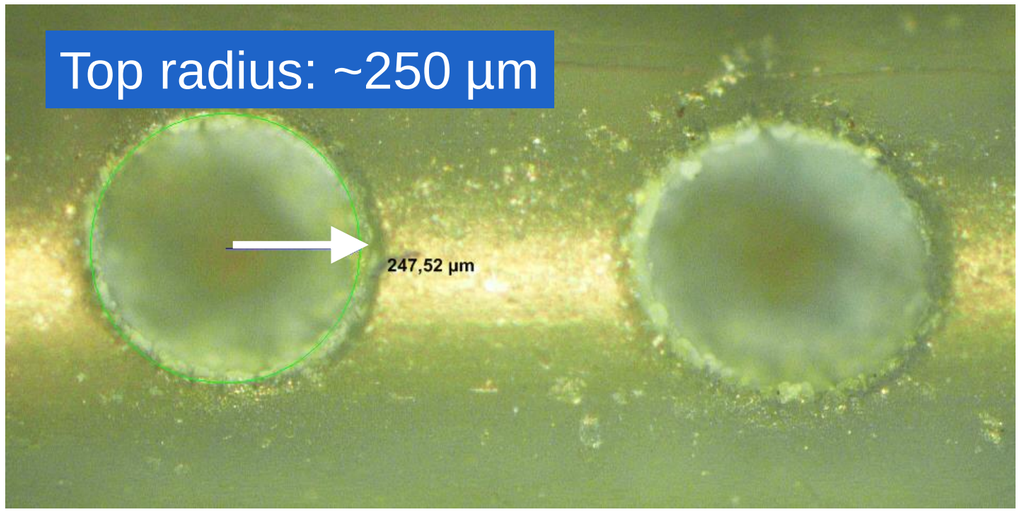
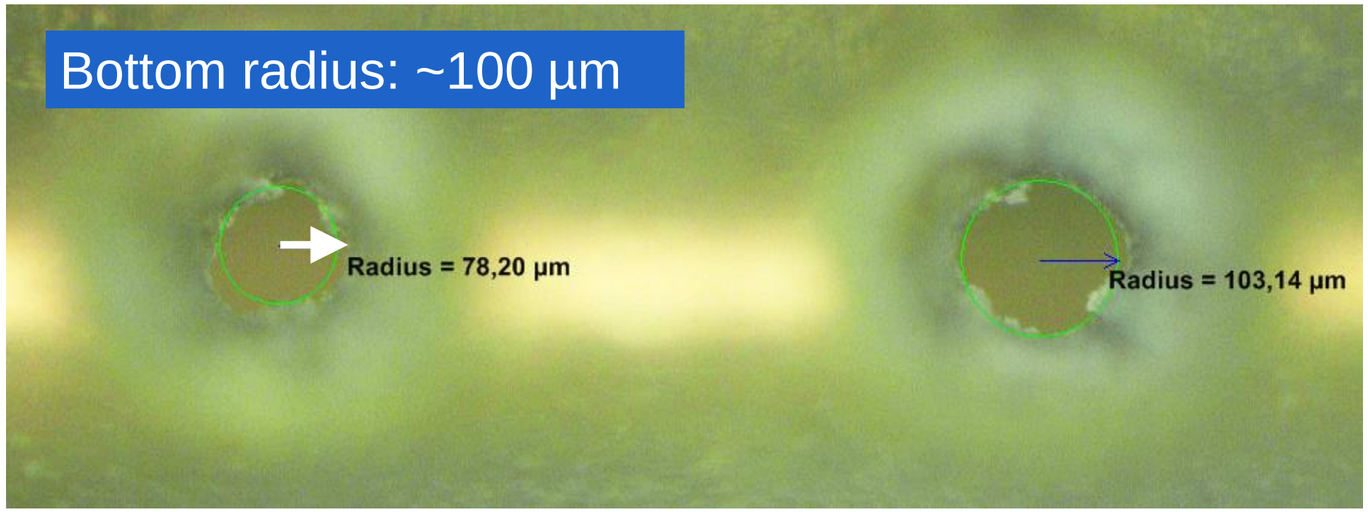
USE CASE EXAMPLES

Laser ablation of PDMS catheter for controlled drug release

→ Request from Biofluid, Tissue and Solid Mechanics for Medical Applications group (Prof. Patrick Segers)

- Perforations in a PDMS catheter
  (tube inner diameter of ~1mm, 0.4mm thickness)





Laser ablation was done with pico- and femtosecond laser setup

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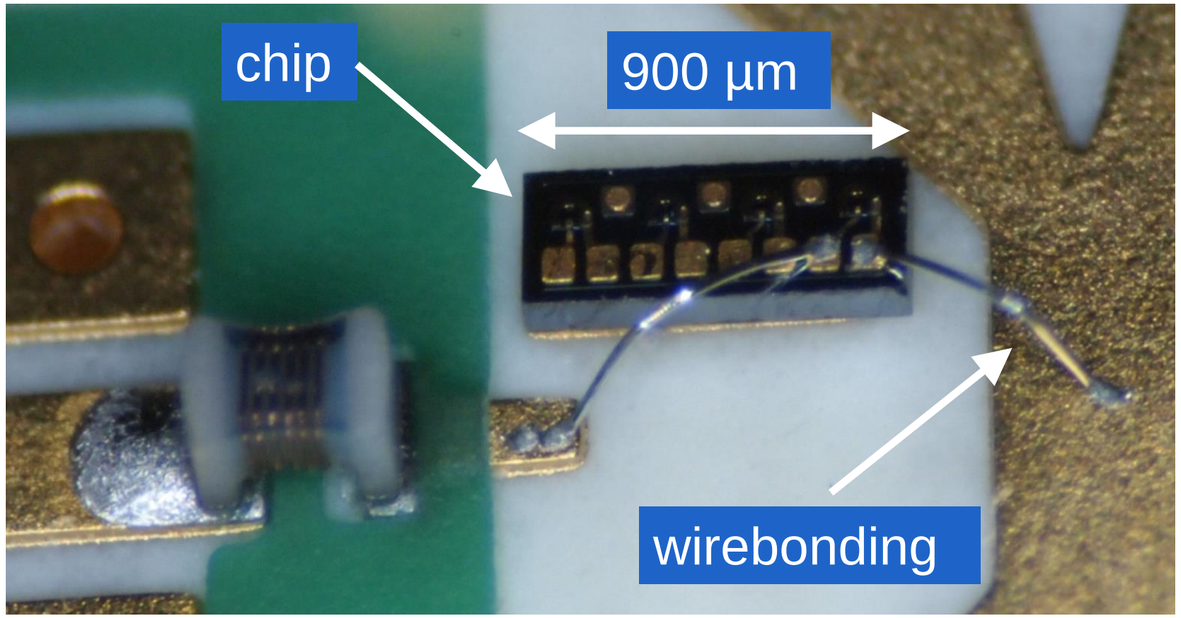
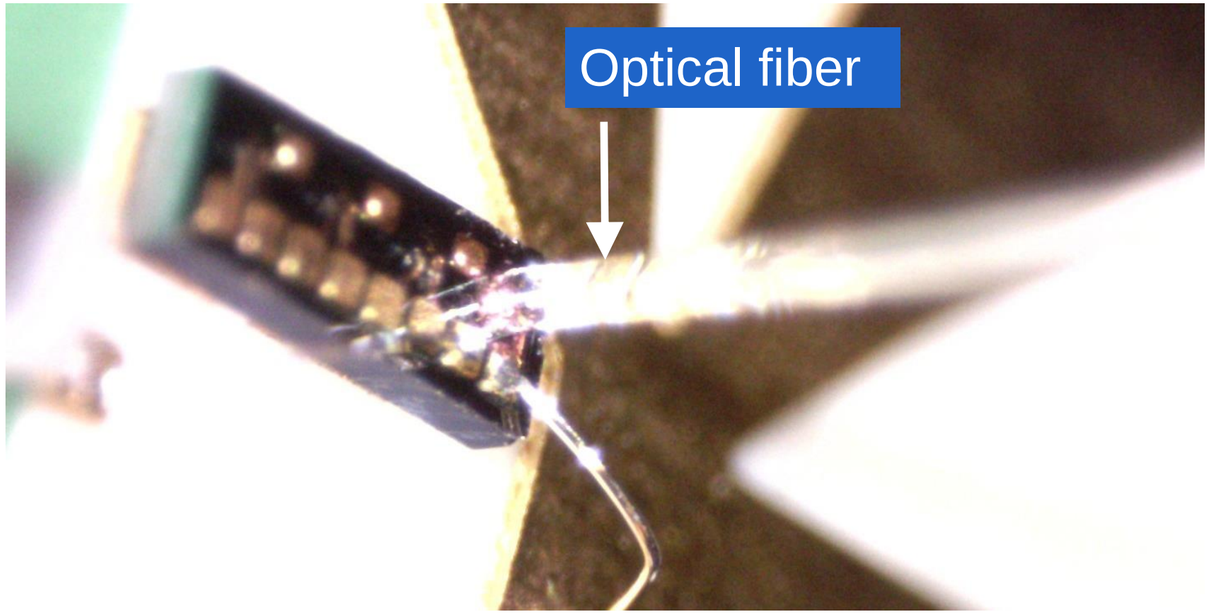
USE CASE EXAMPLES

Wirebonding and pigtailing of a photodiode chip

→ Request from Electromagnetics research group (Prof. Hendrik Rogier)

- Assembly off a photodiode chip onto a PCB
- Optical connection between chip and an optical fiber





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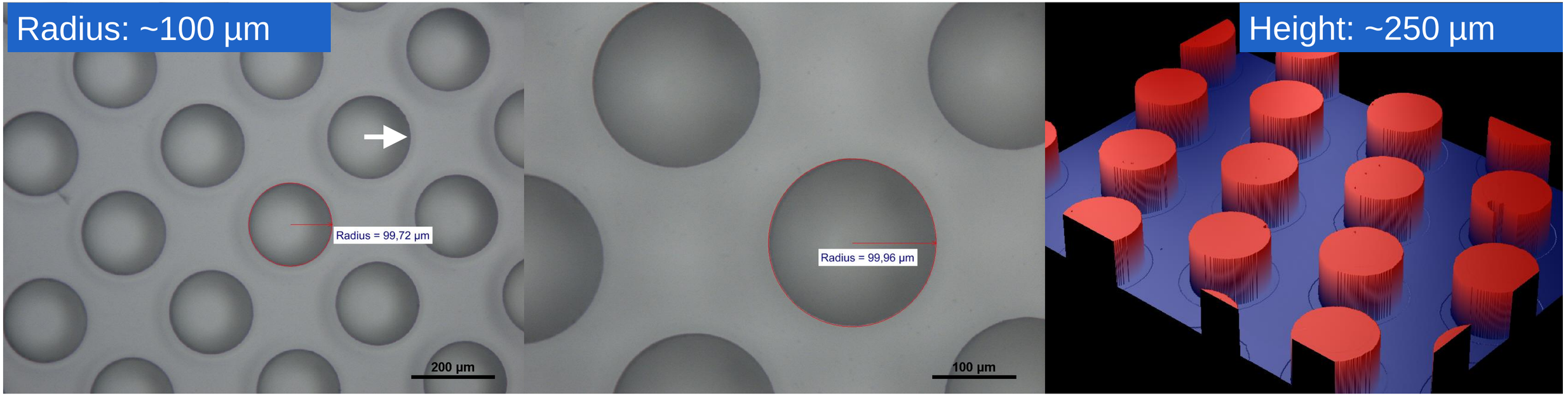
USE CASE EXAMPLES

Fabrication of a microwell-based tissue culture platfrom

→ Request from Tissue Engineering and Biomaterials research group (Prof. Ria Cornelissen)

- Fabrication of a PDMS mold to produce a microwell-based tissue culture platform
- The PDMS molds should contain micro-sized cylindrical sticks



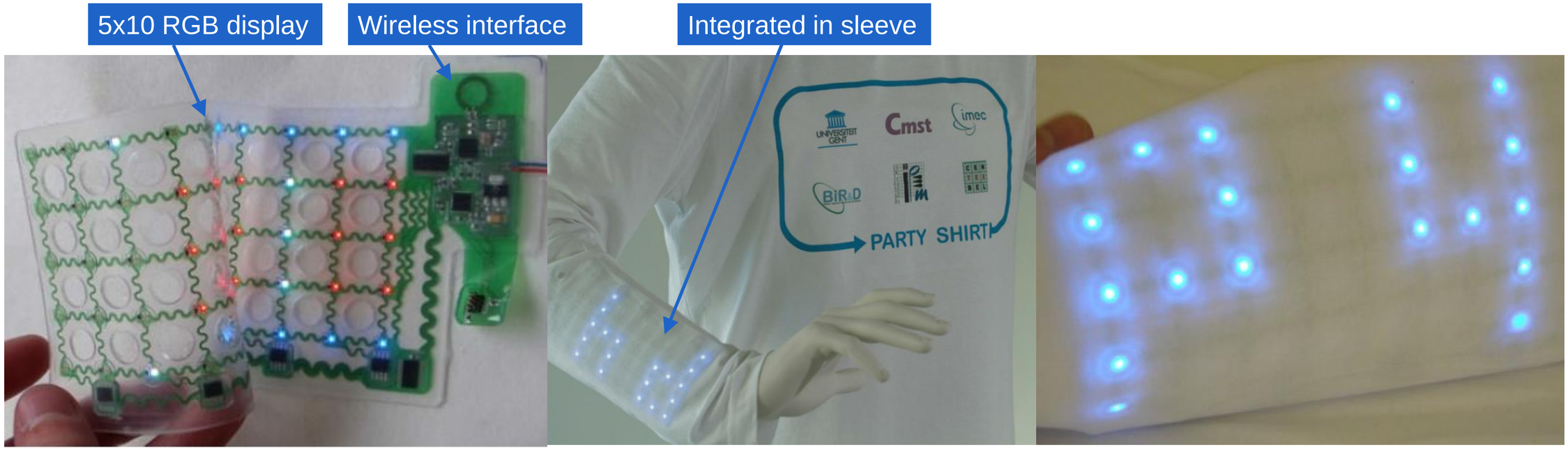
Paper: High Throughput Micro-Well Generation of Hepatocyte Micro-Aggregates for Tissue Engineering, Gevaert, E. et al., Plos One (2014)

USE CASE EXAMPLES

Fabrication of a stretchable and textile integrated LED display

→ This was developed in the frame of a BIR&D award winning multidisciplinary master thesis

→ The resulting “party shirt” was used by the IPEM institute for systematic musicology (Prof. Marc Leman)



Published: Synchronizing music and movement with BeatLED: an interactive musical social game, T. De Nies et al., Journal of new music research (2012)

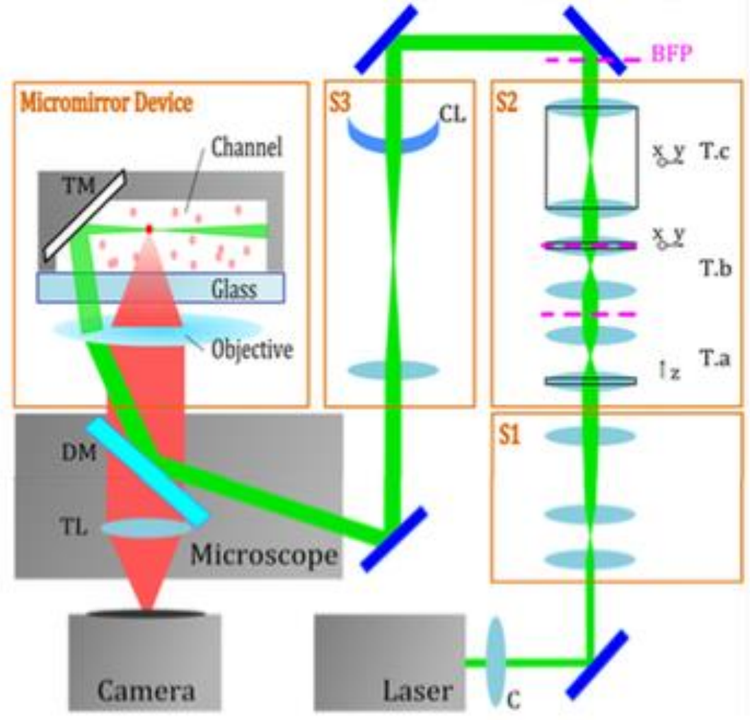
USE CASE EXAMPLES

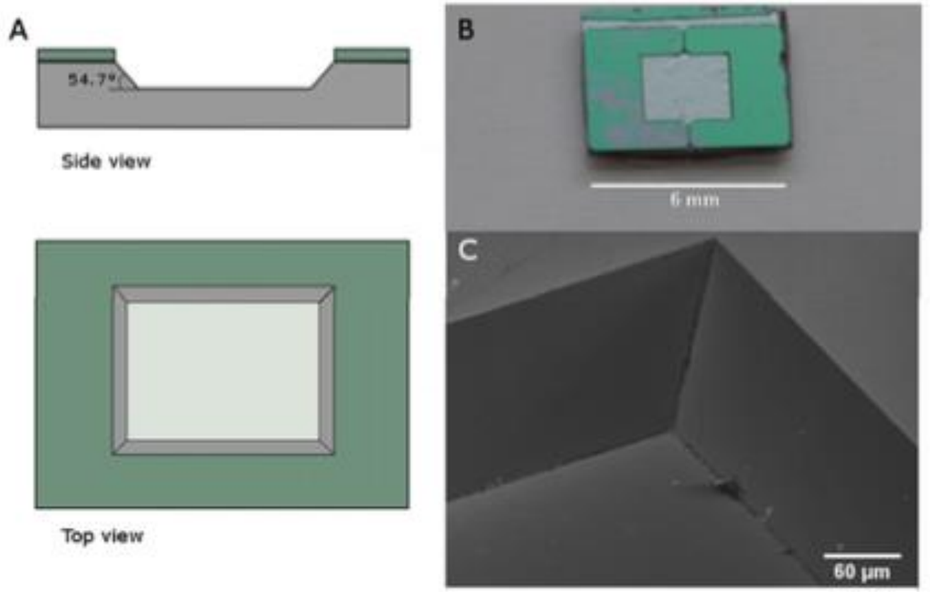
Silicon microstructure for Light Sheet Microscopy

→ Request from Laboratory of General Biochemistry and Physical Pharmacy (Prof. Kevin Braekmans)

→ Light Sheet Microscopy gains increasing interest but requires complex optical setup

→ **Relatively simple silicon microstructure** overcomes this problem





Silicon microstructure with integrated mirror

Published: Microfabricated devices for single objective single plane illumination microscopy (SoSPIM), Zagato e.a., Optics Express, 2017)

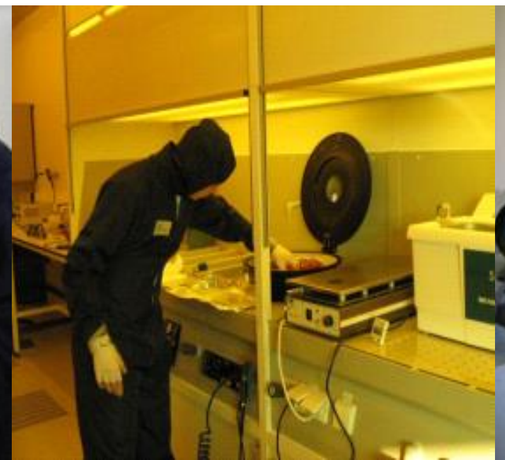
NAMIFAB EXPERTISE

→ Execution of small exploratory projects,
which can form the base for more extended collaborative project proposals
=> create new ideas and opportunities for original interdisciplinary research subjects

→ Knowhow and infrastructure for designing, realizing and inspecting nano- and microsystems of very diverse shape, dimensions and complexity

(List of test and research infrastructure on www.ugent.be/namifab/en/infrastructure)





NAMIFAB EXPERTISE

Nano- and microfabrication technologies:

Photolitography (pattern definition)

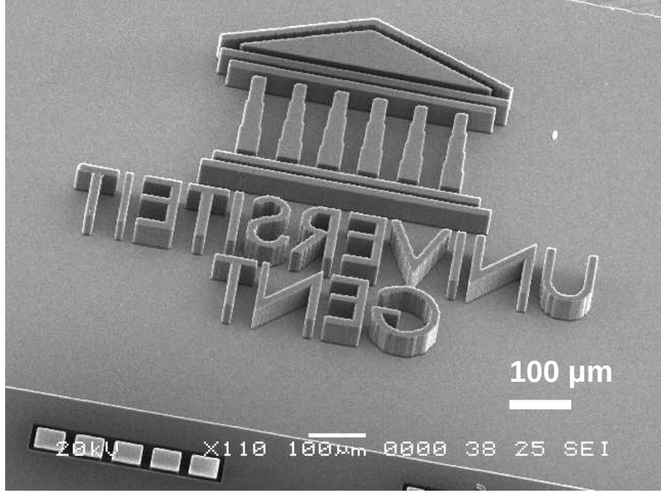
→ Photomask alignment and exposure (resolution down to 800nm)
→ Laser direct imaging (resolution down to 1µm)
→ Electron beam lithography (resolution down to 10nm)

Layer deposition

→ Spin coating
→ Plasma deposition
→ Sputter deposition
→ Electron beam evaporation
→ Thermal evaporation for deposition of organic layers
→ Atomic layer deposition (aluminium oxide)

Etching

→ Development, etch and strip line for flexible PCBs
→ Plasma etching (RIE, ICP, Oxygen)
→ HF-vapor etching



Plasma deposition

Thermal evaporation

Flexible PCB processing

Plasma etching

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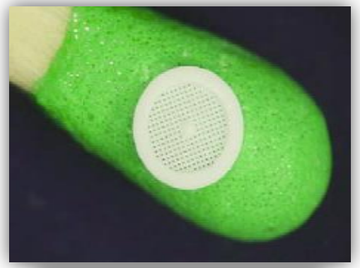
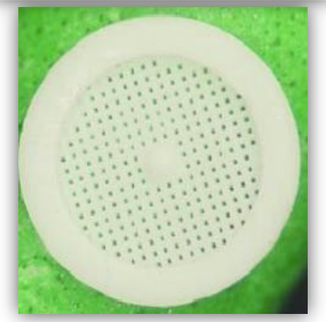
NAMIFAB EXPERTISE

Nano- and microfabrication technologies:

Material structuring

→ Laser structuring, cutting, drilling and welding on a variety of substrates
→ Microinjection moulding of small parts (<1g)
→ Dicing, lapping, polishing
→ Lamination, imprinting
→ Vacuum forming



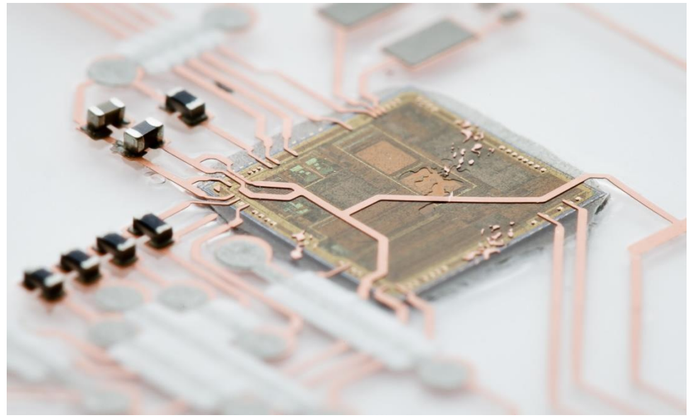


Micromoulding

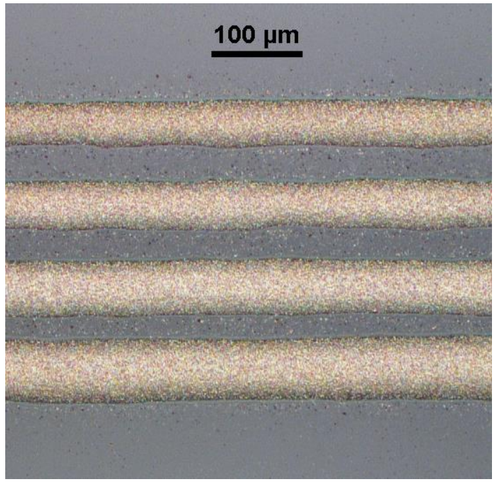
Vacuum forming

Assembly

→ Die and flip-chip bonding (± 5µm accuracy)
→ Accurate (± 1µm) placement of chips and toher 3D structures
→ Micro-Transfer-printing (µTP)
→ Wafer bonding
→ Automated needle dispensing
→ Screenprinting
→ Reflow soldering
→ Wire bonding
→ Aerosol-jet printing (print metallic conductive inks)
→ Liquid crystal device assembly



Assembled smart label



Jet printed silver tracks

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NAMIFAB EXPERTISE

Sample inspection:

Microscopy

→ Optical microscopy (mm to µm size features)
→ Electron microscopy: SEM, FEG-SEM with in situ FIB
→ Au & C coating for SEM

Profilometry

→ 3D optical profilometry
→ Step height measurement (stylus 2.5 or 25 µm)

Cross sectioning

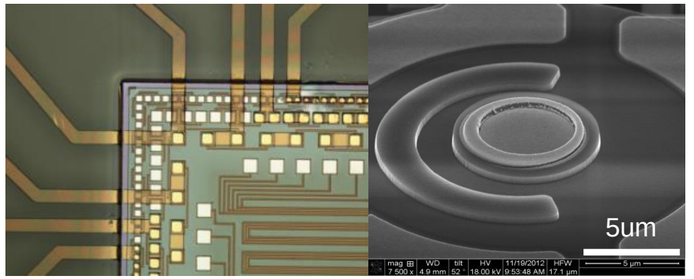
→ Sample molding in resins followed by grinding and polishing
→ Ion beam polisher
→ FIB local cross sections integrated in a FEG SEM instrument

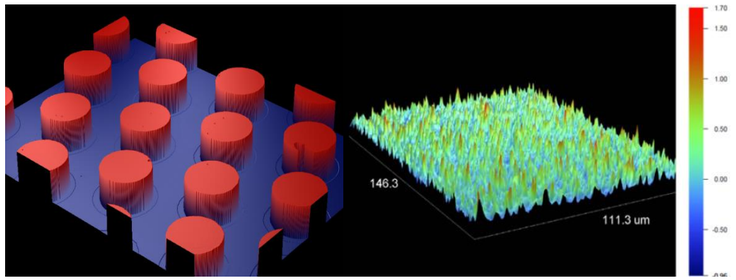
Surface analysis

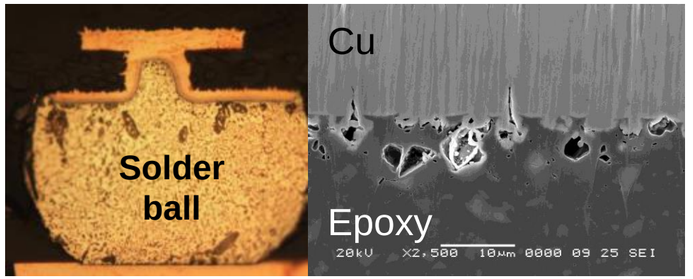
→ Contact angle
→ Soldarability, Critical Cleanliness Control

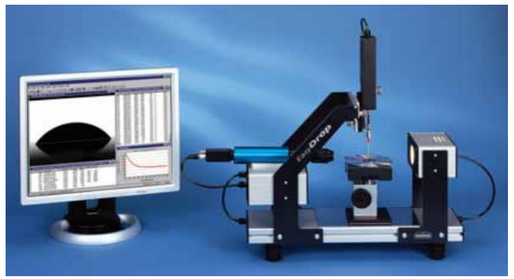
Material analysis

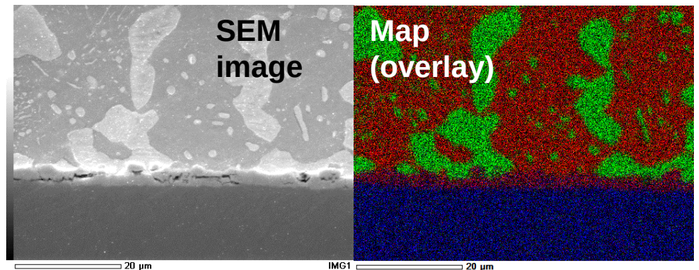
→ SEM+EDS











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NAMIFAB EXPERTISE

Reliability testing and failure analysis:

Mechanical testing

→ Peel test (90º & 180º)
→ Component shear and pull testing
→ Stress/strain measurements
→ Standardized washing tests

Climate chamber testing

→ Temperature storage (37 - 200 ºC)
→ Temperature-humidity testing (10 – 95 °C, 10 – 98 % RH)
→ Temperature cycling (-70 °C to 180 °C) with in-situ resistance measurement

Universal Testing Machine (INSTRON)

Universal Bond Tester

Humidity testing

Thermal cycling

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NAMIFAB EXPERTISE

Electrical measurements:

DC measurements

→ Contact resistance

→ Sheet resistance

→ Component characterization (I/V curve, leakage current)

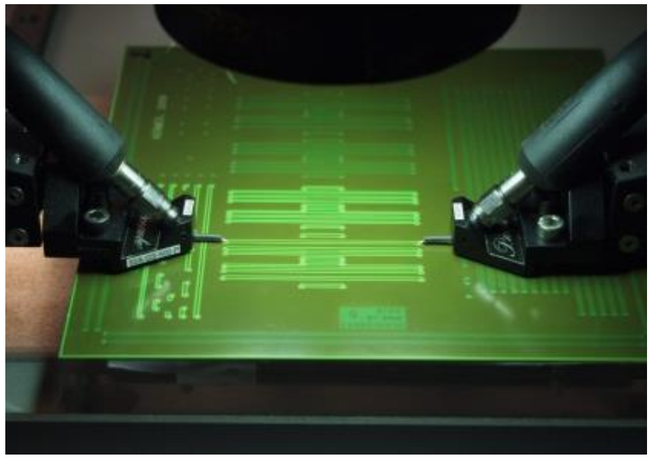
→ Surface insulation resistance (linked to climate chamber)

AC measurements

→ Electronic circuit analysis

→ Impedance and network analysis

→ Dielectric withstanding voltage testing up to 6kV



Four-point probe station

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COLLABORATION WITH NAMIFAB

Start working with us in three simple steps:

→ File a request

Fill out the NaMiFab request form and send it after completion to thomas.vervust@ugent.be

→ Feedback from NaMiFab

We will contact you to explain what we can do and we will request more input if needed.

→ Execution of the work

Once we both agree on how we will tackle the request, we can start with the actual work.

(Please call or mail if you have questions!)

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COLLABORATION WITH NAMIFAB

The NaMiFab request form

→ Can be downloaded from the website (see collaboration page)

→ Should be filled out in a clear and concise way (keep it short)

→ Provides us information about:

- Contact details
- Background of the research
- The request itself
- Expectations on the outcome
- Future plans (additional requests, paper, project proposal,…)

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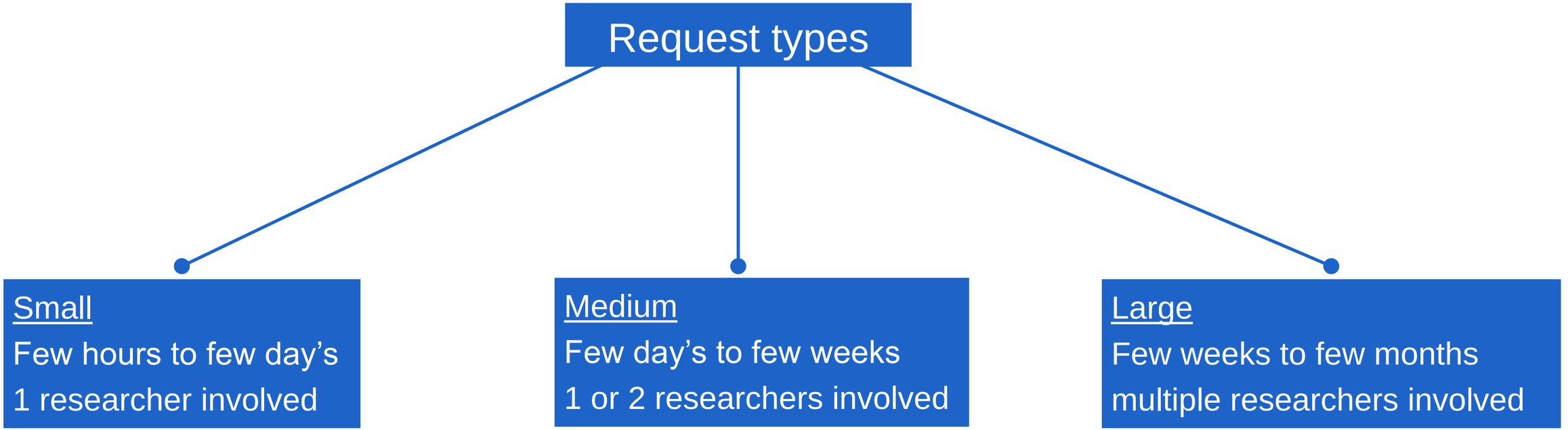
COLLABORATION WITH NAMIFAB

We defined three types of project requests, with different duration and requirements for resources



e.g. Imaging, perforations, wirebonding

e.g. PDMS mold for microwells

e.g. Party shirt, Light Sheet Microscopy

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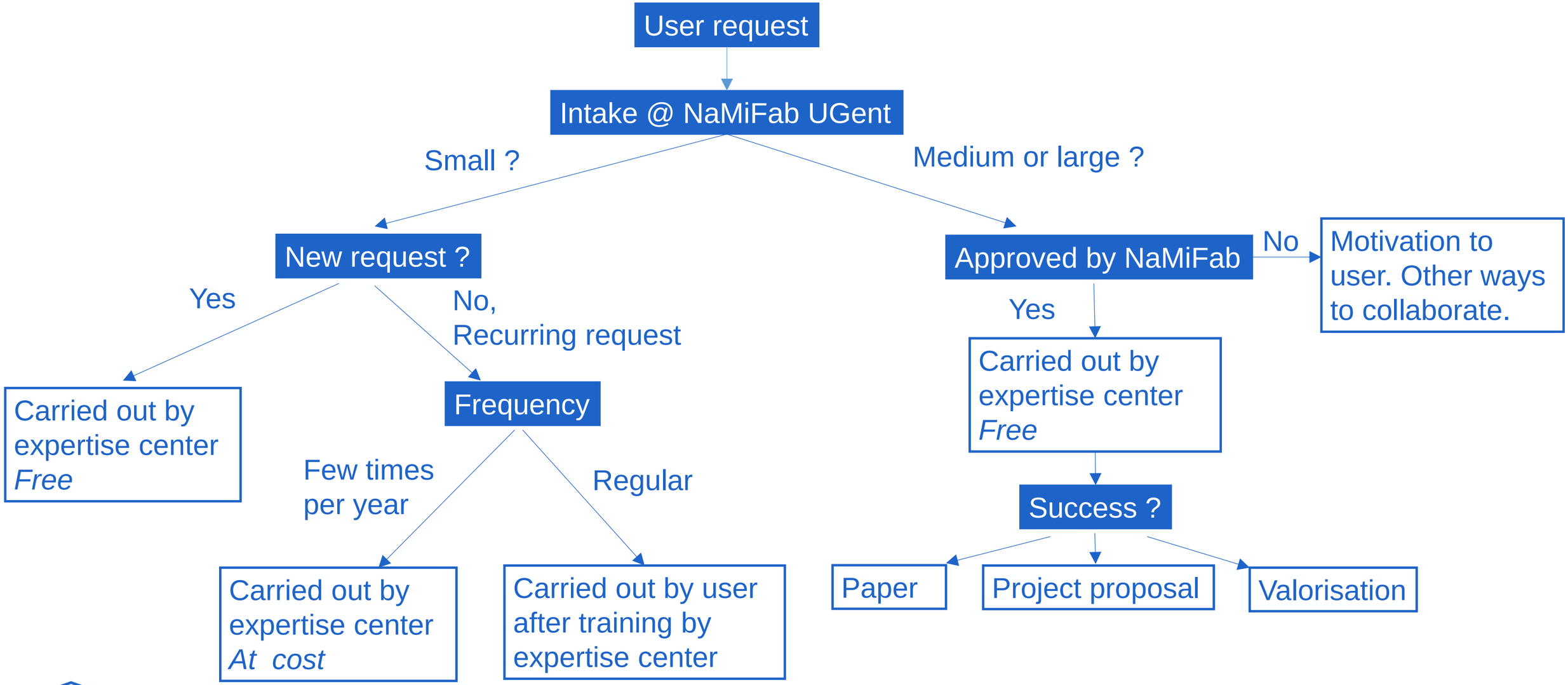

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COLLABORATION WITH NAMIFAB

What's the cost for Ugent research groups?

→ The aim of NaMiFab is to **lower the barrier and hence the costs for first entry** as much as possible.

→ The target is to accommodate **new requests free of charge** for the user. The user will only be charged in the case of, for example, high consumable costs or special tooling.

→ In case of recurring (and hence successful) requests, the user will be requested to carry the costs involved, such as consumables, machine time and operator time (at effective cost).

→ Project coordination time will not be charged

FACULTY OF ENGINEERING
AND ARCHITECTURE

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