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INTERNATIONAL
Our chips drive your business
www.lionix-international.com

MEMS Developments at LioniX International BV

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Our Mission

LioniX International is a leading global provider of customized microsystem solutions, in particular integrated photonics-b ed, in scalable production volume

Why

Applying dis gies to solve challenges

Integrated Photonics is one of the key enablers for this

Microsystems @ LioniX

Lion Photonix, Micro System Technologies to Develop Lab-on-a-Chip Systems

Photonics.com
Apr 2002

ENSCHEDE, The Netherlands, April 19 -- Lion Photonix Technologies BV and the business unit Micro System Technologies of 3T BV, both based in Enschede, The Netherlands, have joined forces to develop lab-on-a-chip systems.

All the activities of Micro System Technologies have been transferred to Lion Photonix Technologies BV, and the transfer has been paid for in shares to 3T. Lion has also acquired new venture capital and has made and an IPR agreement with the University of Twente on microfluidics technology from the research institute MESA+.

As a result of these activities, Lion Photonics will be renamed LioniX. LioniX will focus on the emerging product-market combinations, components and subsystems in telecommunications and on instruments and equipment in life sciences and industrial process control markets. LioniX is partnering with a variety of providers of complementary technology services and MST-foundries.

MAGIC
4th Industrial Revolution Leader

2001 2002 2008 2009 2016 2018

Who

- Located in the Netherlands (Europe)
- Established in 2001 (LioniX)
- Merged with XiO Photonics & SatraX in 2016
- Spin-out PHIX Photonics Assembly in 2018
- >50 employees, >50% PhD
- Development and production for applications in
  - Integrated photonics based light/signal/data processing: 5G and (RF) satellite systems, visible light engines, spectrometry
  - Lab-on-a-Chip and (bio)chemical sensor systems
- Customized MEMS/microsystem services

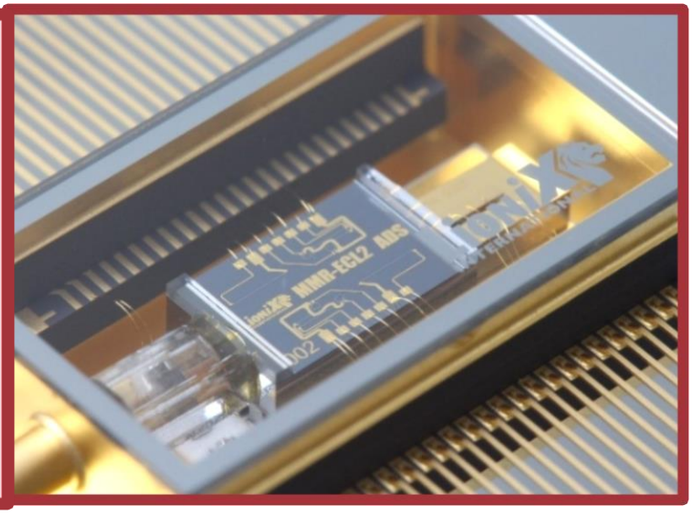
LioniX & Nanolab

- MESA^{+} nanolab, University of Twente
- 1250 m^2 labspace and 200+ pc of equipment
- Facility sharing, pay per use
- Close collaboration with industry
  - Nanolab depends on income from industrial partners
  - LioniX participates as a main stakeholder
- LioniX International is the largest external user
- Processing by trained LioniX personnel
- Dedicated equipment for
  - Ultra Clean Processing — CMOS
  - Metal Free Processing — High-T (700 – 1150 C)
  - In Line Processing — Metals, glasses, polymers
- Suitable for low and medium volumes
- We use a network of suppliers for services we don’t have in house
  - Stepper Lithography
  - Backgrinding
  - Implantation
  - Thick SiO2
  - And more

Customized MEMS Solutions

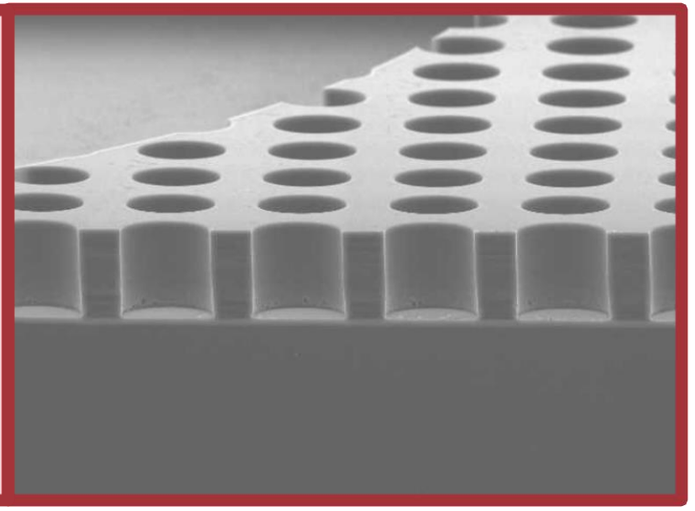
Systems based on **Photonic Integrated Circuits**

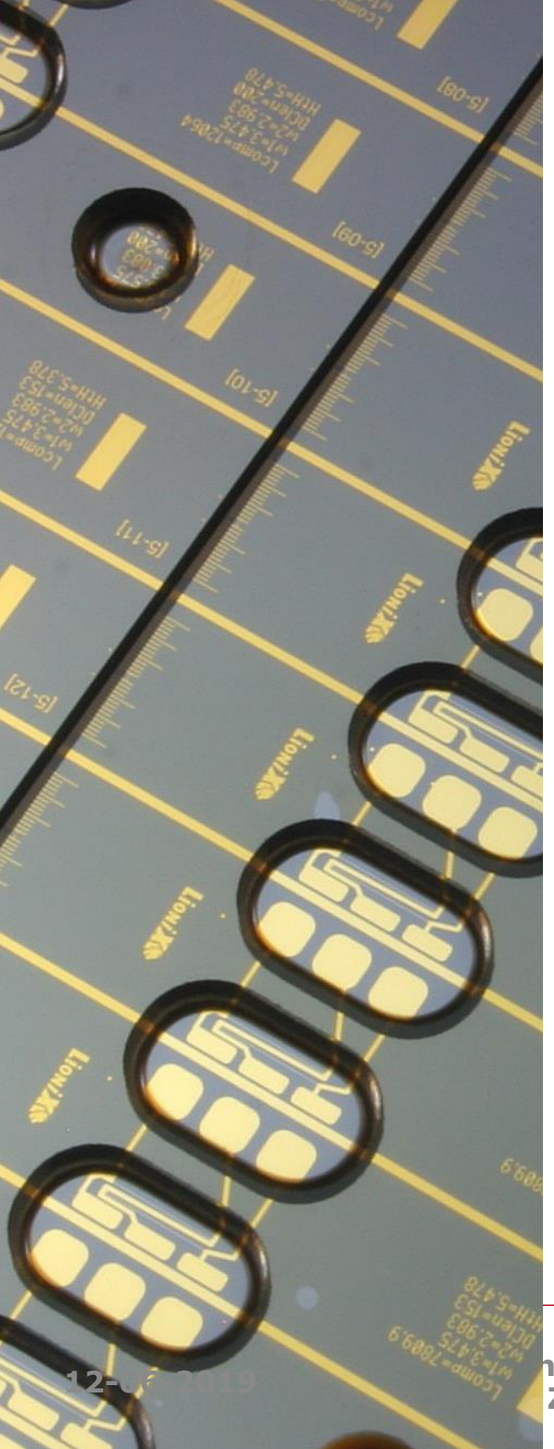
- Technology: Proprietary Integrated Photonics platform TriPleX™
- Competences: Functional Design, PIC (module) manufacturing, Assembly & Packaging, System control
- Applications: Telecom, Datacom, Life Sciences and Metrology markets



Customized **MEMS**

- Competences: MEMS Process development and small to medium volume manufacturing
- Applications: Sensors, Instrumentation and Life Sciences





MEMS Value Proposition

Business model	Independent - contract development & production - no COTS products
Core Competences	Small to medium volume production based on standard processes Customization of production process to fully meet customer specifications
Services	Sensors, micro/optofluidics, bioMEMS, inertial MEMS, MOEMS, micromachining
Customer Types	SME's, Start-ups, Multinationals - customer owns design IP - from all over the world
Applications	Sensors, Instrumentation and Life sciences,
Technology	World class facilities (Nanolab, Enschede, NL) 100 mm Si, SOI, Fused Silica and Glass substrates Platforms: DRIE, WLP, SOI, ISFETs, Triplex
Projects	Sustained relationship achieved by bridging the gap and open communication Process development > Engineering run > Production run
Knowledge	More than 30 years experience - 50 highly educated employees
Vertical Integration	Assembly & Packaging, PIC system design & manufacturing, µFluidic systems, Volume production

MEMS at LioniX International

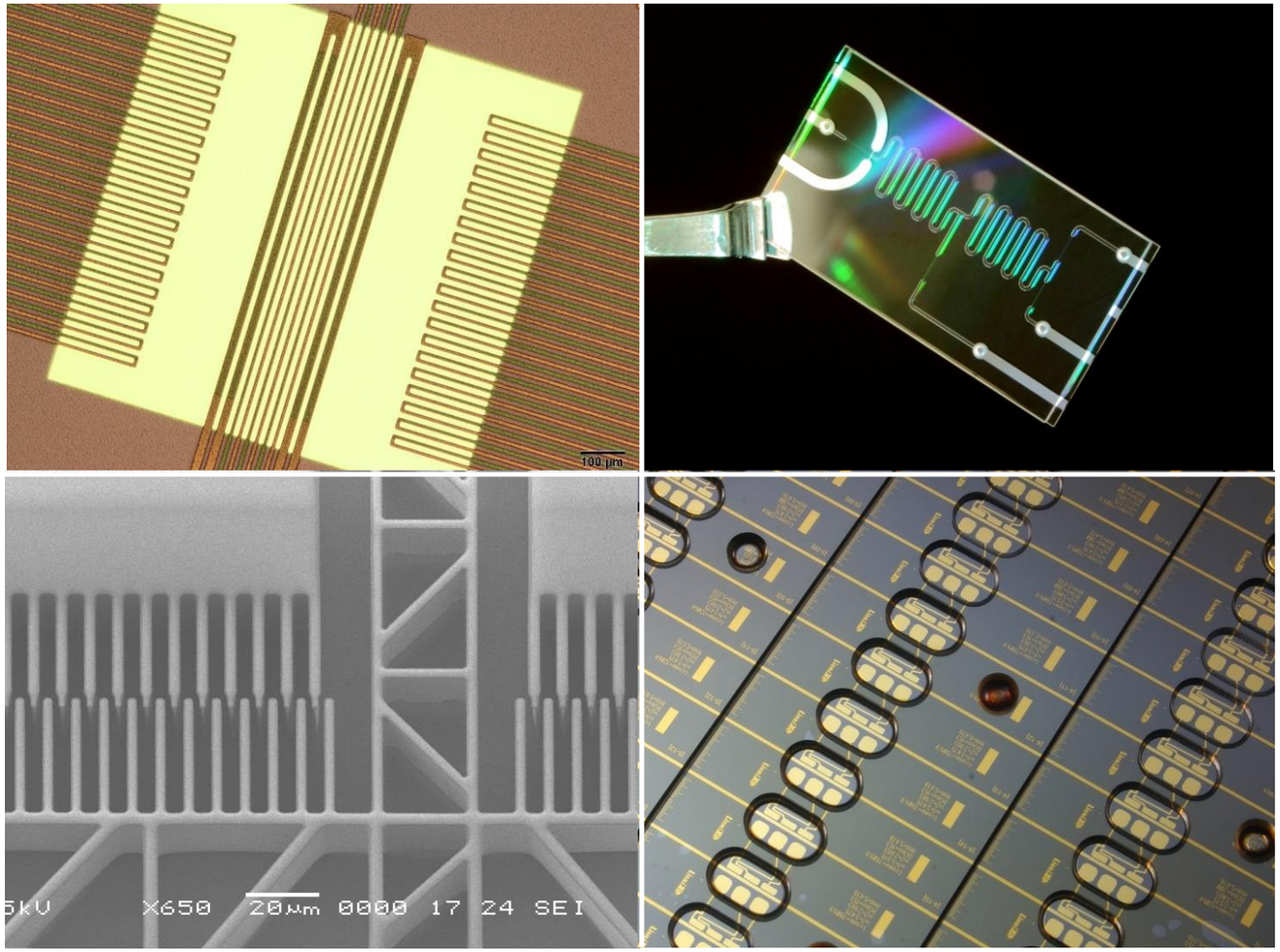
MEMS (literally) = Micro Electromechanical Systems

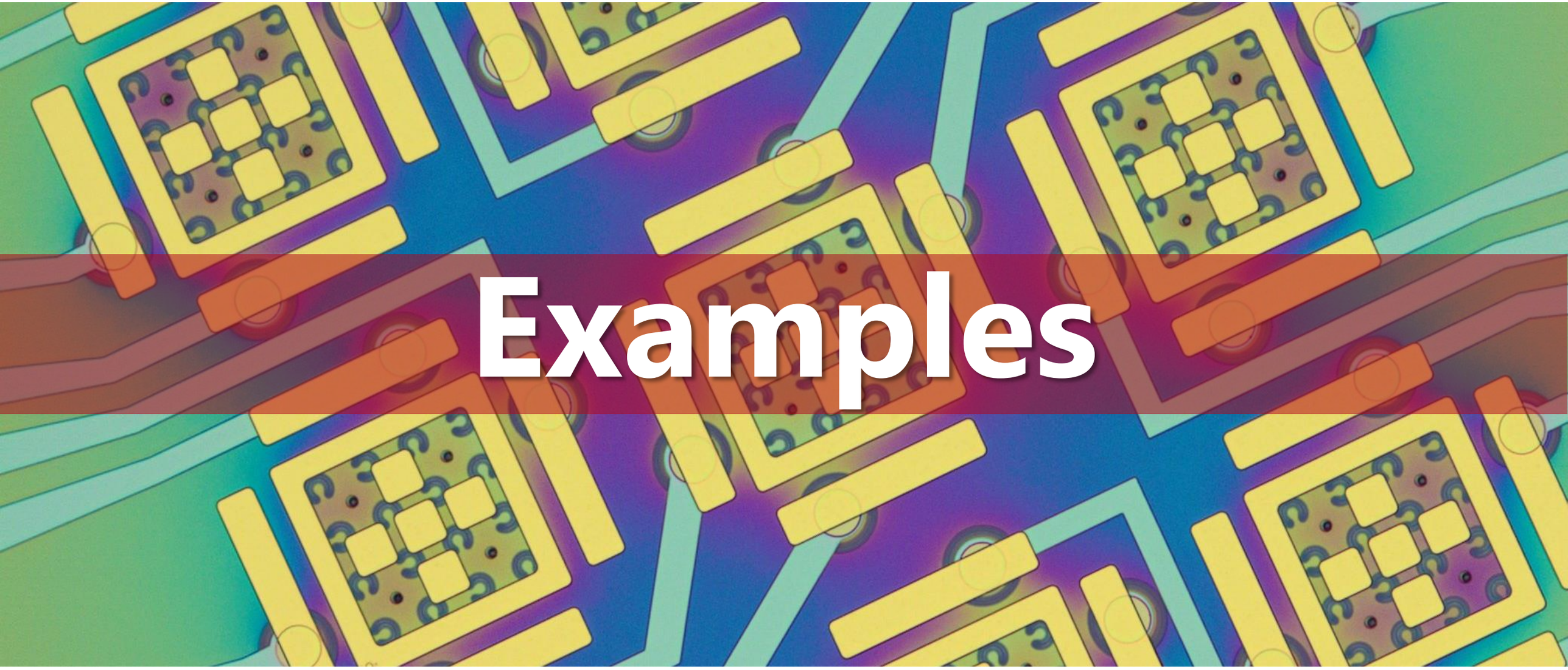
MEMS is also short for anything one can make with Micro(system) technology:

- Not all MEMS have an M or E
- MEMS can also have O, F, C, …

Examples

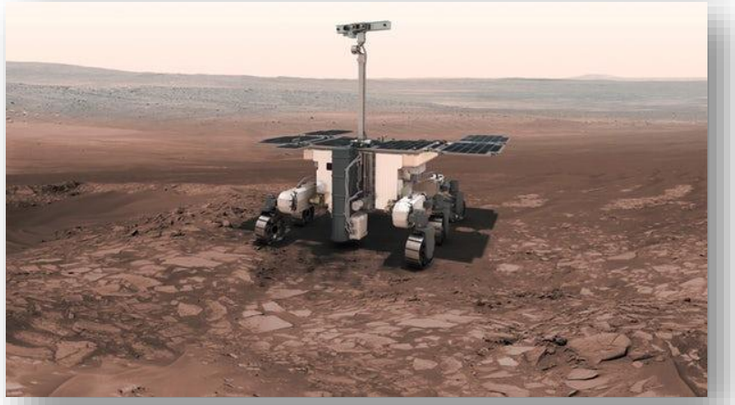
- Sensors
- Microfluidics
- BioMEMS
- Optofluidics
- Inertial MEMS
- Nozzles
- MOEMS
- Micromachining





Examples

ESA: Life Marker Chip



Application

The LMC (Life Marker Chip) is part of ESA's Exomars Mission who's aim is to find traces of past or present life in a Martian subsurface soil sample. The instrument is developed by a consortium led by the University of Leicester (UK) and capable of detecting a wide variety of different biomarkers based on the use of immunoassay techniques in a micro-arrays format.

Request

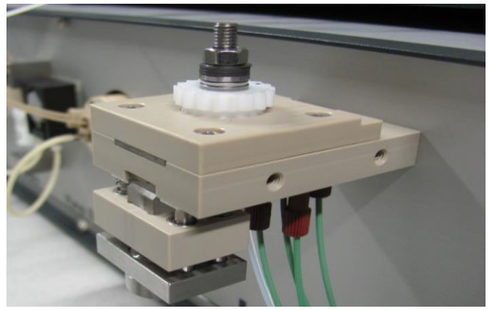
The LMC Consortium needs a microfluidic chip comprising various reaction chambers, fluid channels, in- and outlets, conductivity sensors and a configurable rotary valve, as well as an Photonic Integrated Circuit for fluorescence excitation.

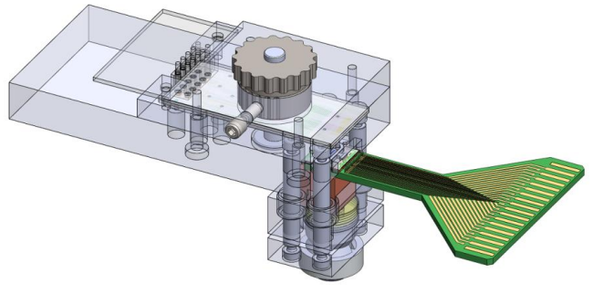
Solution

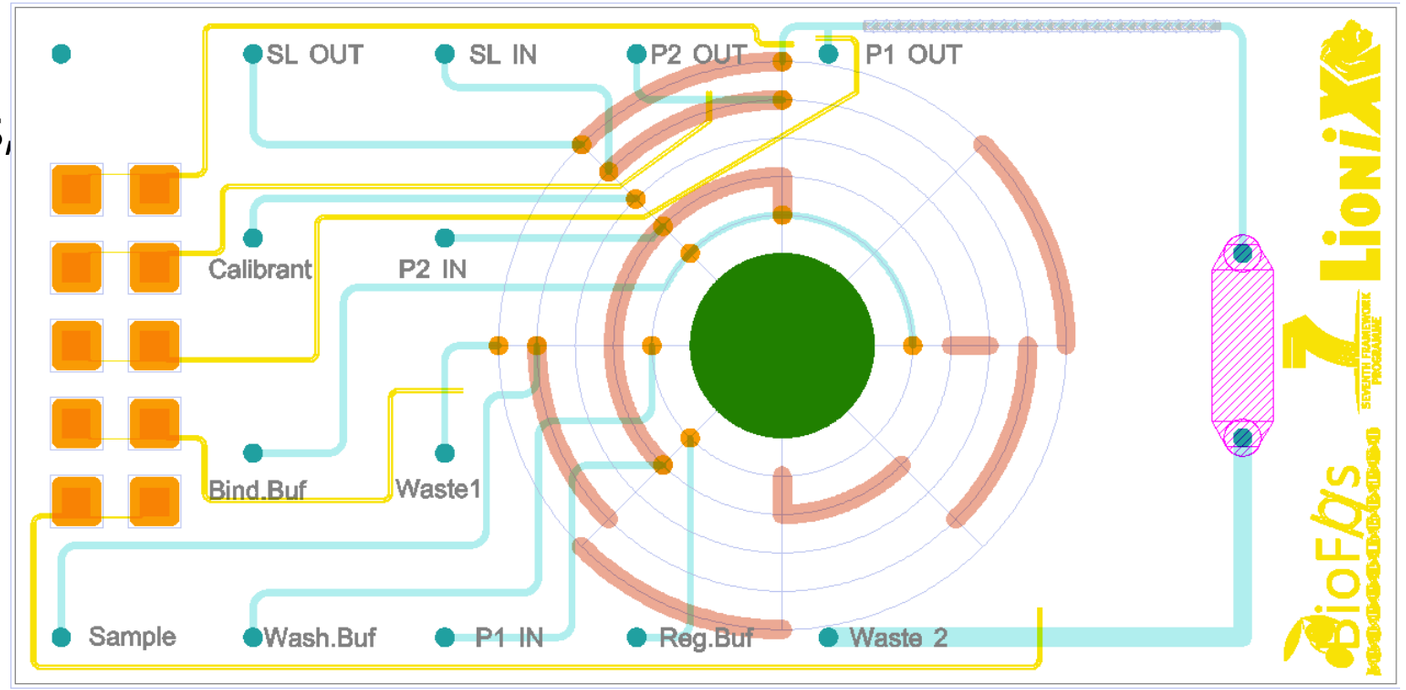
For the glass chip we developed a solution based on a borosilicate glass wafer, powder blasting, HF etching, metal evaporation and integration of a hybrid rotary valve. For the PIC chip we developed a solution based on TripleX waveguide technology.

Integrated rotary valve for liquid management

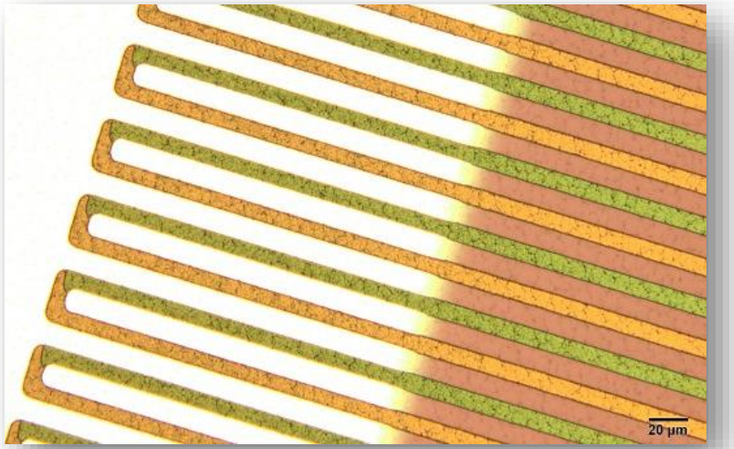
- Integration of micro & macrofluidics
- Enabling complex valving in very compact module
- Extremely small dead volumes
- Microfluidic glass chip with inputs, outputs and connecting channels
- Polymer rotary slider with micromachined trenches
- Stepper motor for control







Bronkhorst: IQ+ flow sensor



Application

Anemometric gas flow sensor for applications in Microfluidics, Microchemistry, Analytics (GC, FID), Life Sciences (IQ+ flow).

Request

The customer needs type-T thermopiles on a membrane with low heat conductivity to sense the temperature profile generated by an integrated heater in a gas flow.

Solution

We developed and are producing a solution based on sputtering and etching of Cu/CuNi, wet etching, anodic bonding and etchback of a Borosilicate glass wafer.

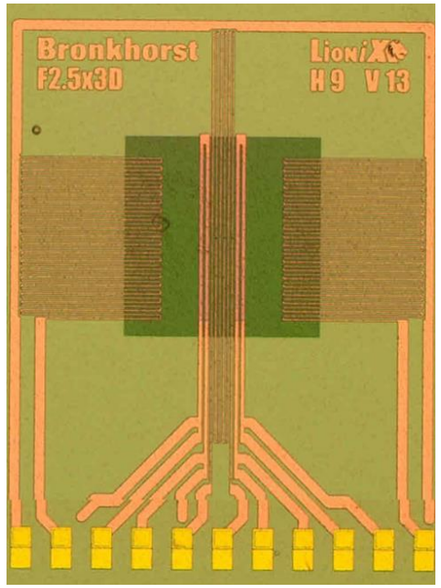
Testing

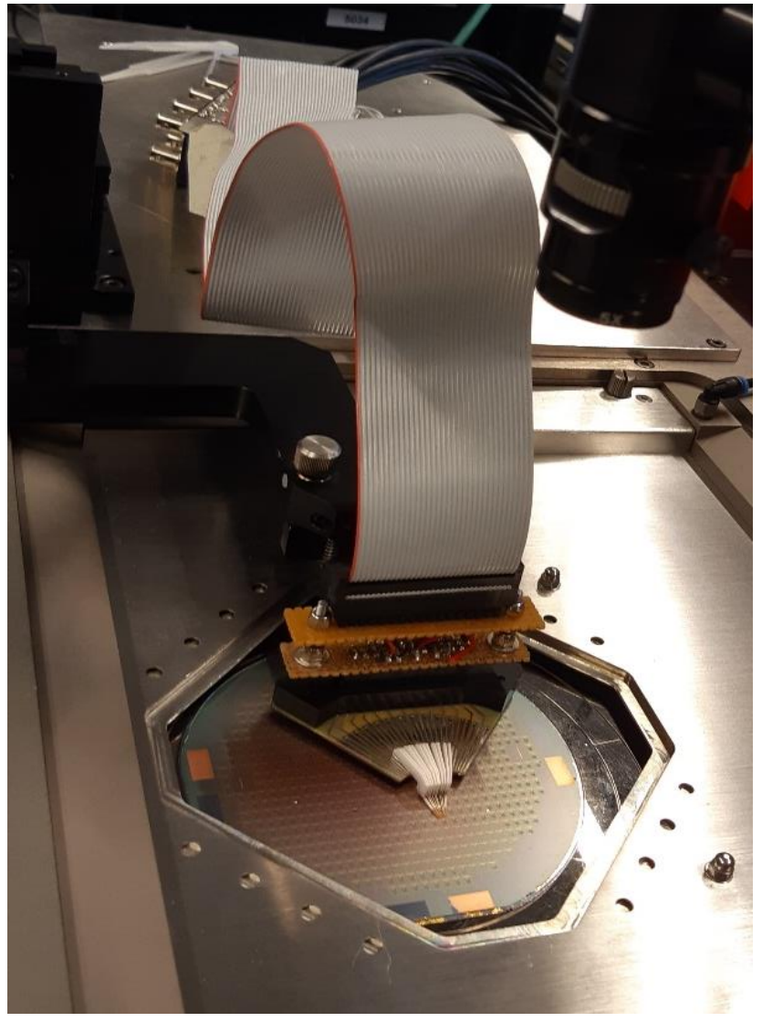
- Waferscale quality test!
- Equipment at University of Twente – MESA Test Center

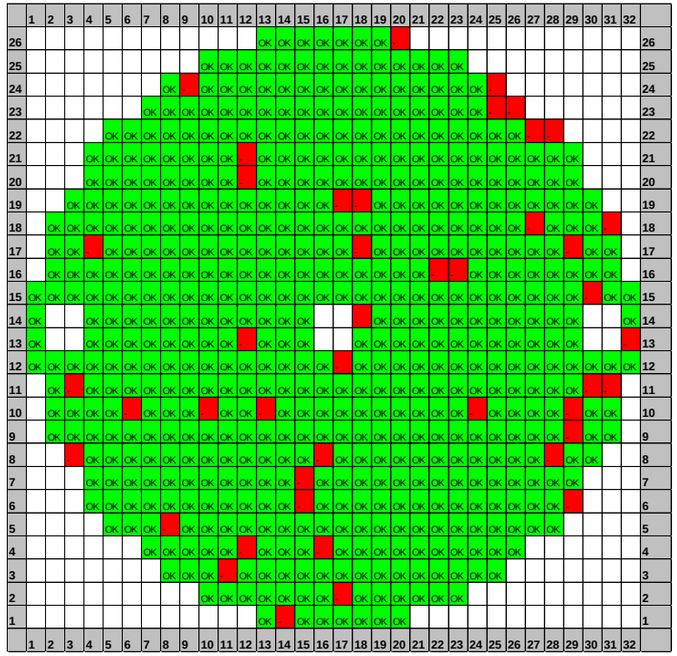
Wafer scale electrical testing

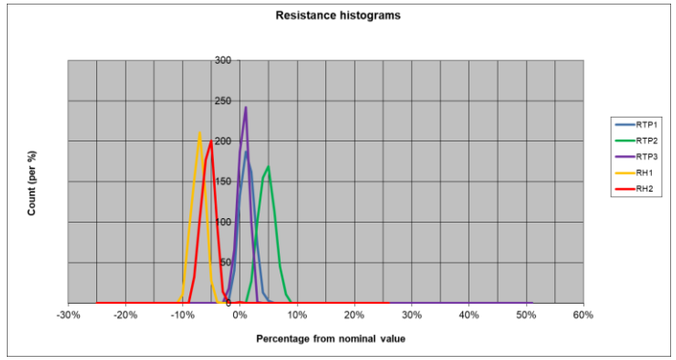
MTC (Mesa Test Center)

- Semi Automatic Probe Station
- Parameter analyser
- 3 hours per wafer - 600 chips

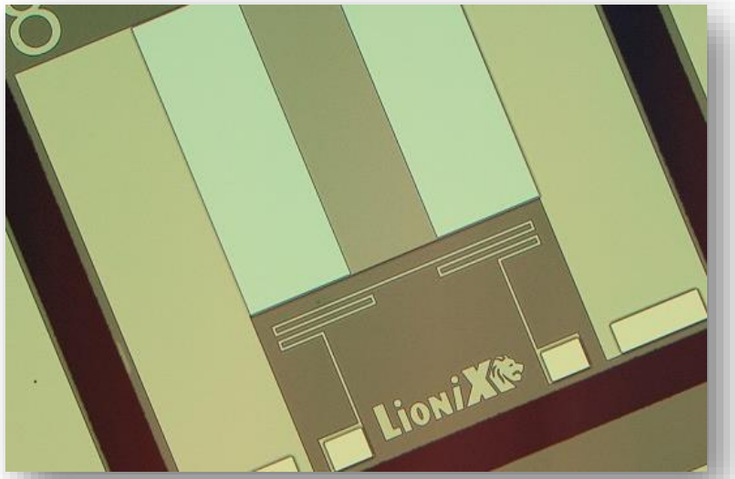








Onset: Conductivity Sensor



Application

HOBO Conductivity Loggers are convenient, rugged, and cost-effective data loggers for a variety of freshwater and saltwater monitoring applications.

Request

Our customer needs a non-contact, chemically inert, robust conductivity sensor with a range of almost 3 decades.

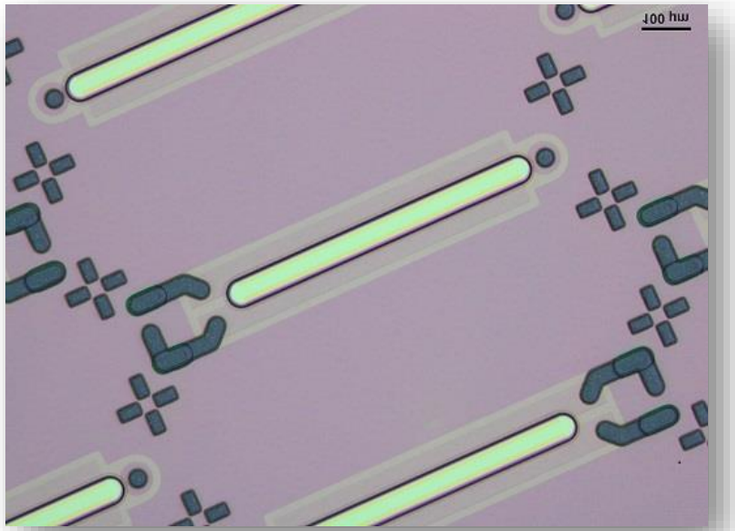
Solution

We developed and are producing a solution based on platinum deposition and tantalumpentoxide capping on borosilicate glass substrates.

Testing

- visual

Various Customers: ISFET pH sensor



Application

The Ion Sensitive Field Effect Transistor (ISFET) is a solid state, potentiometric sensor capable of measuring pH in the range from pH 1 to pH 14 with a linear response.

Request

Various customers need customized ISFETs with high sensitivity, low drift and low light sensitivity.

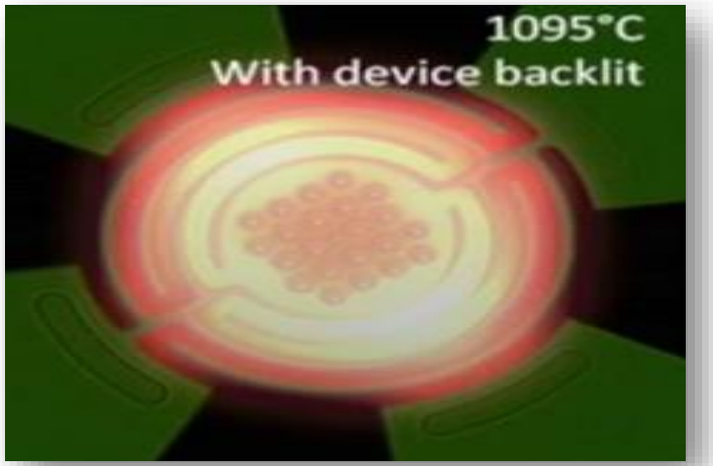
Solution

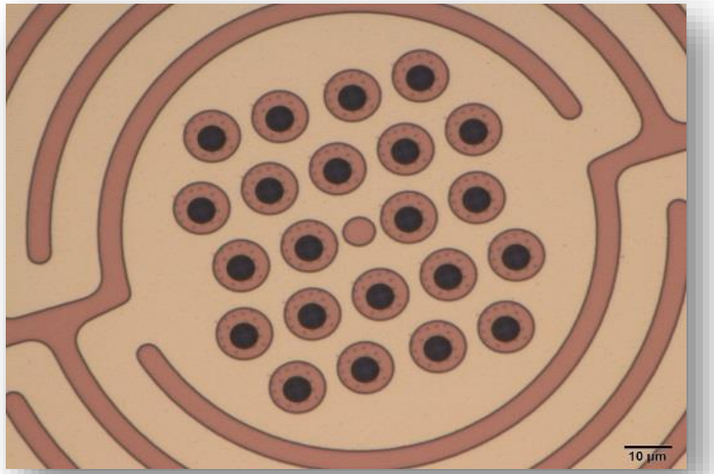
We developed a solution based on ion implantation, gate oxidation, diffusion, and a tantalumoxide (Ta_2O_5) gate material.

Testing

- Visual

ThermoFisher: TEM specimen holder





Application

The FEI NanoEx-i/v is a specimen heating and biasing holder for in situ S/TEM imaging and elemental analysis at elevated temperatures.

Request

The customer needs micron sized, 20 nanometer thin membranes which can be heated uniformly to temperatures up to 1200 C.

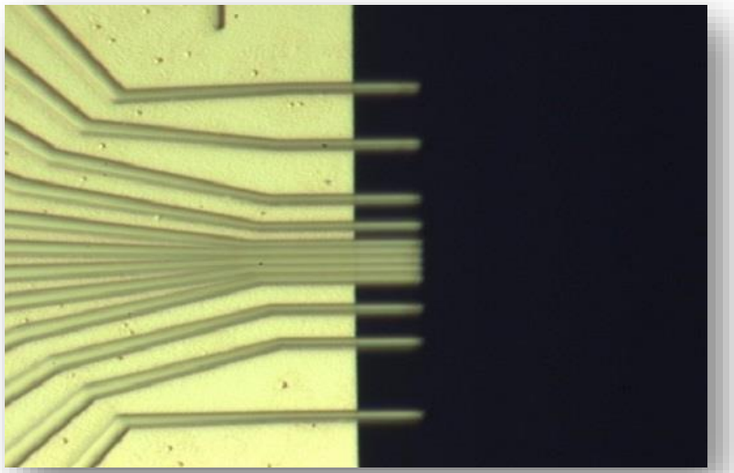
Solution

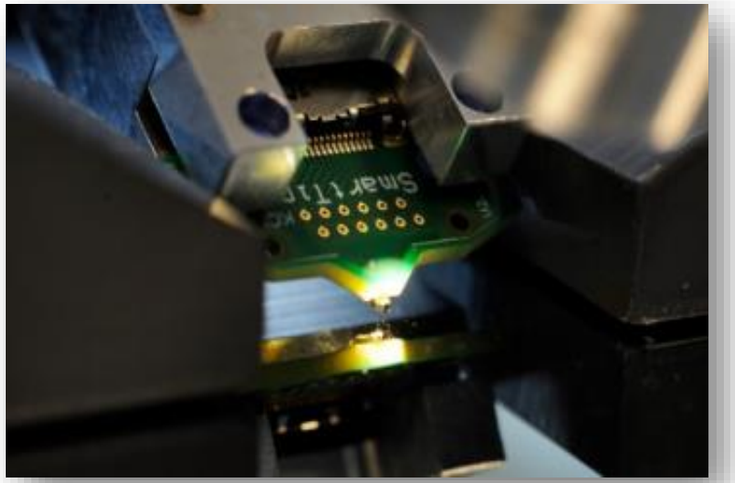
We developed and are producing a solution based on LPCVD silicon nitride membranes and High Temperature Heaters capped also by LPCVD silicon nitride.

Testing

- Waferscale quality test!
- Equipment at University of Twente – MESA Test Center

Smarttip: CIPT Probe





Application

Current In Plane Tunneling (CIPT) is a very fast and cost effective method to characterize Magnetic Tunnel Junctions (MTJ's).

Request

Our customer needs a probehead with multiple conducting probepins with submicron spaces between the probes and isolated from each other.

Solution

We developed and are producing a solution based on Thermal Oxidation, Stepper Lithography, RIE Etching, Au evaporation and advanced KOH Etching.

Testing

- Visual

Photonic Integrated Circuits

Systems based on **Photonic Integrated Circuits**

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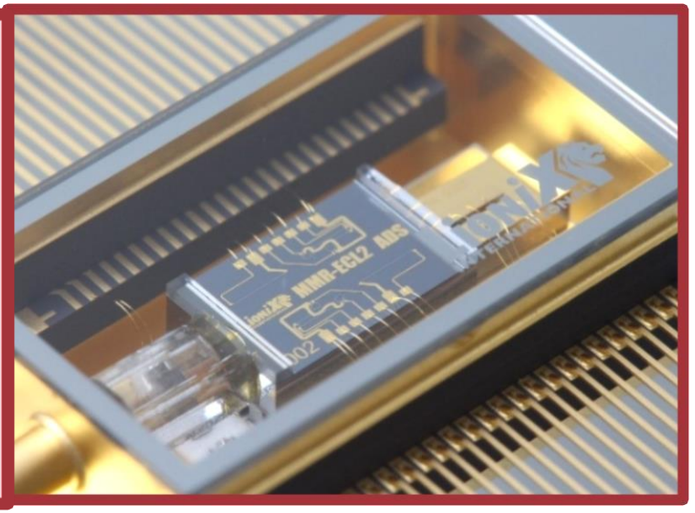

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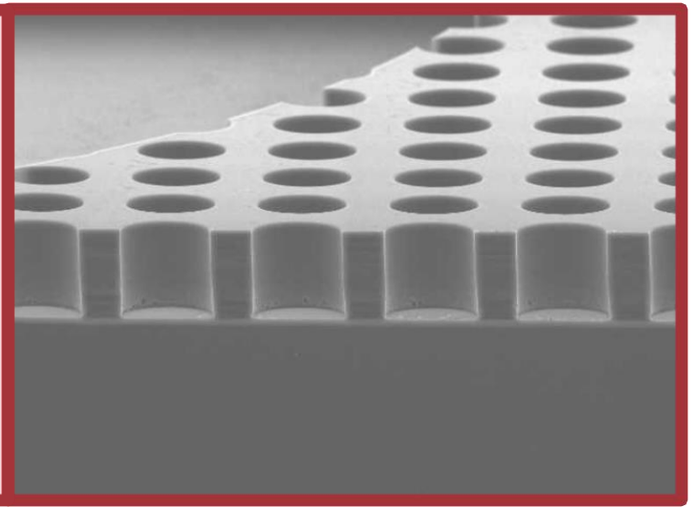
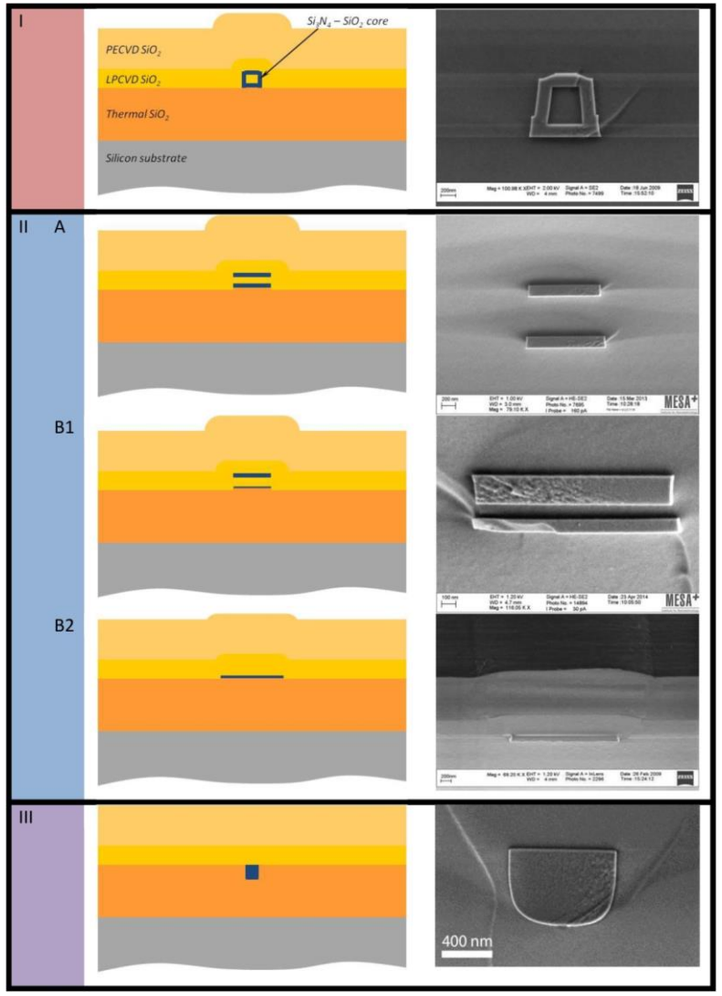


TriPleX™: some geometries…

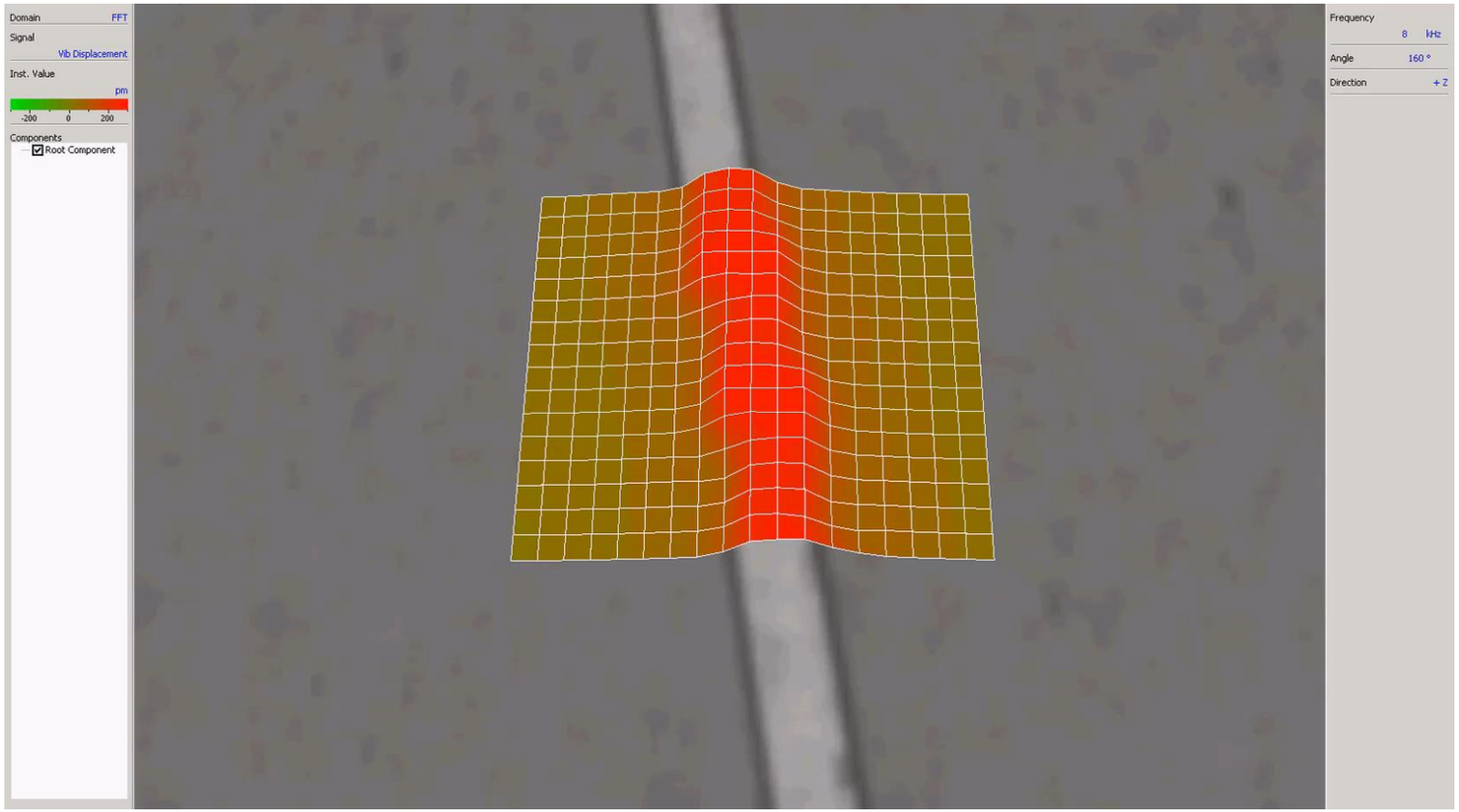


- Extremely low optical attenuation (world record)
- Small bend radii (small footprint!)
- Adjustable polarization properties (sensors ⇔ telecom)
- Design by geometry
- Silicon and glass compatible
- Spot size converters
- **Basic testing** on optical and electrical (tuning) parameters (one-by-one)

MEMS fabrication technologies for electro-optic actuation enable low power phase shifting

PZT stress-optic modulator

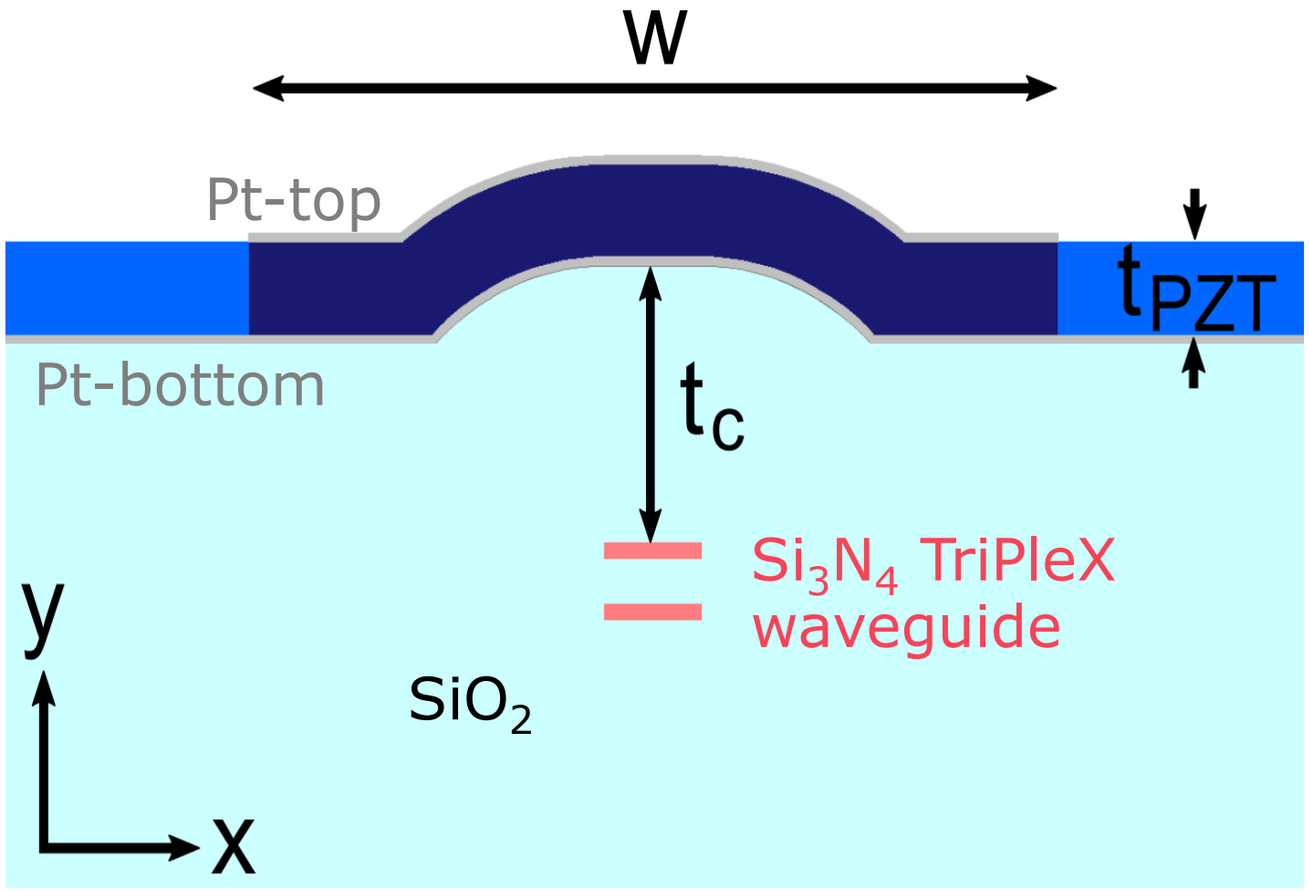
- Alternative for thermo-optical modulator (heater)
- Stress induced refractive index change
- **Low power consumption** at quasi DC operation
- Charging the capacitor (µW at static voltage)
- Collaboration with Solmates

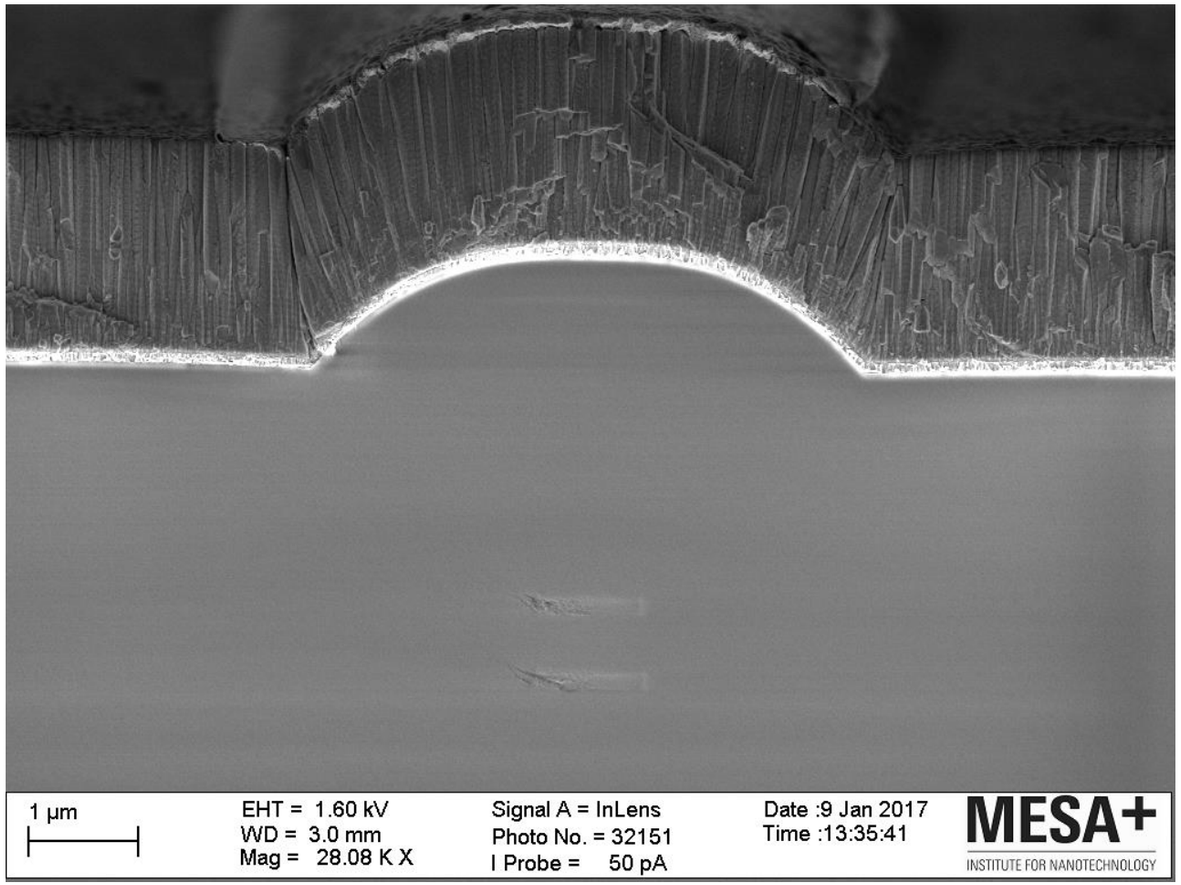


PZT (Lead Zirconate Titanate, $Pb(Zr,Ti)O_3$)

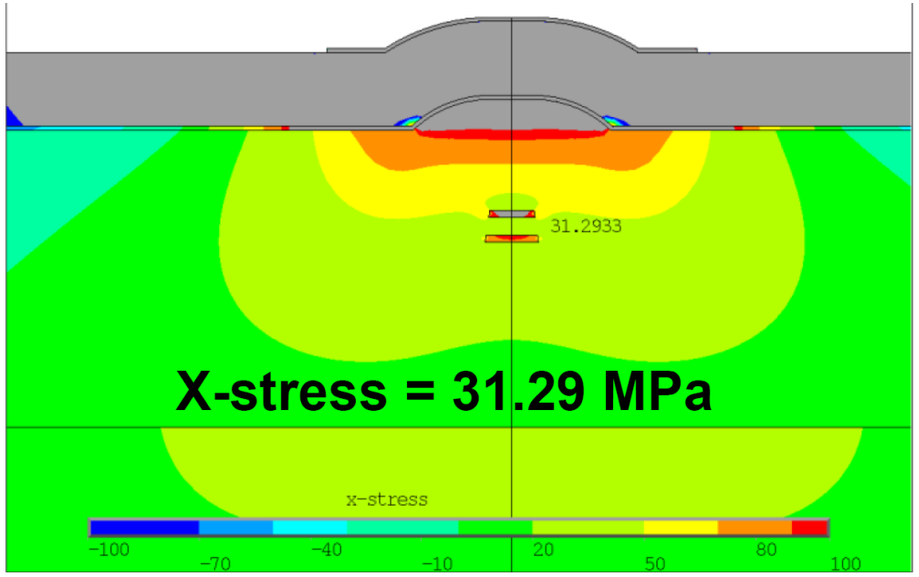
Realization of PZT layer structure

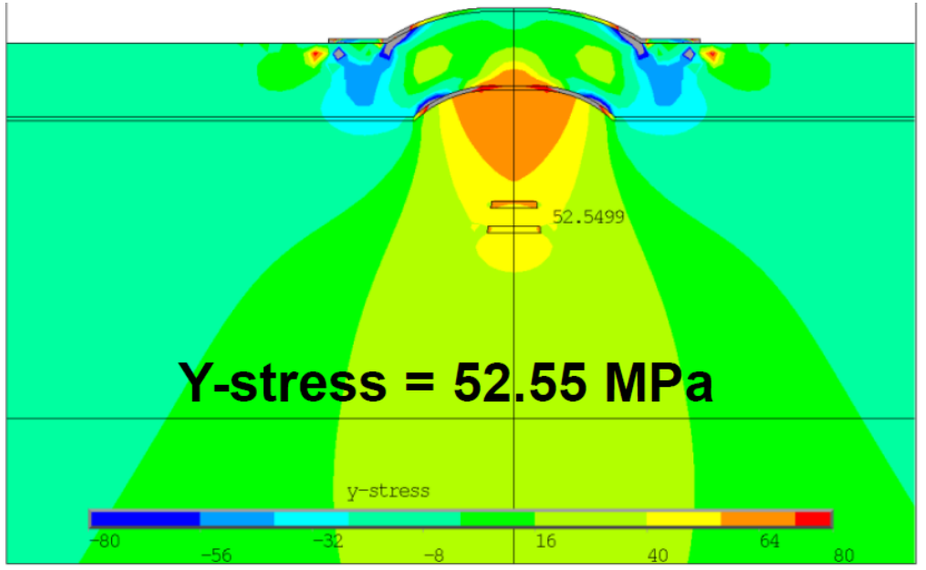
- Devices show a good match between design and realization

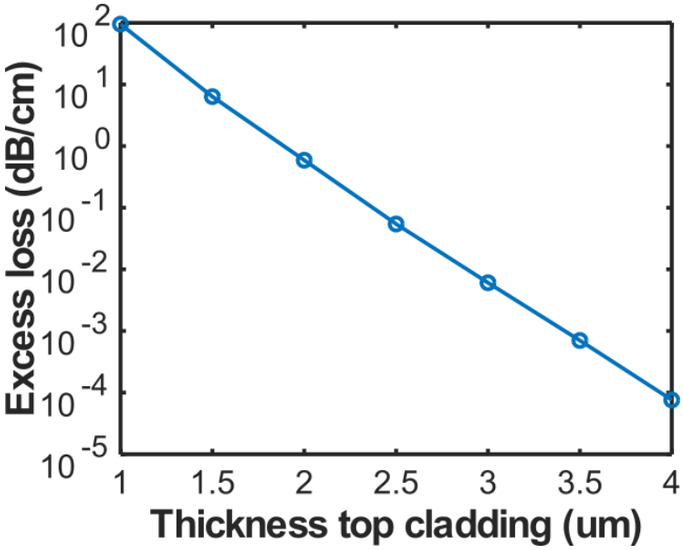




Stress simulation for PZT





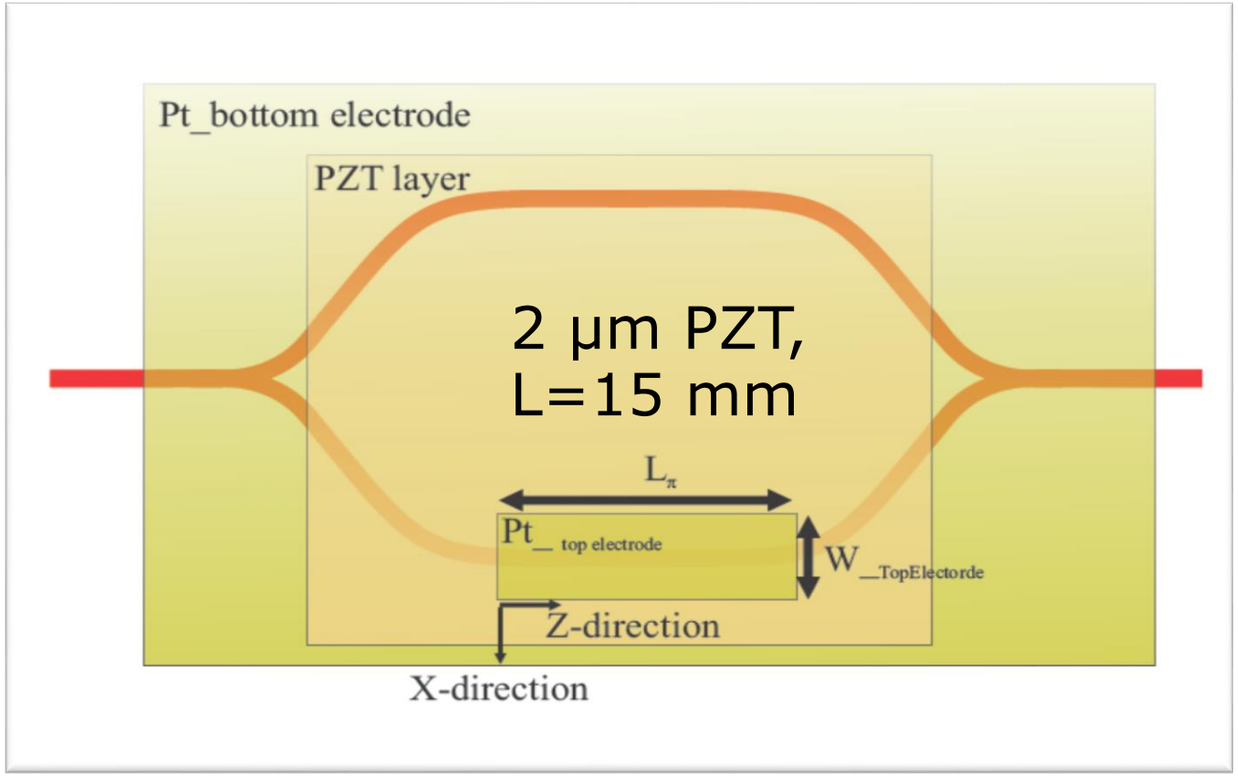


Use > 3 micron top cladding to stay < 0.01dB/cm excess loss

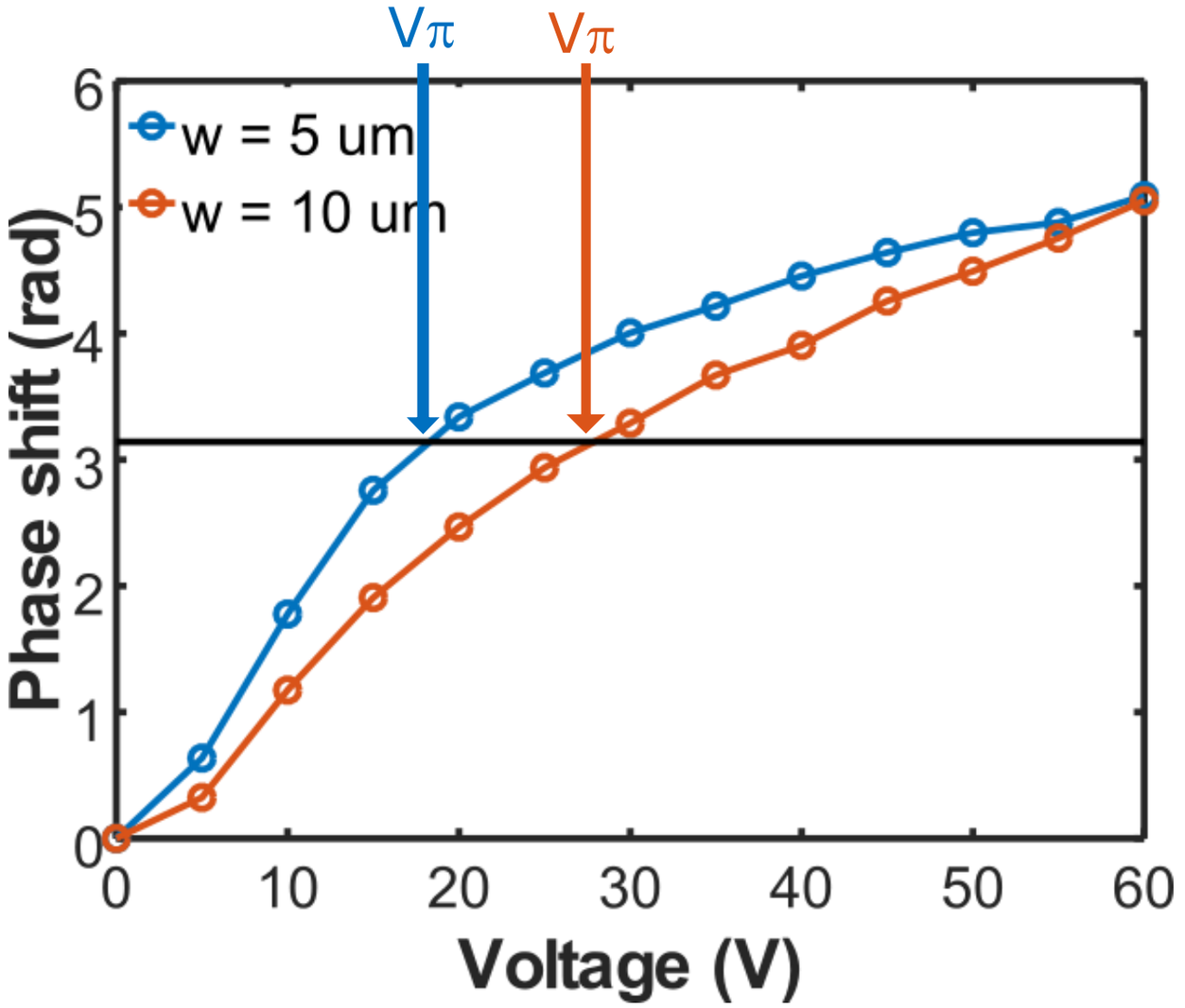
J.P. Epping, D. Marchenko, A. Leinse, R. Mateman, M. Hoekman, L. Wevers, E.J. Klein, C.G.H. Roeloffzen, M. Dekkers, R.G. Heideman: ***Ultra-low-power stress-based phase actuator for microwave photonics****: CLEO Europe 2017 Munich*

Characterization

Mach-Zehnder Interferometer



$$P_{out} = \frac{P_{in}}{2}\ (1+\cos[\Delta\varphi])$$



Conclusions

- Allround microsystems development and production provider in MEMS
- Prototypes, small and medium sized volumes
- Internal test facilities for Photonic Integrated Circuits
- Close collaboration with PHIX for (photonic) module supply

Q&A