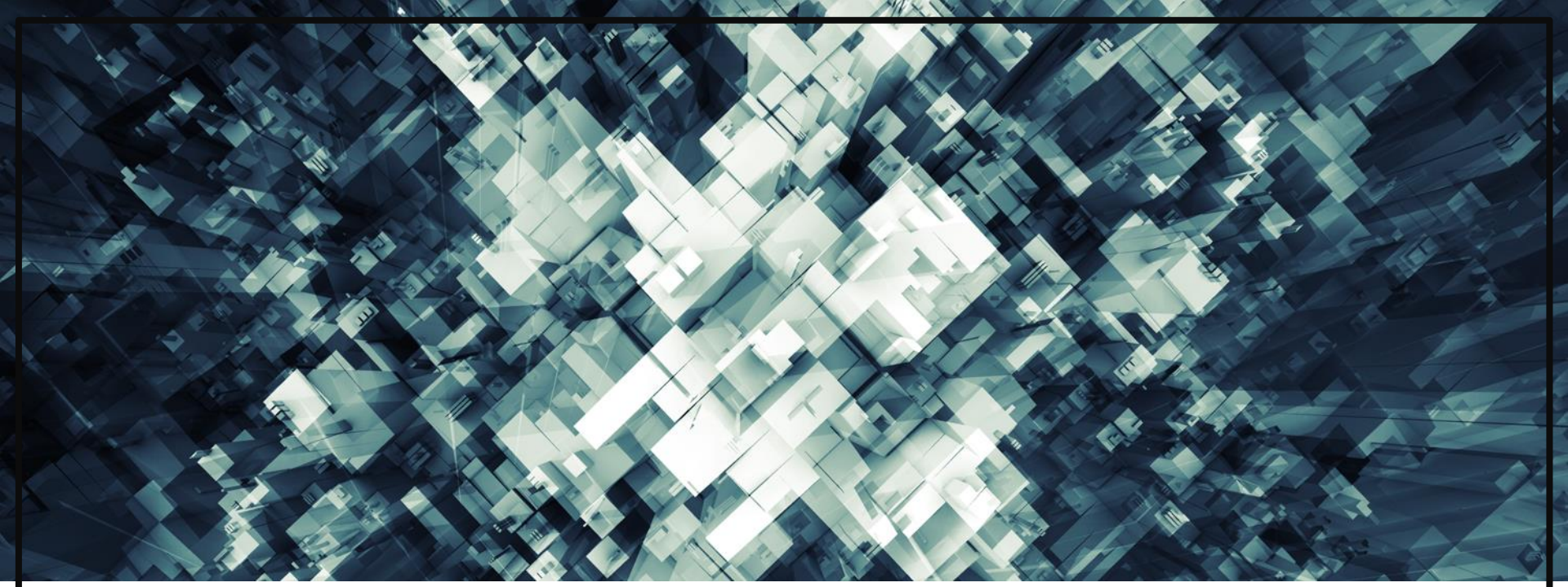

Development of paper-based lab-on-chip devices based on molecularly imprinted polymers

By Frederik Vreys

Promotor: Ronald Thoelen

Co-promotor: Anitha Ethirajan

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IMO-IMOMEC

UHASSELT imec

Introduction

Heat-transfer method for lab-on-chip applications

Small reaction chamber

faster analysis & response times

low fluid volumes consumption

safer platform

massive parallelization

lower fabrication costs

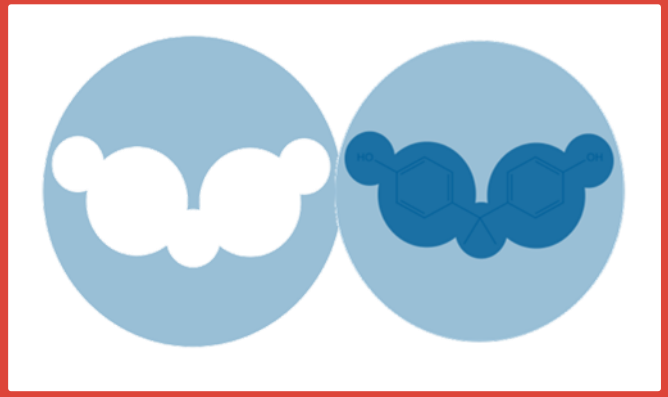
cost-effective disposable chips

Key ingredients

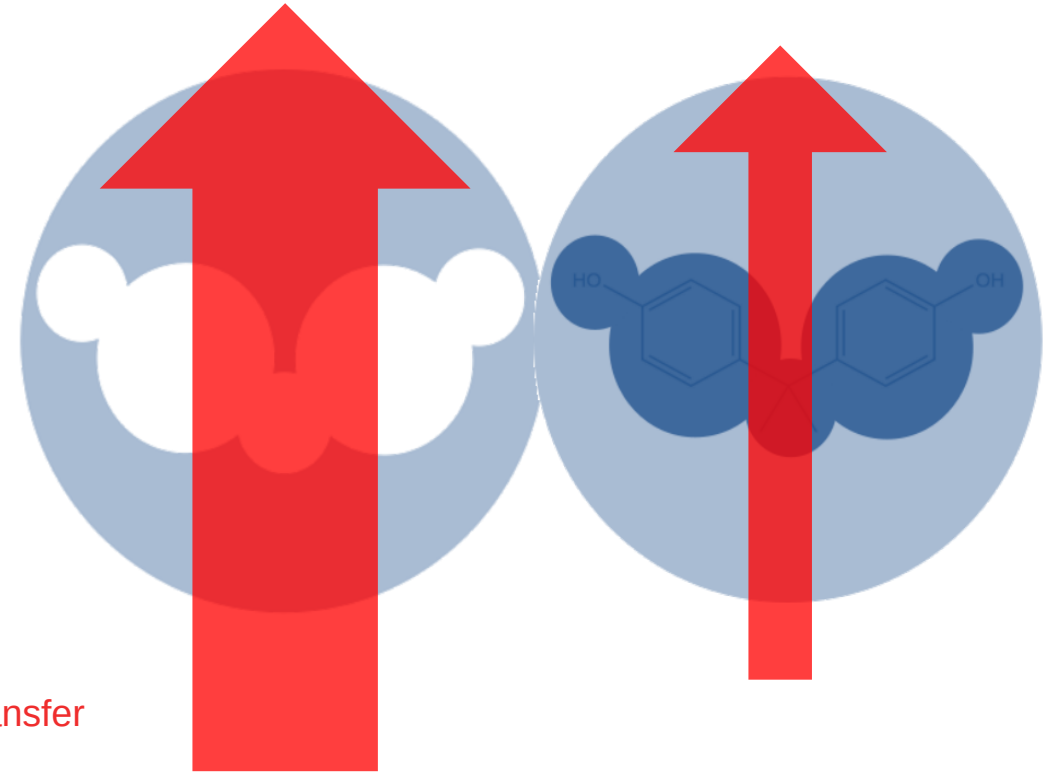
Heat-transfer method for lab-on-chip applications

TRANSDUCER:
THERMAL BASED

RECEPTOR:
MOLECULARLY
IMPRINTED POLYMERS

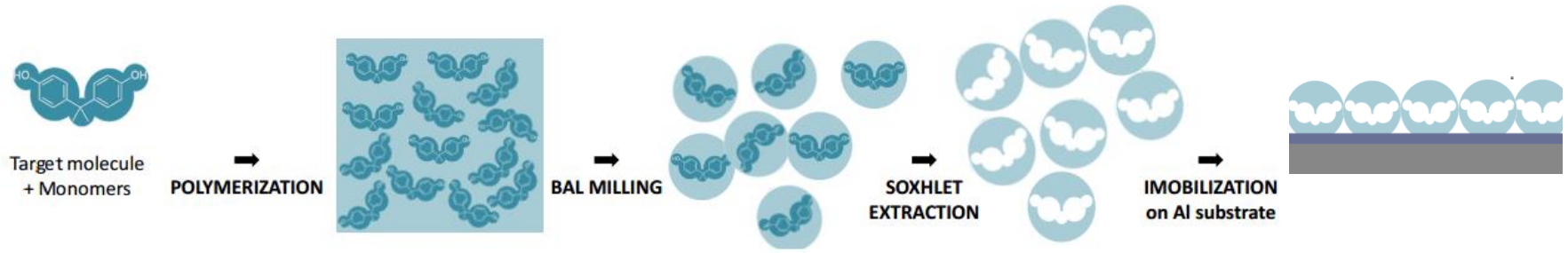


PORE-BLOCKING MODEL



Heat-transfer

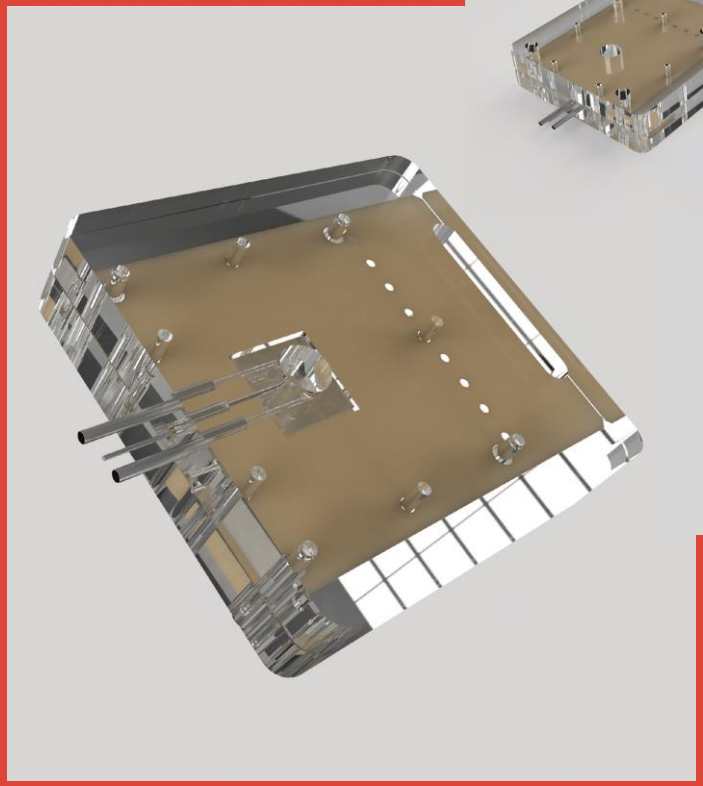
SYNTHETIC RECEPTOR:
MOLECULARLY IMPRINTED POLYMER (MIP)

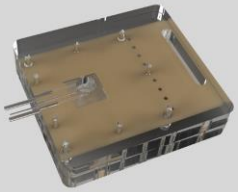


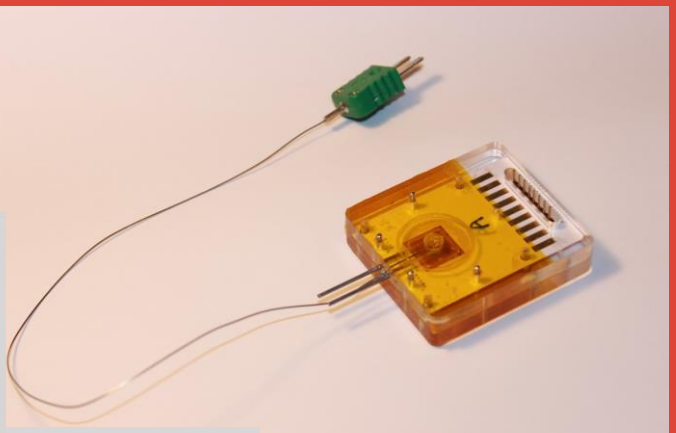
Bulk MIP production process

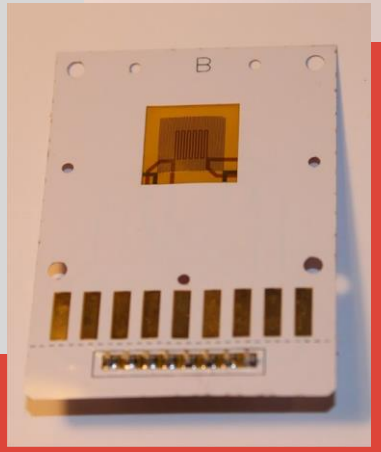
TRANSDUCER

Heat-transfer method







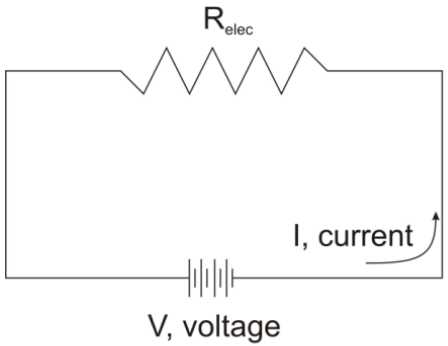


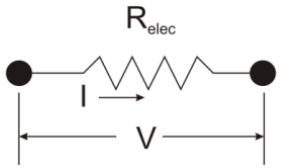
IMO-IMOMEC

UHASSELT imec

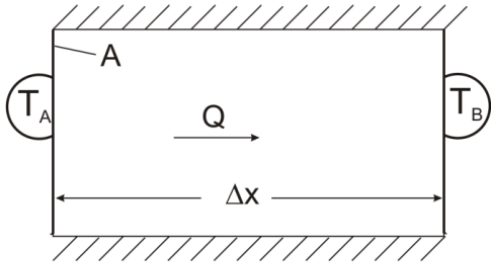
PRINCIPLE:
HEAT-TRANSFER RESISTANCE

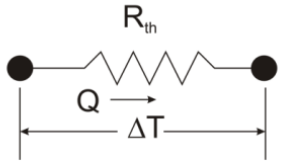
Electric resistance/impedance





Heat-Transfer resistance





PRINCIPLE:
HEAT-TRANSFER RESISTANCE

Electric resistance/impedance

Reason: voltage **V** [V]

Result: current **I** [A]

$$= \frac{charge}{time} \quad [A = \frac{1\,C}{s}]$$

Ohmic resistance: $\mathbf{R} = \frac{V}{I}$ $[\Omega]$

Heat-Transfer resistance

Reason: temperature difference $\mathbf{T_A - T_B}$

Result: thermal current **P** [W]

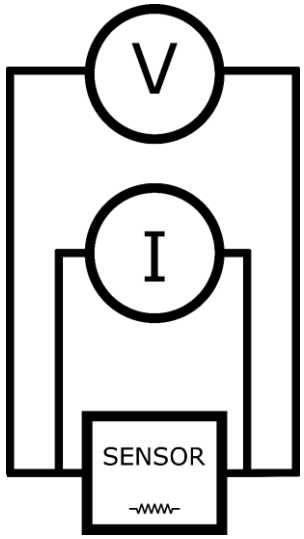
$$= \frac{energy}{time} = \text{power} \quad [W = \frac{1\,J}{s}]$$

Thermal resistance: $\mathbf{R_{th}} = \frac{\mathbf{T_A - T_B}}{P}$ $[\frac{^\circ C}{W}]$

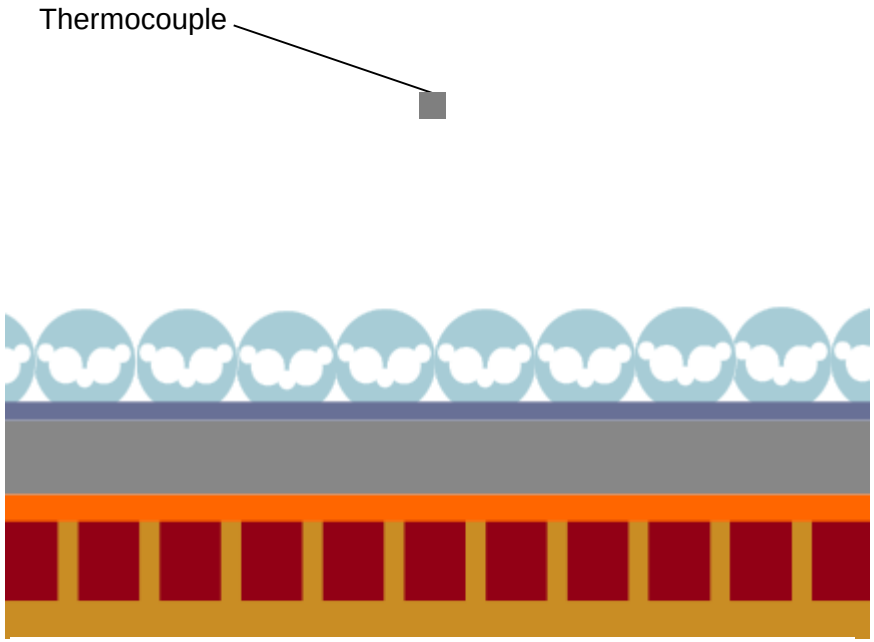
READ-OUT:
HEATING ELEMENT

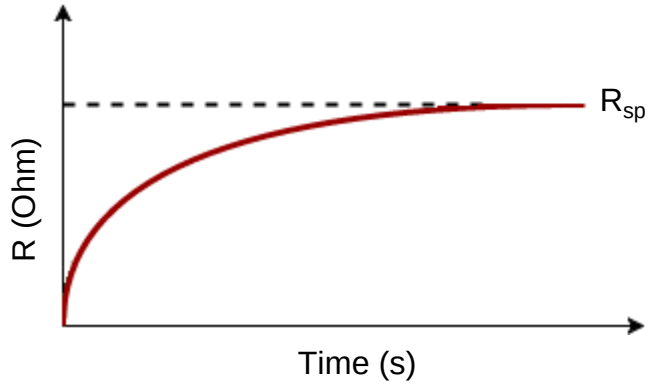
- 4-wire measurement
  - Source current
  - Measure voltage
- Temperature coefficient of resistance (TCR)

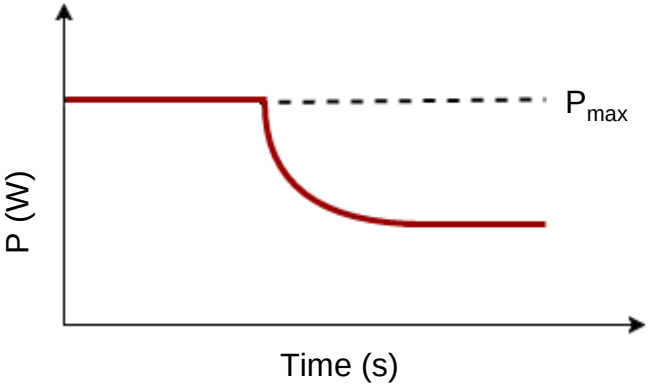
$$R = R_{ref}\,[\,1 + \alpha\,(T - T_{ref})] \quad [\Omega]$$



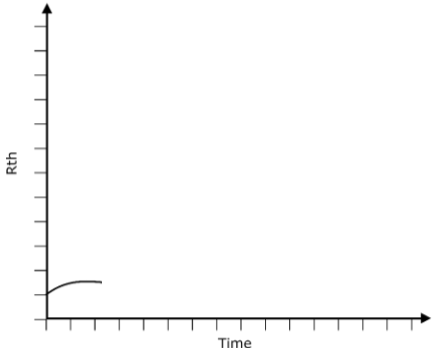
READ-OUT:
WORKING PRINCIPLE



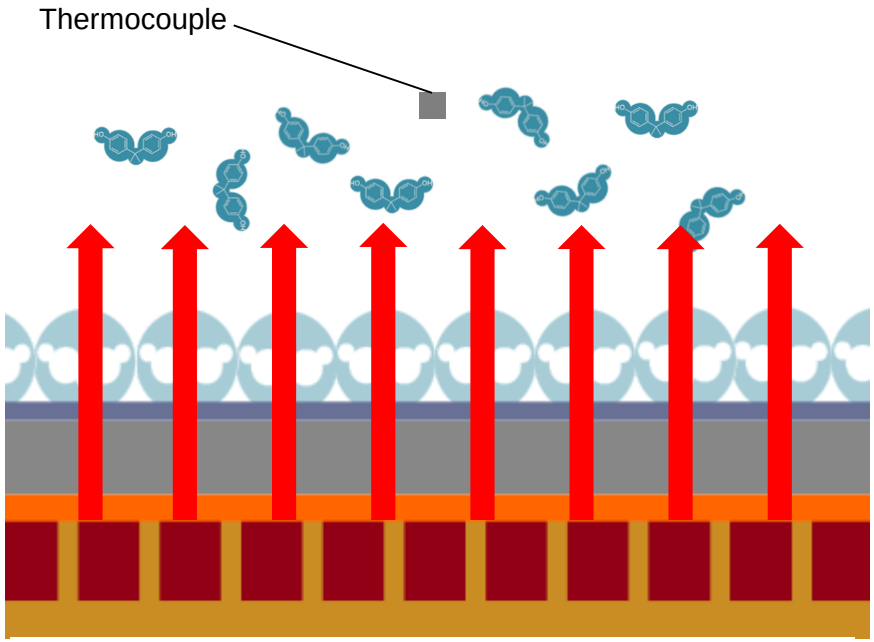


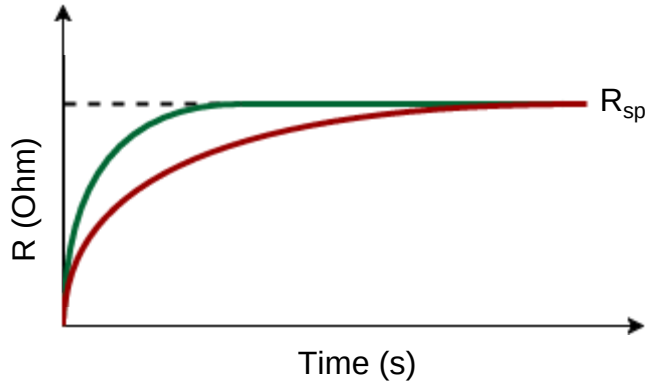


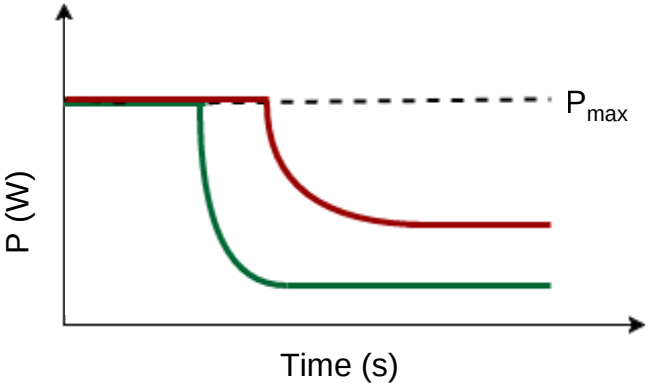
$$R_{th} = \frac{T_A - T_B}{P} \left[\frac{°C}{W}\right]$$



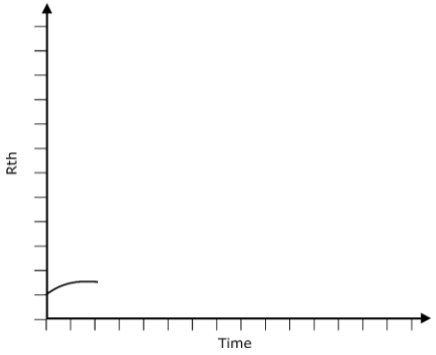
READ-OUT:
WORKING PRINCIPLE





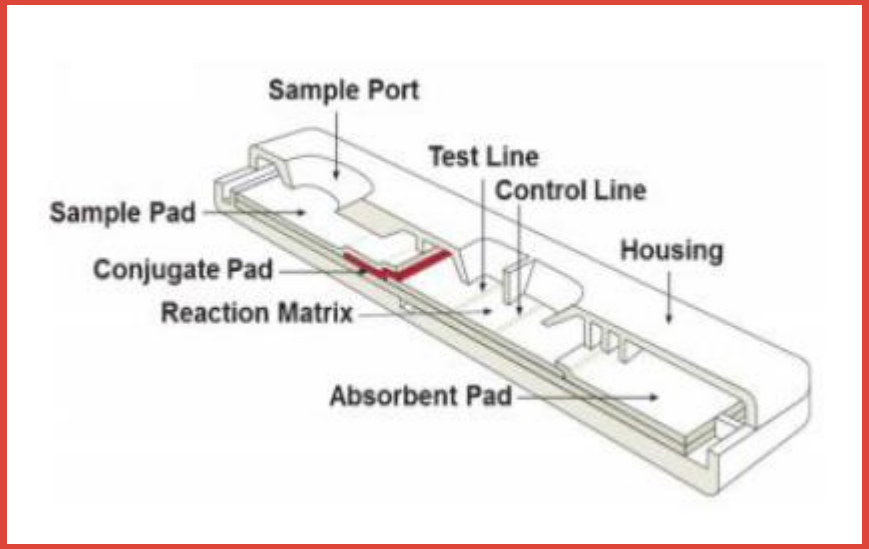


$$R_{th} = \frac{T_A - T_B}{P} \left[\frac{^\circ C}{W}\right]$$



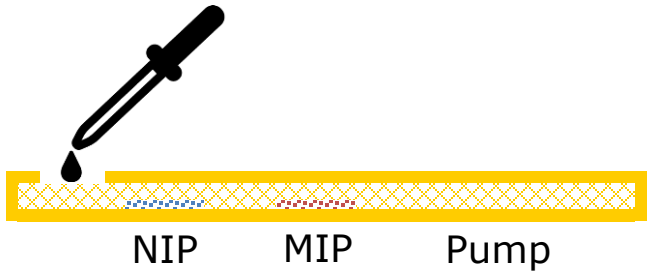
POINT-OF-CARE

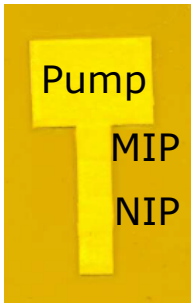
Paper-based microfluidics



DESIGN & DEVELOPMENT

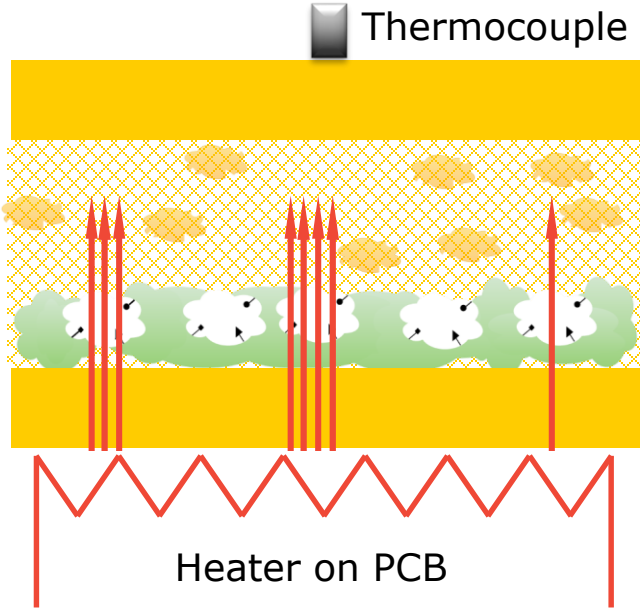
Materials
Kapton tape as sealant and MIP adhesive
Low thermal resistance
Bisphenol-A MIPs
Whatman Nr 1. Filter paper
Methods
Laser cut filter paper
µPad contains pump/absorbent pad
20µL absorbing capacity
120 sec / measurement



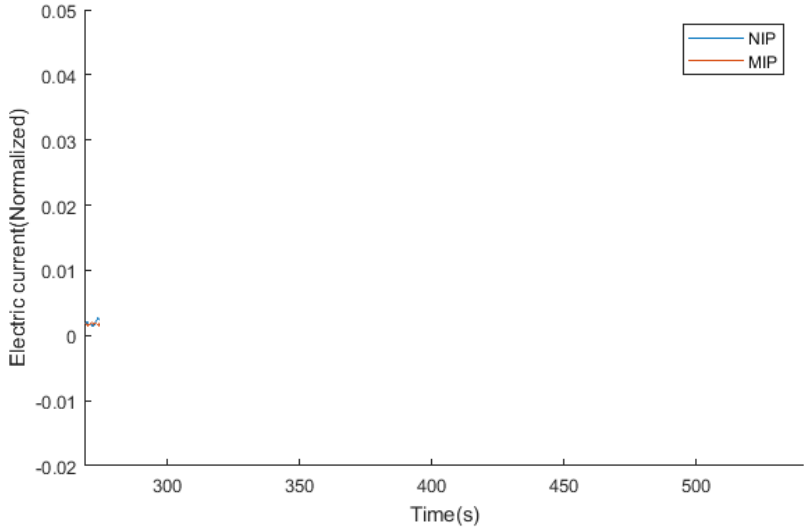


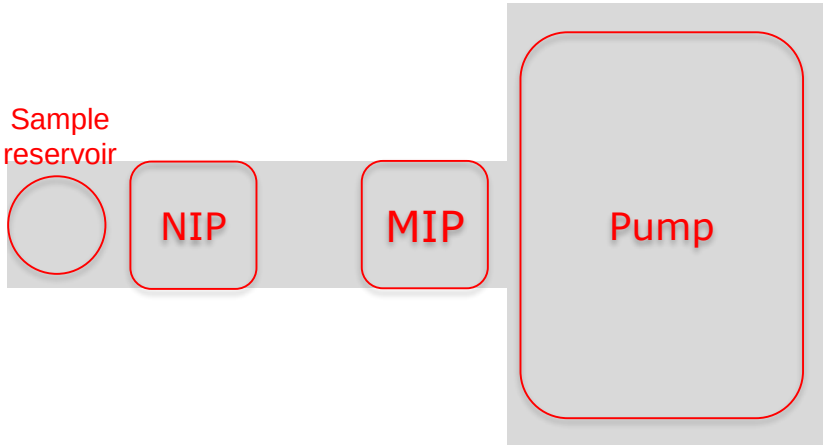
µPAD

READ-OUT:
WORKING PRINCIPLE



PROOF-OF-PRINCIPLE: BISPHENOL-A





CONCLUSIONS & OUTLOOK

- Fast, disposable
- Point-of-care
- Cross-referencing with impedance spectroscopy

THANK YOU!