E-DosiS
Einweg-Dosiersystem mit intelligenter Sensorik

Towards a fully disposable pressure and flow sensor for industrial and medical applications

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Outline

E-DOSIS Project

Measurement principle

Results

Summary

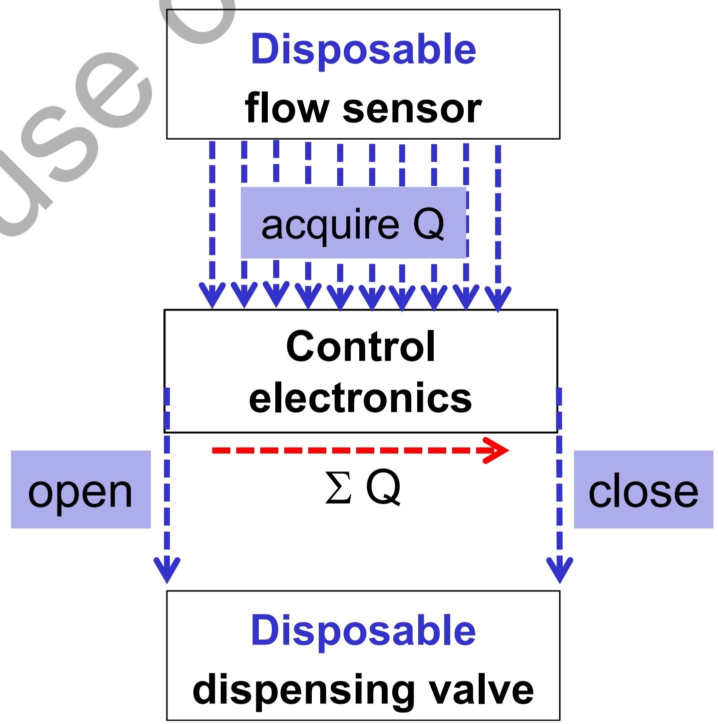
Project “E-DosiS”
(Disposable Dispensing System with intelligent sensor technology)

“Intelligent” liquid handling system

- Closed-loop controlled liquid delivery system
- For low volume dosage & flow control

System components

- Disposable flow sensor
  - Differential pressure principle
  - Media contaminated parts are disposable
- Disposable dispensing valve
  - Electromagnetic valve
  - Injection molded valve body and nozzle
  - External coil drive & electronics (reusable)
- Monolithic control electronics
  - Peak and hold valve actuation
  - Flow sensor supply & read out
  - Microcontroller to execute control loop



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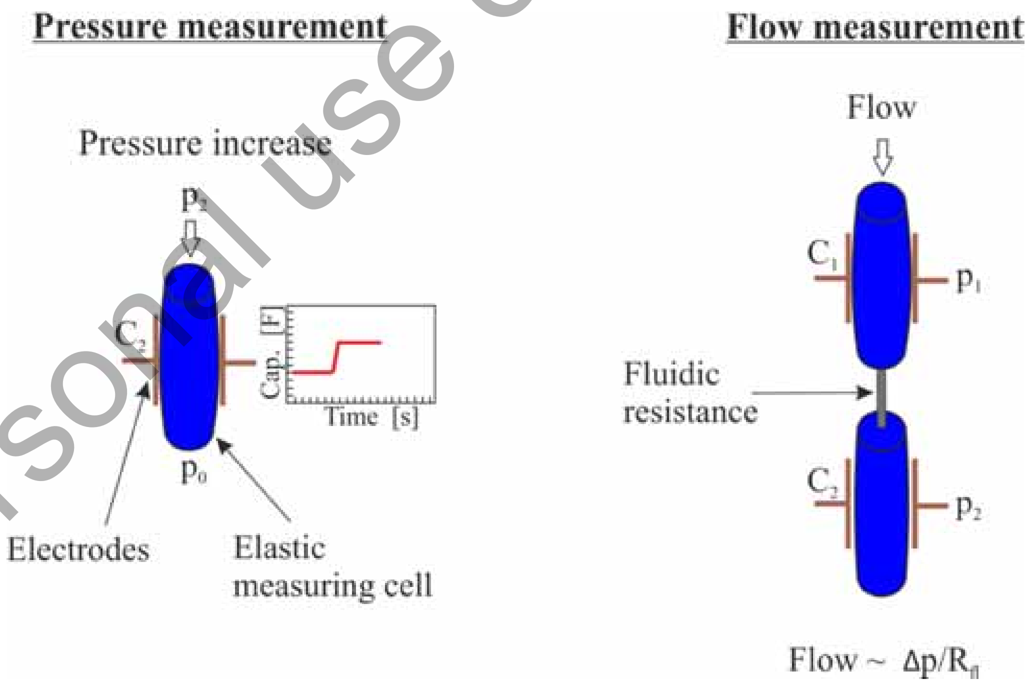
Measurement principle

Pressure measurement

- Elastic measuring cell
  - Expands due to pressure increase
  - By expansion amount and distribution of the dielectric liquid changes
- Electrodes around measuring cell
  - Detect dielectric change inside the measuring cell

Flow measurement

- Based on the differential pressure principle
- Fluidic resistance causes pressure drop: $Q \sim \Delta p$



Sensor Concept

Disposable parts in contact with the liquid

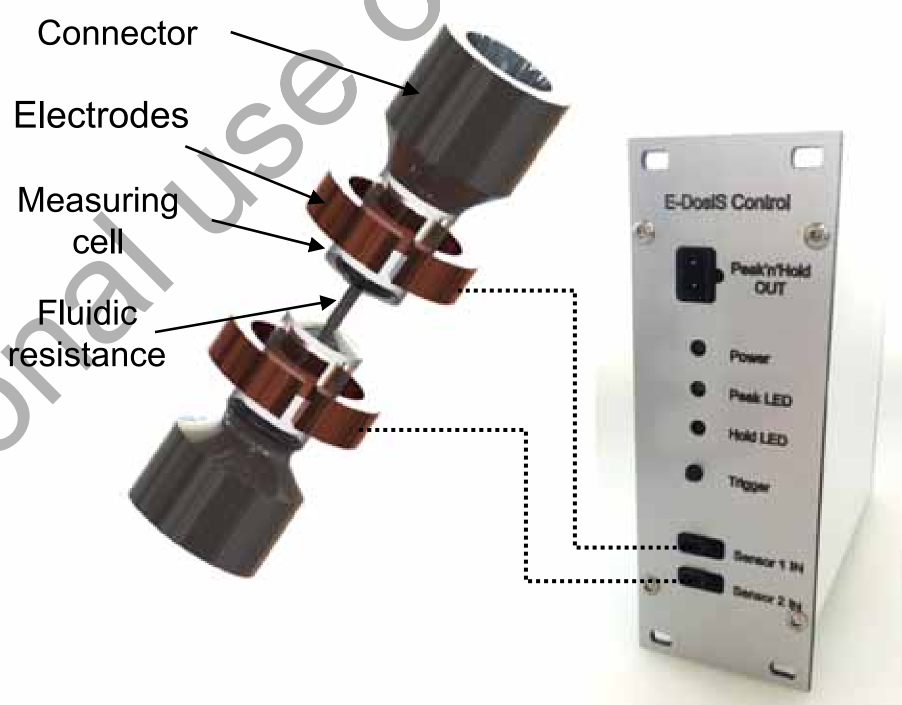
- Measuring cell
  - Low-cost polymer tube
- Fluidic resistance
  - Steel or polymer capillaries

Transducer

- Consists of the measuring cell and the electrodes

Sensor

- Consists of the transducer and the read-out electronics



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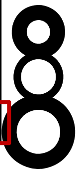
CFD Simulation of measuring cell

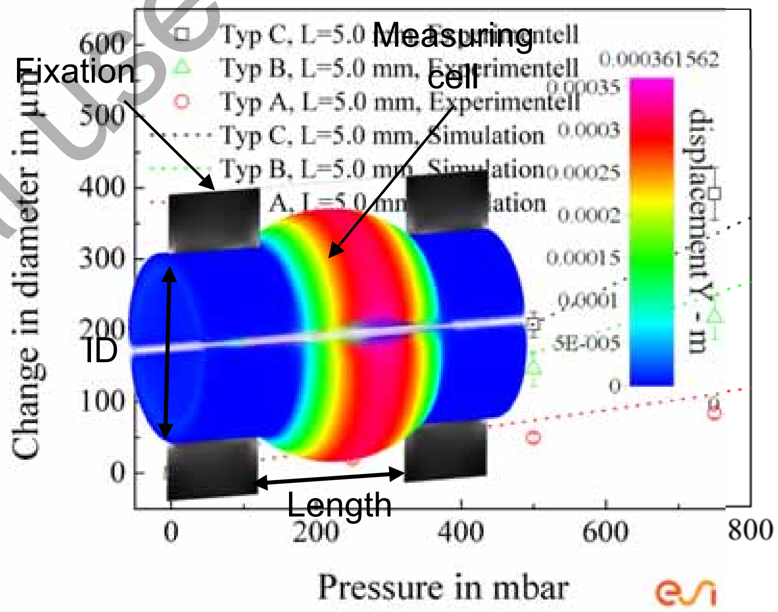
Parameter study

- Different inner diameter ID and wall thickness WS

Dimensions of the measuring cell considering commercially available tube material

Type	ID	WS	Change in outer diameter @500 mbar (simulated)
A	1,5 mm	0,2 mm	65,5 µm
B	1,9 mm	0,1 mm	191,87 µm
C	2,5 mm	0,2 mm	203,9 µm





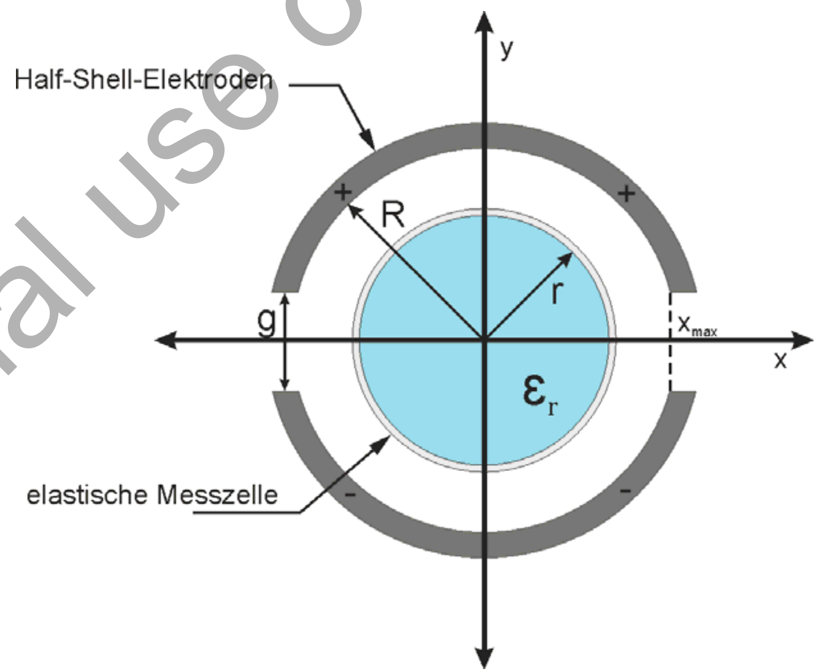
Influence of electrode geometry

Investigated electrode geometry

- Half-Shell type
- Seven variations studied (V1 – V7)

Parameters varied:

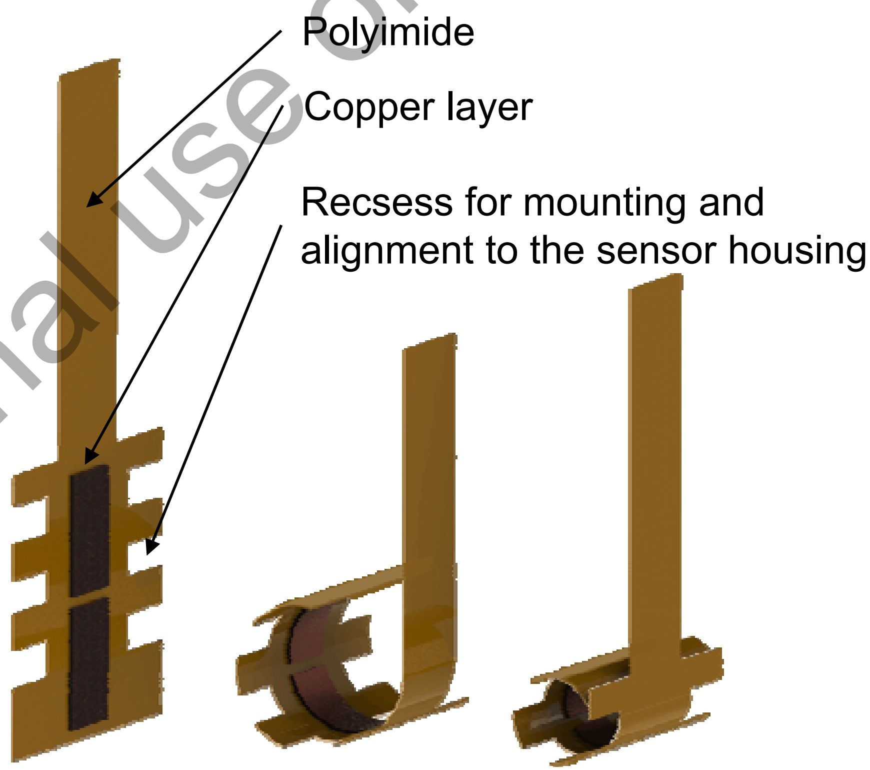
- Electrode diameter (d = 2R)
- Distance g between the electrodes
- Electrode area by varying the length of the half shell electrodes



Fabrication of the electrodes

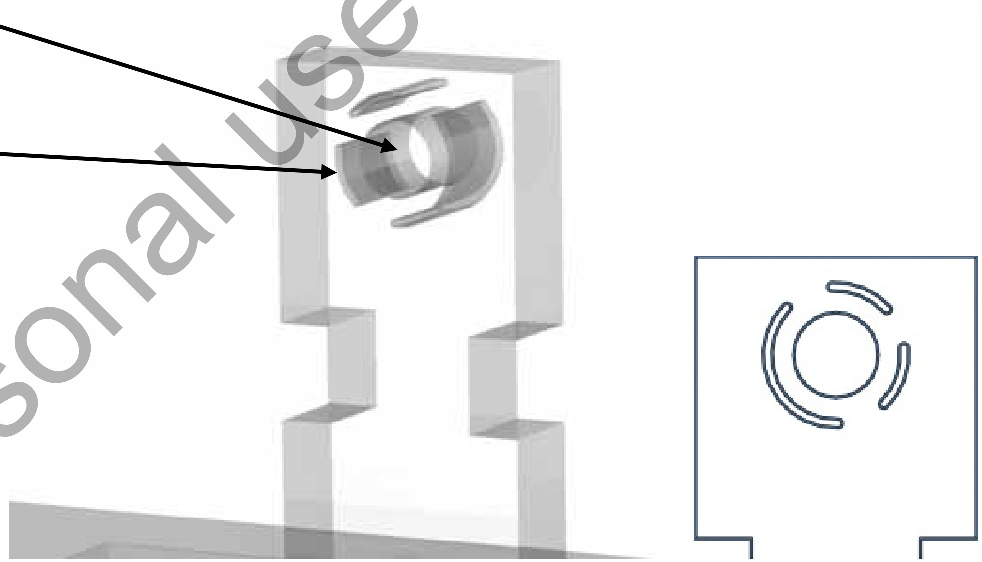
Based on flex boards

- Base material
  - Polyimide (50 µm)
- Electrodes
  - electrolytic ally deposited copper layer (35 µm)
- Half-shell arrangement of the electrodes by rolling up the plain flex boards
- Low material costs



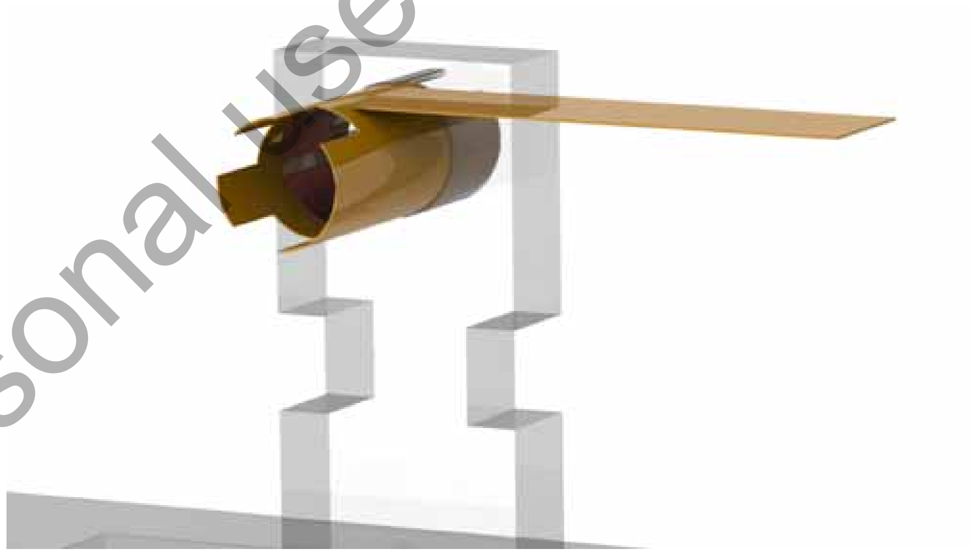
Fabrication of the pressure transducer

- Material: PMMA (tickness 4 mm)
- Opening for the measuring cell
  - D = 2,9 mm
- Recsess for mounting and alignment of the flex boards



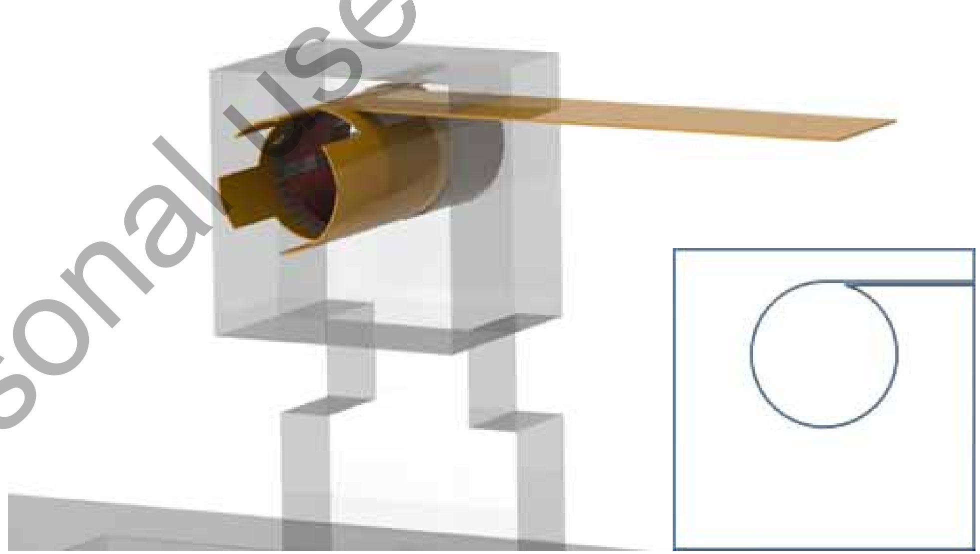
Fabrication of the pressure transducer

- Insertion of the flex board



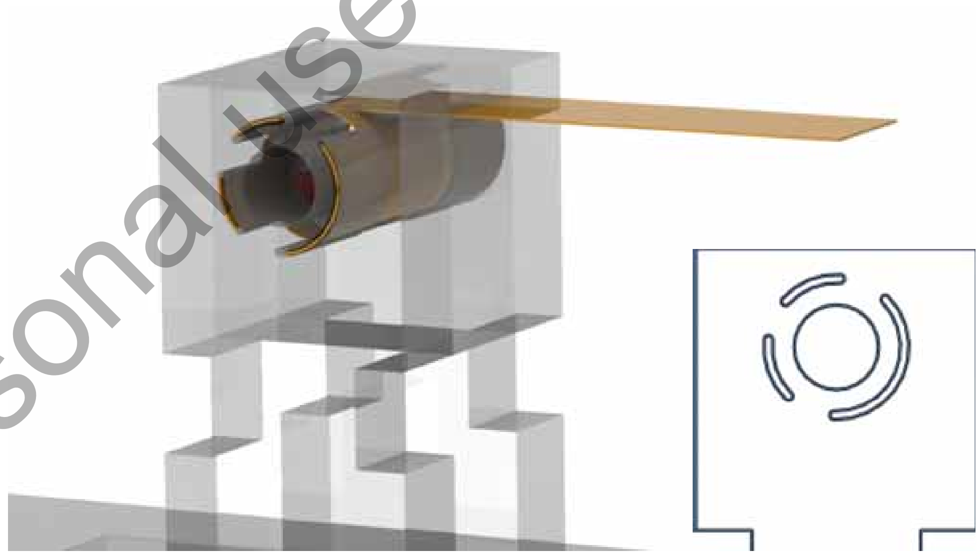
Fabrication of the pressure transducer

- Intermediate piece of PMMA for shape retention of the rolled electrode



Fabrication of the pressure transducer

- Attaching the second side part with recess for mounting and alignment of the flex boards



Fabrication of the pressure transducer

- Gluing the measuring cell into the PMMA holder

Measurement set-up

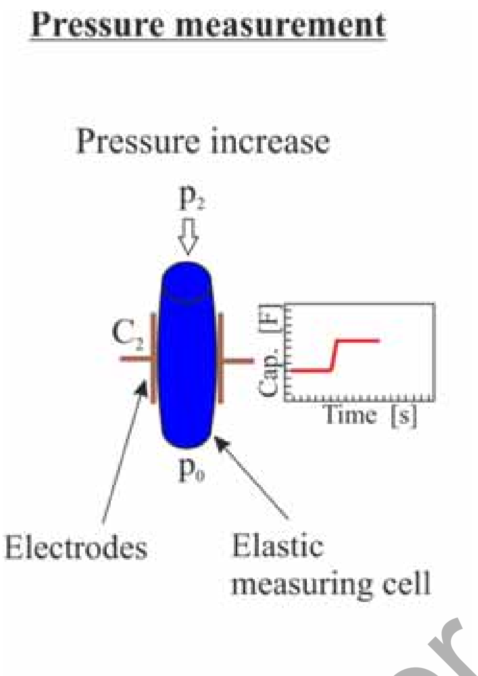
Transducer is connected to a pressure source

- Different pressure boundaries up to 50×10^3 Pa in 5×10^3 Pa steps

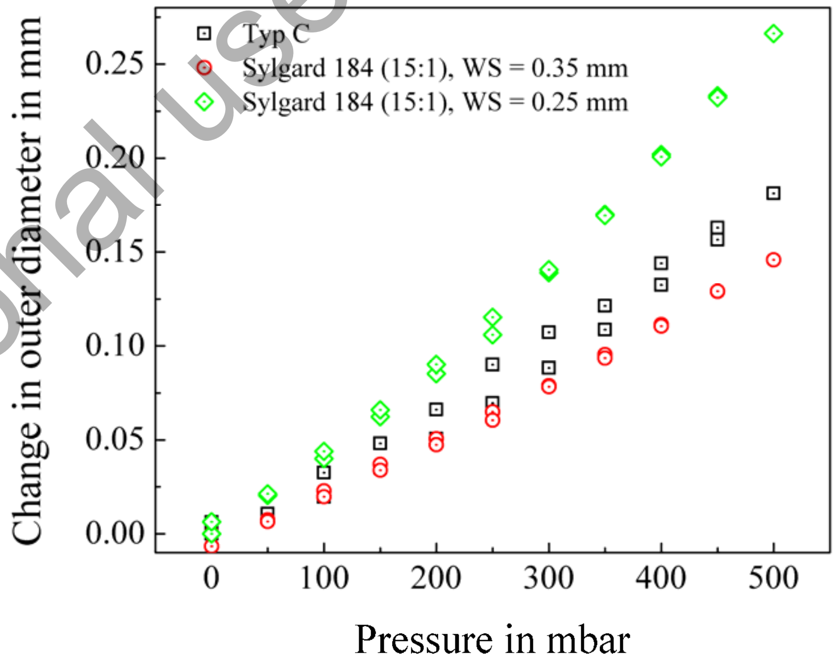
Transducer is filled with DI water with a liquid stop on the transducers second end

Capacitance is extracted applying the PCap02 capacitance-to-digital converter from ACAM.

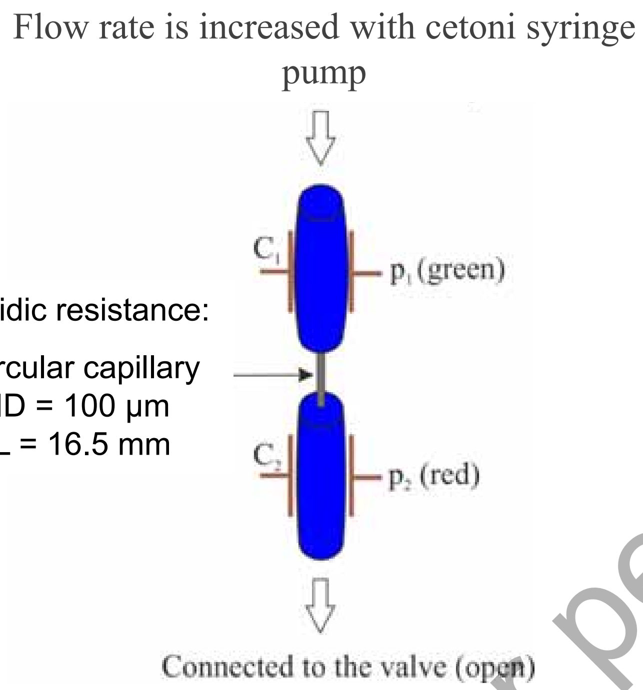
Proof-of-principle: Pressure sensor



Hysteresis can be overcome by the right material choice

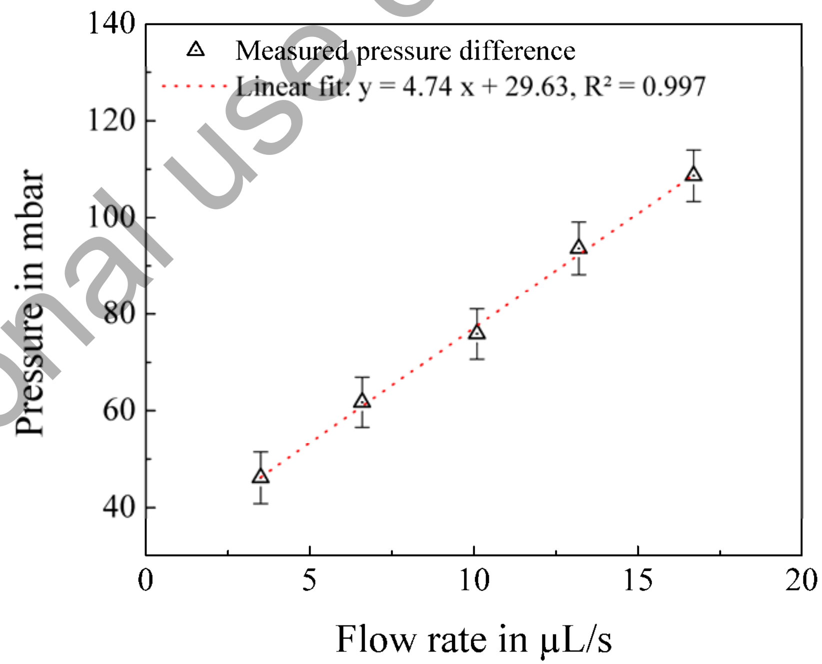


Proof-of-principle: Flow sensor



Fluidic resistance:

Circular capillary
ID = 100 µm
L = 16.5 mm



Outline

Project concept

Measurement principle

Two transducer concepts

Results

Summary

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Achievements

- Expansion behavior of the measuring cell was evaluated (simulation and experiment)
- Hysteresis effect of the measuring cell was optimized by material selection
- Influence of electrode geometry was evaluated (simulation and experiment)
- Proof-of-principle of a pressure transducer is demonstrated
  - Pressure range with current prototypes: 50 – 500 mbar
  - Resolution: ~ 10 mbar
- Proof-of-principle of a flow transducer is demonstrated
  - Flow range with current prototypes: 3µl/s – 280µl/s (0.18 ml/min – 16.8 ml/min)
  - Resolution: ~ 2 µl/s

Outlook

- Reliability testing & optimization of sensor specifications according to requirements

Thank you!

BioFluidiX
- Project coordination
- Electronic & Periphery
- Implementation of a control algorithm

B. BRAUN
Molding your visions
- Injection molding of the EM valve / sensor parts

IMTEK
- Sensor design and implementation
- Fluidic characterization of all components

Sponsored by: VDI/VDE-IT & BMBF

END