THERMAL BASED DETECTION OF BISPHENOL-A BY INCORPORATING MOLECULARLY IMPRINTED POLYMERS

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bioinspired materials 2017

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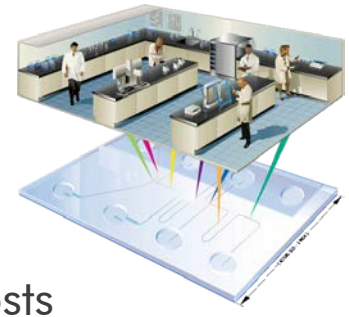
INTRODUCTION

Thermal based sensors 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

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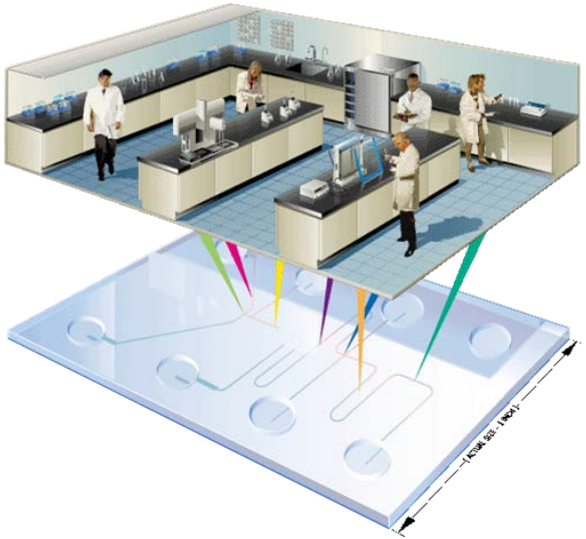

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KEY INGREDIENTS

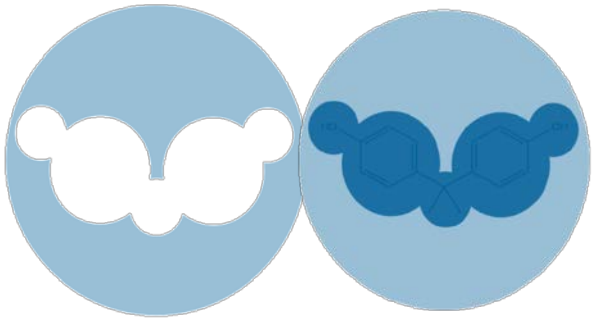
HTM & MIP

TRANSDUCER:

THERMAL BASED

RECEPTOR:

MOLECULARLY IMPRINTED POLYMERS



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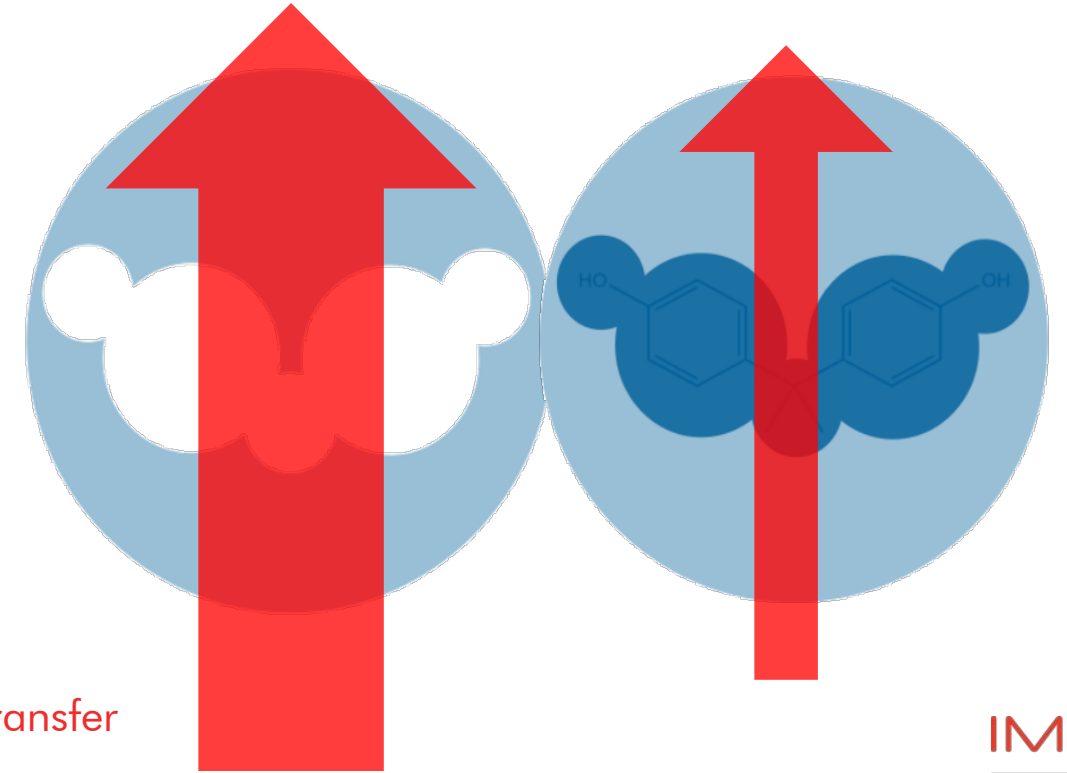
PORE-BLOCKING MODEL



Heat-transfer

P. Wagner *et al.*, *Anal Bioanal Chem*, vol. 405, pp. 6453–6460, 2013.

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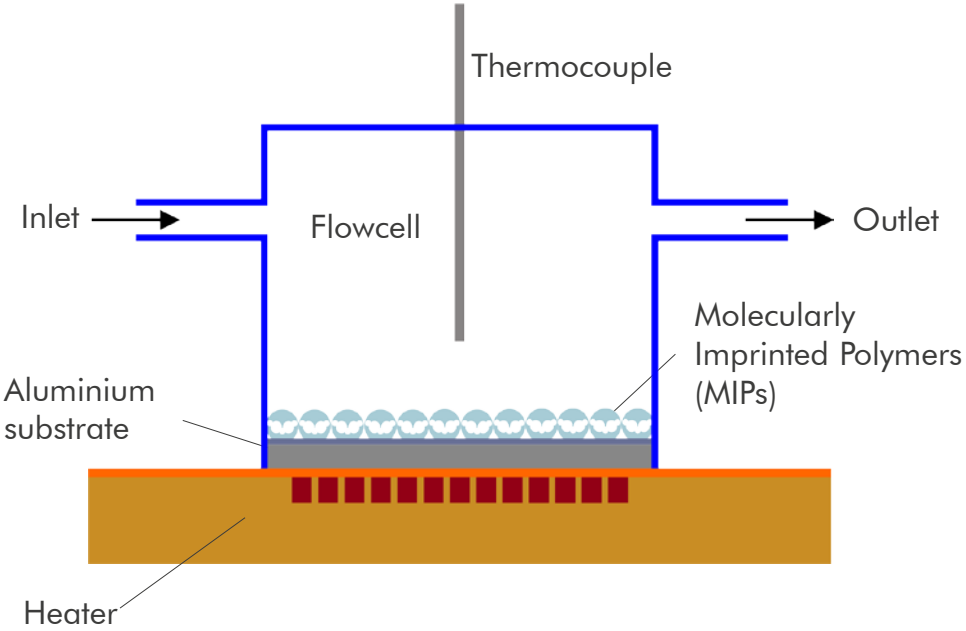
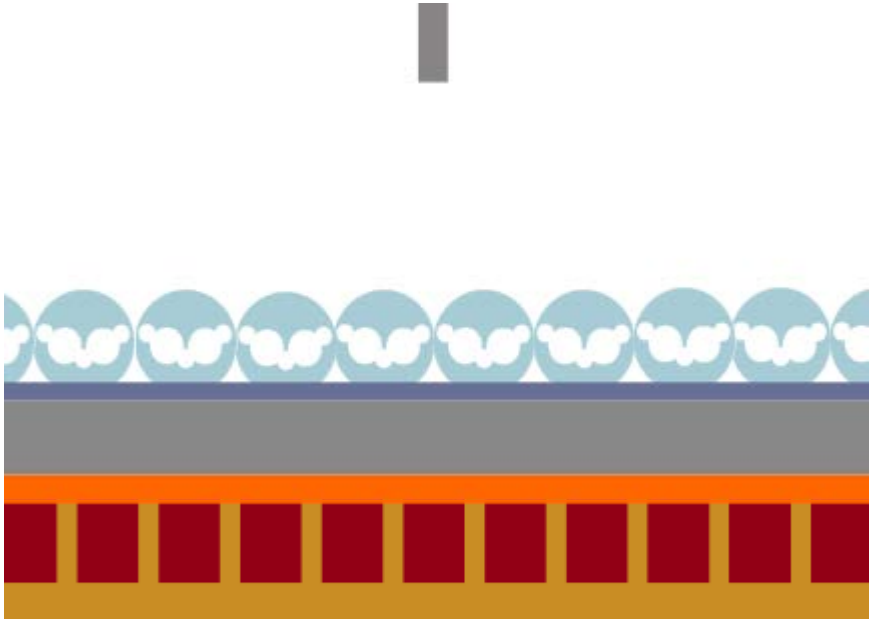
SYNTHETIC RECEPTOR TO SENSOR

HTM BIOSENSOR SETUP

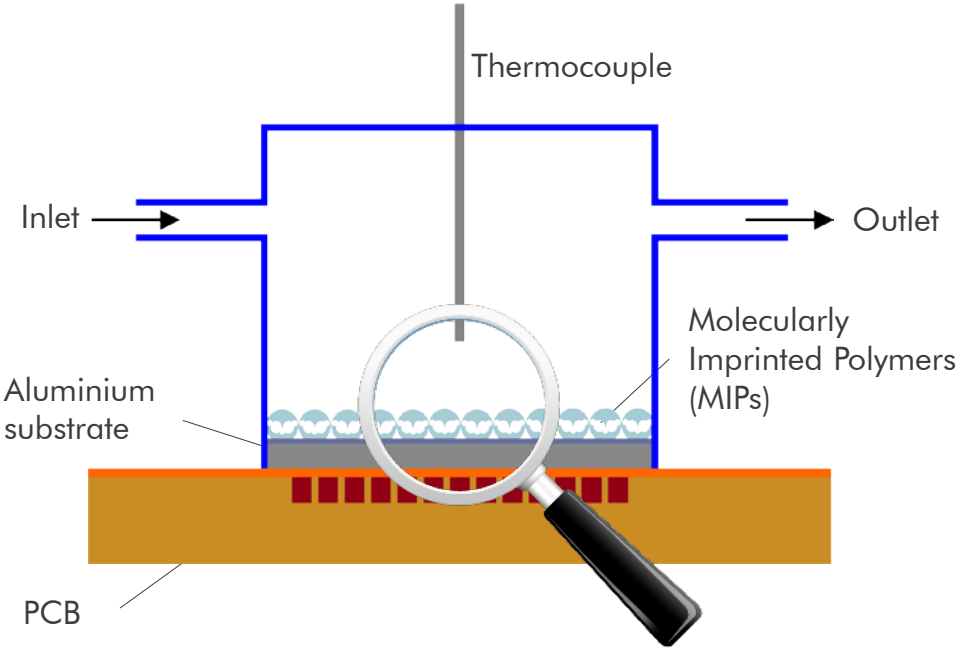
MARK 2

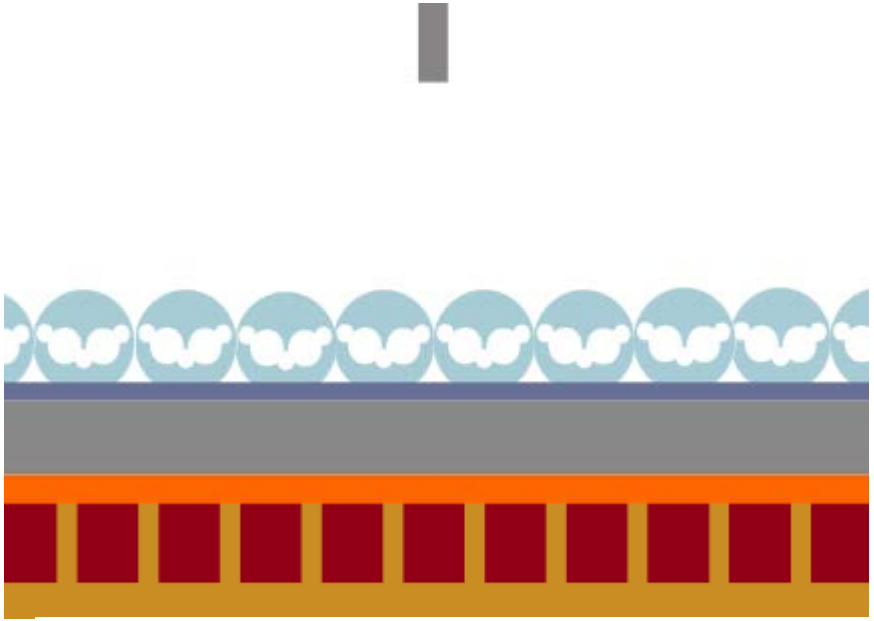




HTM BIOSENSOR SETUP

WORKING PRINCIPLE





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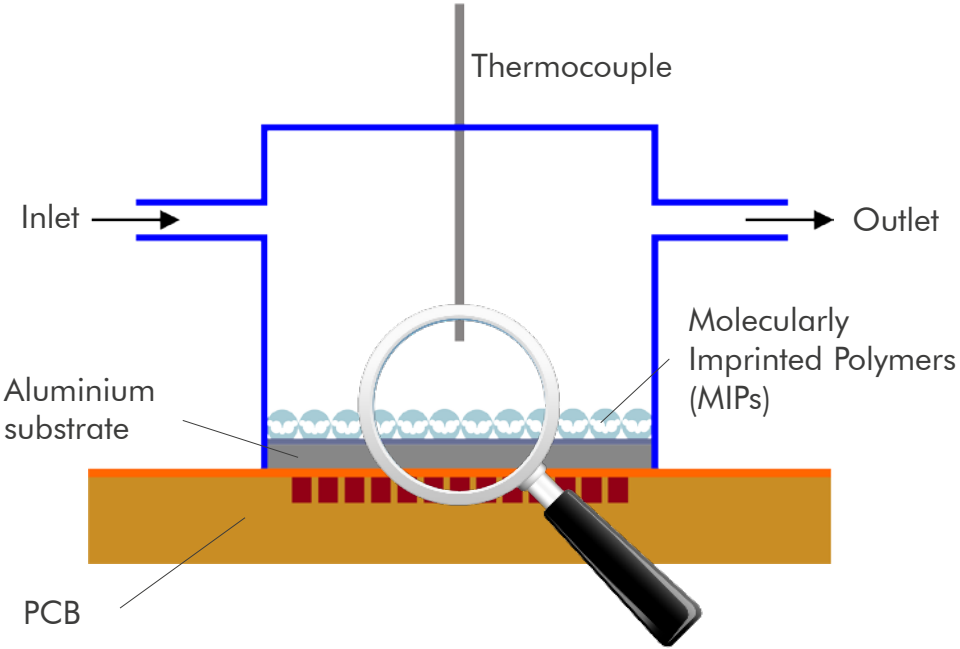

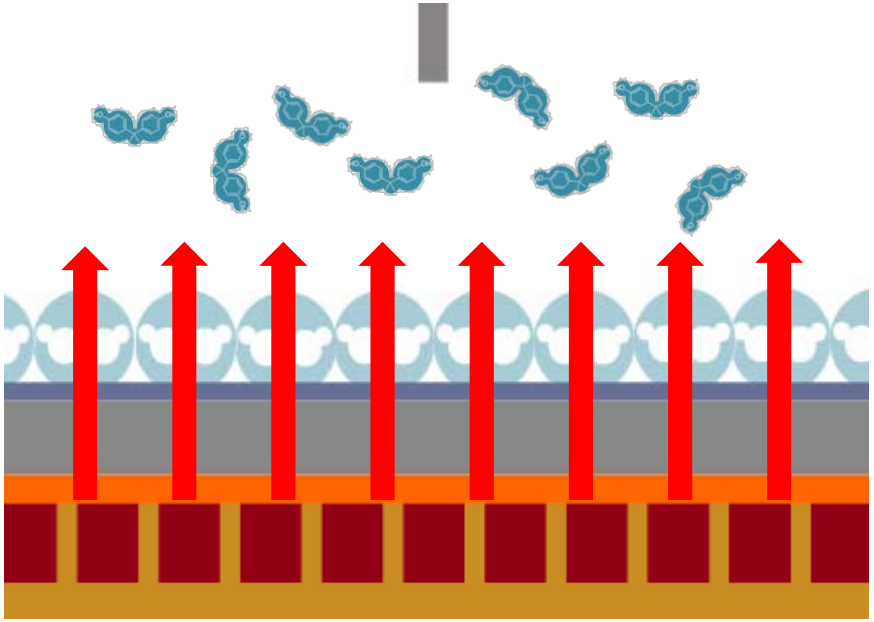

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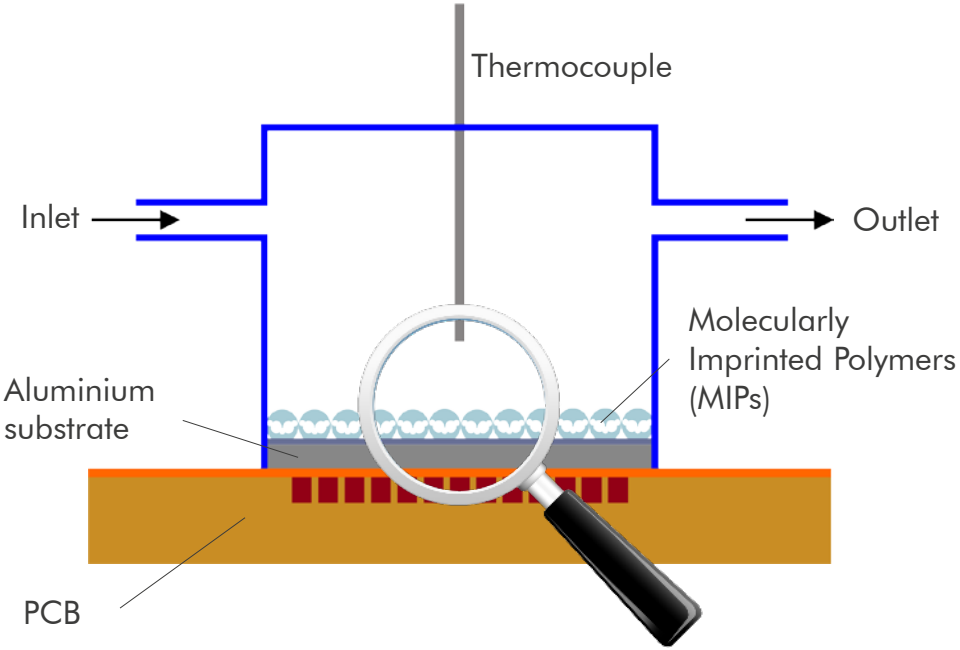
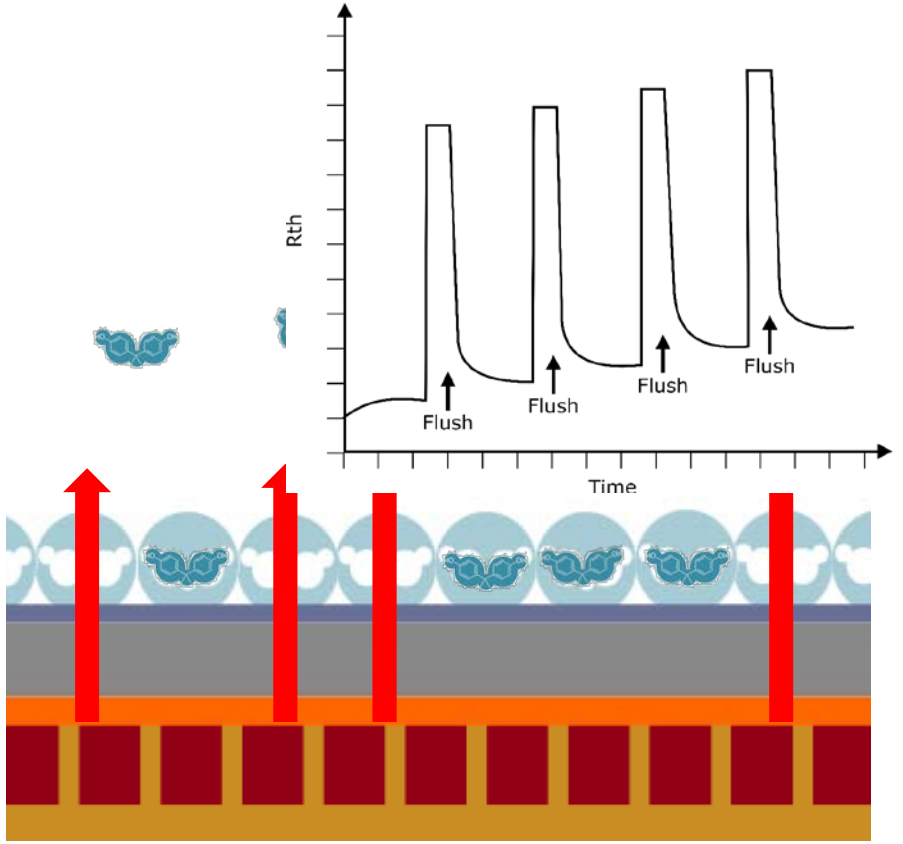
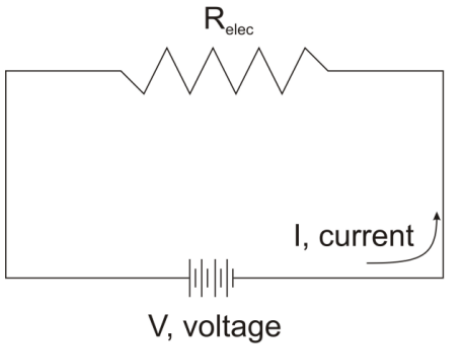


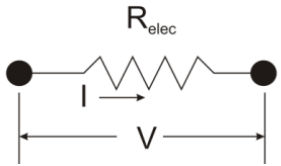


READ-OUT

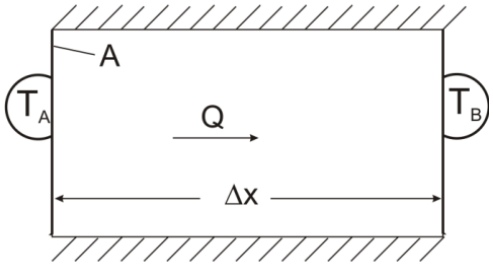
HEAT-TRANSFER RESISTANCE

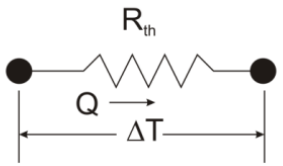
Electric resistance/impedance





Heat-Transfer resistance





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READ-OUT

HEAT-TRANSFER RESISTANCE

Electric resistance/impedance

Reason: voltage **V** [V]

Result: current **I** [A]

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

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

Heat-Transfer resistance

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

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

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

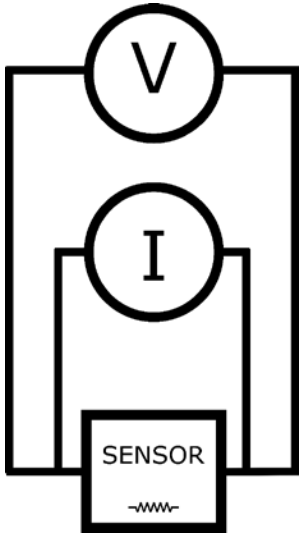
Thermal resistance: $\mathbf{R_{th}} = \frac{\mathbf{T_A - T_B}}{\boldsymbol{P}}$ $[\frac{^\circ C}{W}]$

READ-OUT
HEATING ELEMENT

- 4-wire measurement
  - Source current
  - Measure voltage

- Temperature coefficient of resistance (TCR)

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



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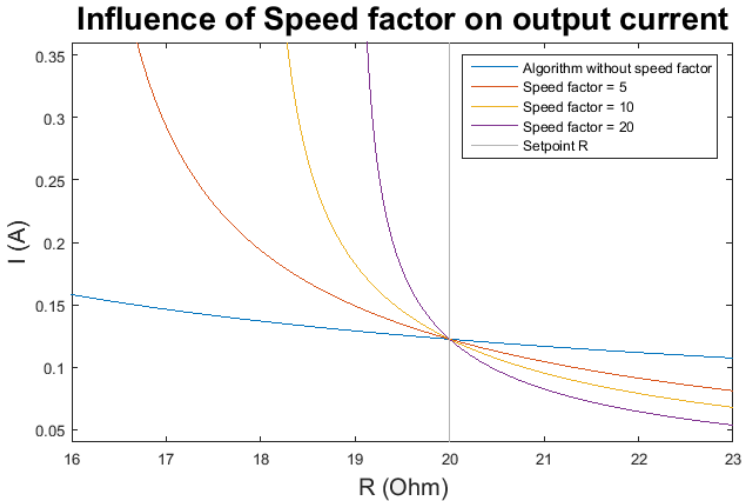
READ-OUT
CONTROL ALGORITHM

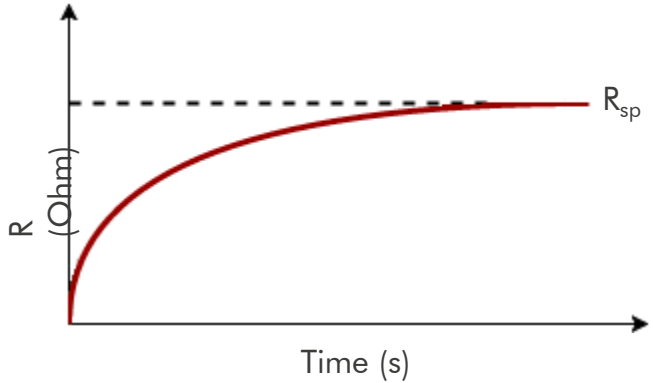


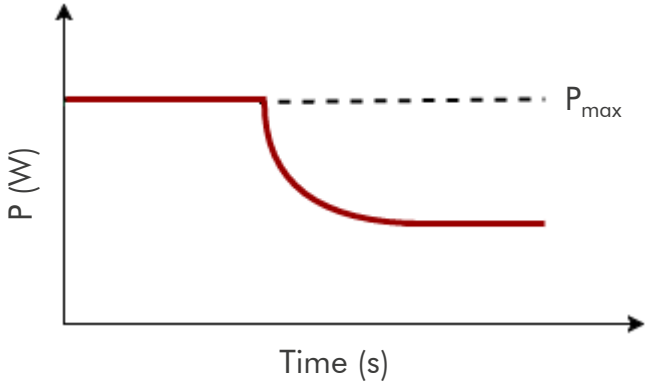
Feed forward sensor control

$$I = \sqrt{\frac{P}{\left[R - \left(R_{sp} - R\right)\right] * \left[\left(E_{ptc} * (-S)\right) + 1\right]}}$$

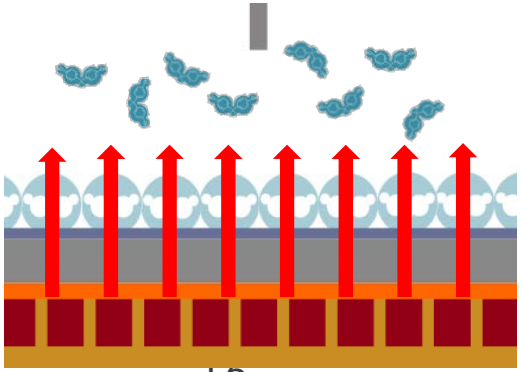
- E_{ptc} = percentage error
- S = “Speed factor”

READ-OUT
CONTROL ALGORITHM





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



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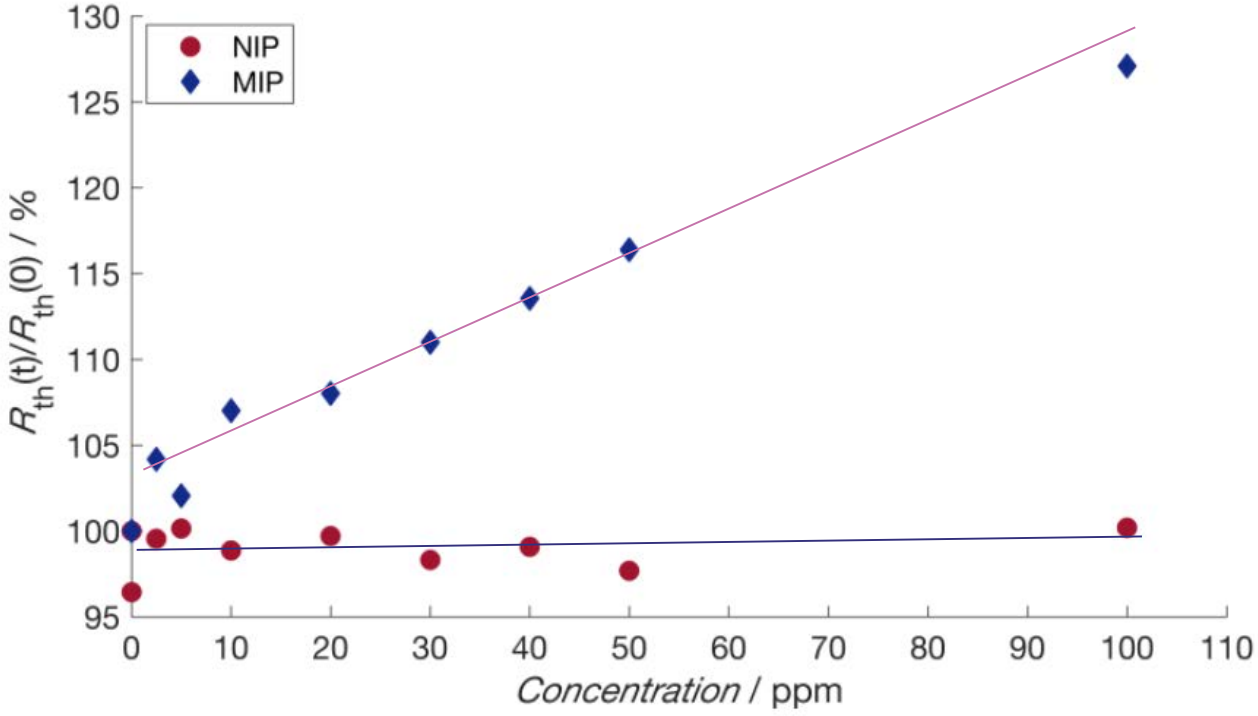
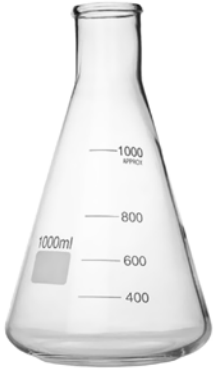
RESULTS: DOSE-RESPONSE

BISPHENOL-A IN PBS BUFFER



RESULTS: COMPLEX MATRICES

BISPHENOL-A IN MILK



Towards complex matrices

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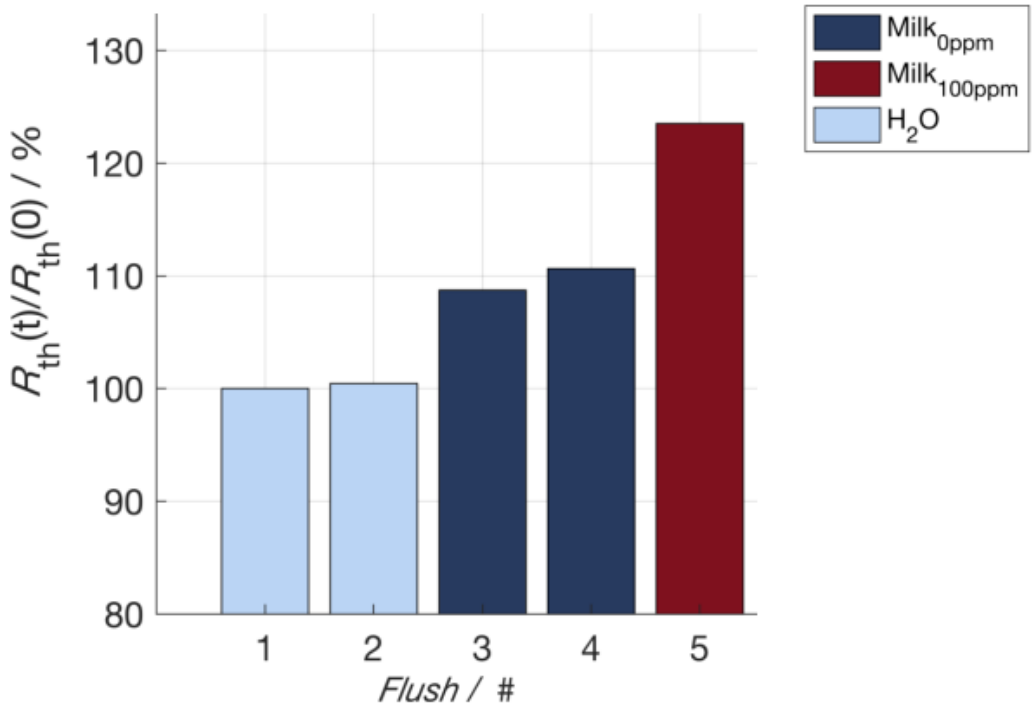
RESULTS: COMPLEX MATRICES

BISPHENOL-A IN MILK



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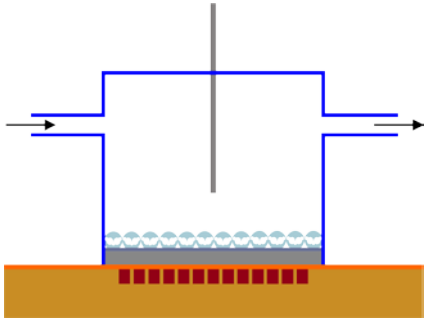
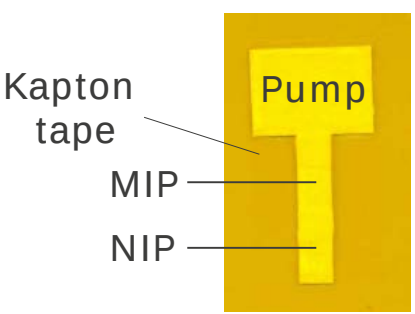
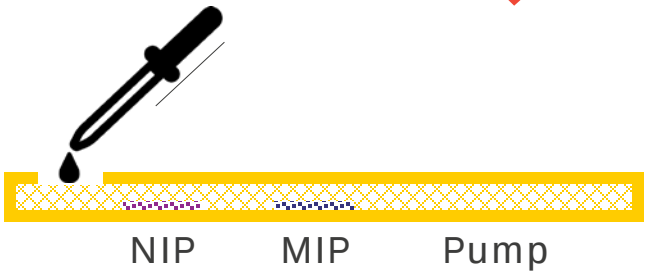
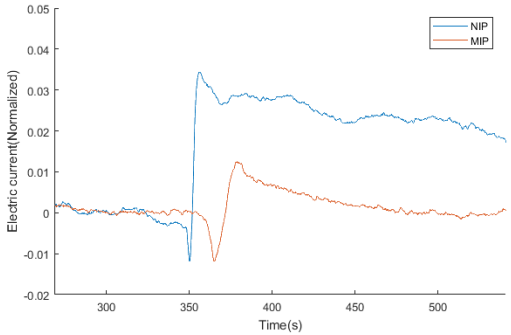
ON GOING
SENSOR DESIGN



Towards disposable sensors



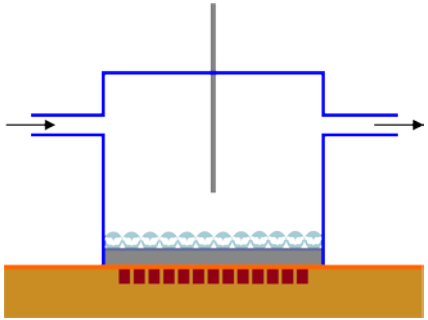




Paper-based microfluidics

ON GOING

SENSOR DESIGN



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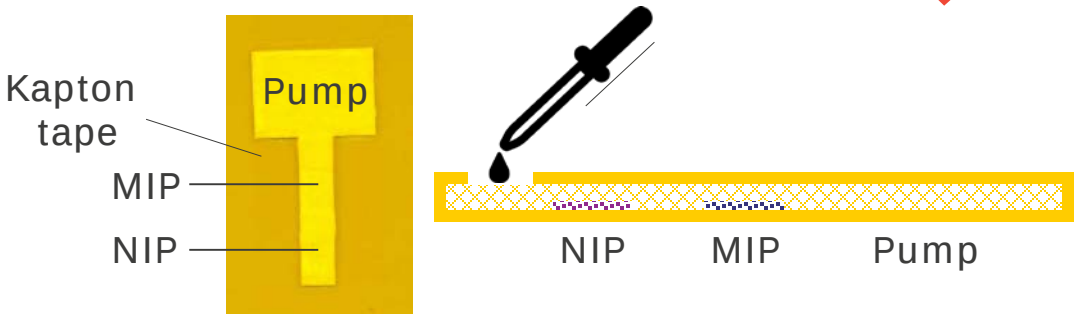
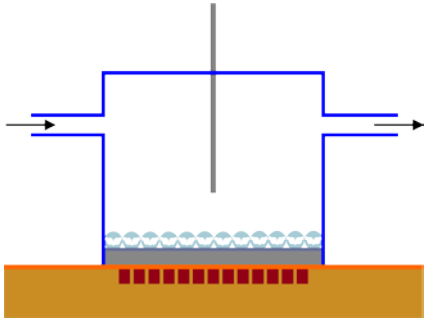


Paper-based microfluidics

POSTER 31

ON GOING
SENSOR DESIGN



Towards disposable sensors

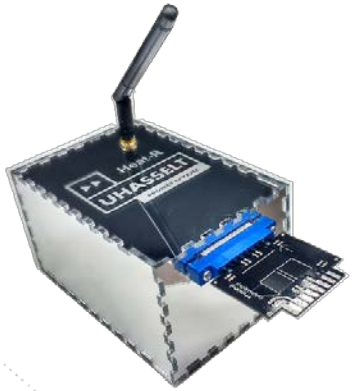
Low cost flexible heaters

ON GOING
SENSOR DESIGN

Benchtop devices

Custom dedicated setup

Custom hardware



CONCLUSIONS

- INTRODUCTION TO A NEW BIOSENSOR PRINCIPLE
- POSSIBILITIES FOR LAB-ON-CHIP APPLICATIONS
- BENEFITS: LABEL FREE, SIMPLE ELECTRONICS, DISPOSABLE SENSING, NO EXTERNAL INFLUENCES, DIRECT SIGNAL

THANK YOU

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PRD
POLYMER REACTION DESIGN

BIOMEDICAL DEVICE ENGINEERING

fwo Research Foundation Flanders
Opening new horizons