

TAC meeting Report on progress, ongoing work and outlook

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List of content

DONE:

- Microfluidic design and first FET sensors
- β-galactosidase/ONPG assay
- Circular microfluidics
- Smart catheters
- Other activities

UPCOMING WORK:

- Incubation bio-assay and monitoring
- Plans and outlook

- Soft lithography
- UV lithography
- Laser lithography
- EBL
- SEM
- Microfluidic operation
- Microscopy
- Voltammetry, amperometry, electrochemistry

Learned techniques

- Origin
- Clewin
- COMSOL Multiphysics
- 3ds MAX
- EAGLE
- Device operation softwares



Motivation:

• Towards miniaturized lab on a chip solution for real biochemical detection and monitoring applicable for medical and biochemical analysis

Aim:

 To design assembly of functional microfluidic device and sensor element in order to manipulate and monitor enzymatic reaction and analyze ionic changes

Motivation and aim



Concept figure









Colorimetric assay (color change due to reaction)

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Motivation and aim

β-galactosidase is an exoglycosidase which hydrolyses the β -glycosidic bond formed between a galactose and its organic moiety. To define activity of in vitro β -galactosidase, lactose was exchanged with synthetic analogue: ONPG. Formed ONP has absorption peak at 420nm wavelength;









formation frequency.

Main approach - to tune flow rate in order to change the time in which droplets with the reaction inside reach the sensor.

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Photo of the chip, SEM images of the sensor and honeycomb structure



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β-galactosidase/ONPG assay: sensor

- 16 FET in a row
- Ag/AgCl modifies gate electrode
- SU8 passivation of the chip





β-galactosidase/ONPG assay: sensor characterization



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β-galactosidase/ONPG assay: reference measurements



Colorimetric assay as reference measurement

Conductivity assay as reference measurement





β-galactosidase/ONPG assay: result

- Several time points of the reaction
 - <u>Streaming</u> potential is <u>subtracted</u>
 - Measured at two fixed [**β**-gal]
 - Kinetics of the reaction. The reaction rate is associated with the shift of Isd vs time in dependency on [ONPG] and [β-galactosidase]





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β-galactosidase/ONPG assay: result

Kinetics map of the reaction for different time points, concentrations and peak values



β-galactosidase/ONPG assay: outcome and perspective





Article Nanosensors-Assisted Quantitative Analysis of **Biochemical Processes in Droplets**

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Findings and perspective:

- addressing flow rate is <u>not</u> the best strategy for reaction monitoring
- lots of data points are missing due to design of microfluidics
- ionic composition of the media can be addressed
- <u>continuous monitoring</u> is preferable















The aim was to design microfluidics to enable circulation:

- no inlets/outlets —> closed «patrol engine» approach
- precision expected to be the key parameter

Development of circular microfluidics



Development of circular microfluidics: design

- Bacteria screening
- Antibiotic applications
- Bio-chemical reaction monitoring



Development of circular microfluidics

Development of circular microfluidics: further work

- Automatization of circulation
- Impedimetric sensor fabrication on Si substrate (known protocol)
- Development of cell/bacteria screening assay: at least 5 hours of continuous monitoring
- Monitoring of the antibiotic effect on bacteria
- To publish...

- In collaboration with JKU Linz (Austria), Martin Kaltenbrunner group
- Developed design and first attempts
- Waiting for new samples (corona delay)
- Coating of sensor with thin PET film for isolation and protection

Lab practicums for mastel

- Co-author «Single step modified electrodes for electrochemical vitamin C monitoring in sweat» (submission)
- Conferences: BioEl 2019, DPG 2019
- Patent application attempt (plan to renew)
- Dresden EXIST application (ongoing)
- Review «Implantable biosensors» coauthorship (ongoing)
- Drafting thesis (ongoing)

ther activities during Ph.D.

Development of bioassay with enabled circulation:

- MF automatization
- Sensor fabrication
- Assay development
- Measurements
- Publication

Plans and outlook

- Writing thesis (plan to submit in November)
- Experiments and proposal for Dresden **EXIST** application
- In case of success to patent
- Give input to catheters collaboration to publish

Thank you for your attention!

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