Towards lab-on-card, label-free immunoassays based on electrical impedance spectroscopy

A high throughput screening device

Belgian Physical Society General Scientific Meeting,
ULBruxelles, 22 May 2019

Frederik Vreys

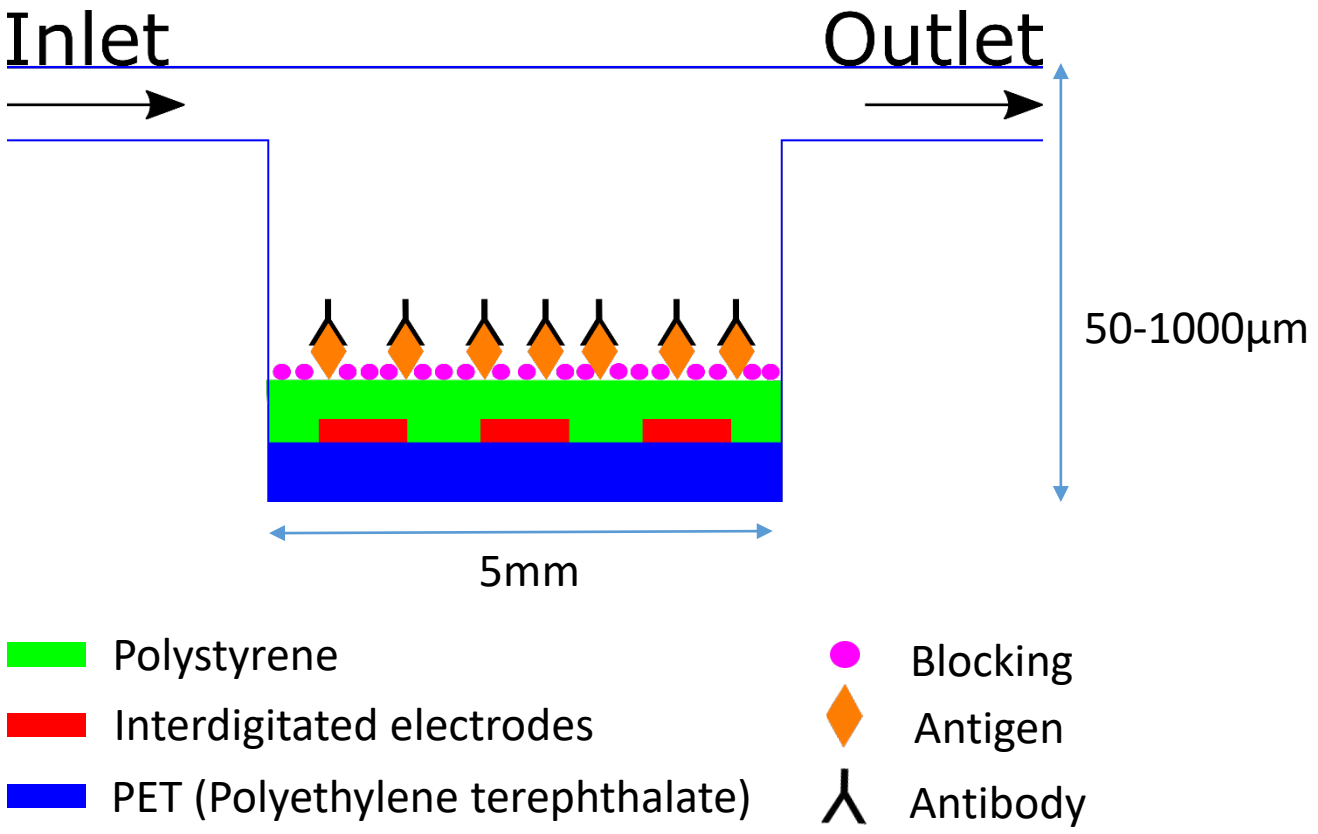
Contents

- Introduction
  - Healthy aging
  - Sensor principle
- Characterization
  - Contact angle measurements
  - Antigen coating on substrates
- Sensor development
  - Lab-on-card principle
  - Lab-on-card with impedimetric cell
  - Lab-on-card with microplate format
  - Multichannel impedimetric cells on glass
- Reference measurements
  - ELISA as golden standard
- Measurement setup
- Impedance spectroscopy of SPAG coating
- Outlook

Introduction: Healthy aging

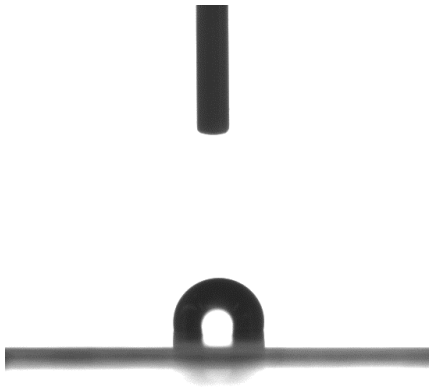
- The project which supports and consolidates medical research, technological development and innovation of chronic geriatric disorders.
- The goal:
  - To decrease costs in the healthcare sector
  - Development of a technological platform for sharing knowledge in the field of healthy aging
- Workpackage T1: Biomarkers
  - Development of a high throughput screening device

Introduction: Sensor principle

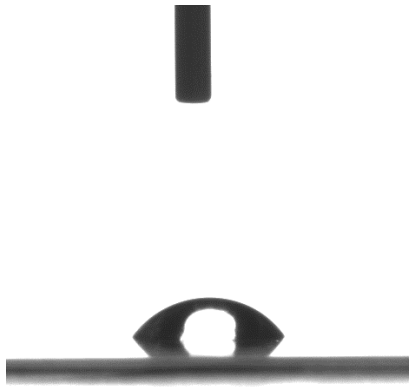


Characterization: Contact angle measurements

- Measuring the angle between the liquid–solid interface and the liquid–vapor interface.
- The angle decreases when a substrate is more hydrophilic.
- The angle is a number for the amount of antigen bound.



no coating

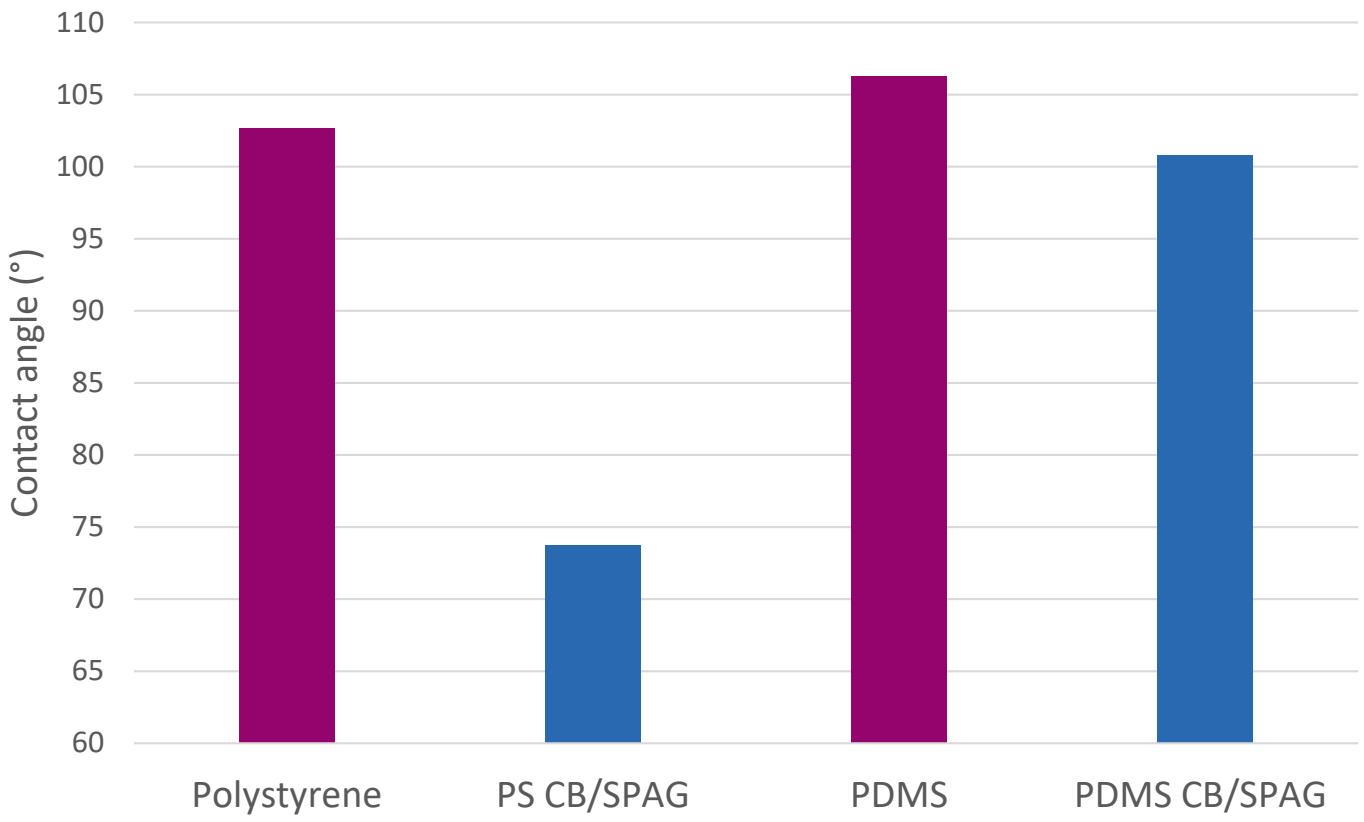


100µg/ml SPAG16 coating

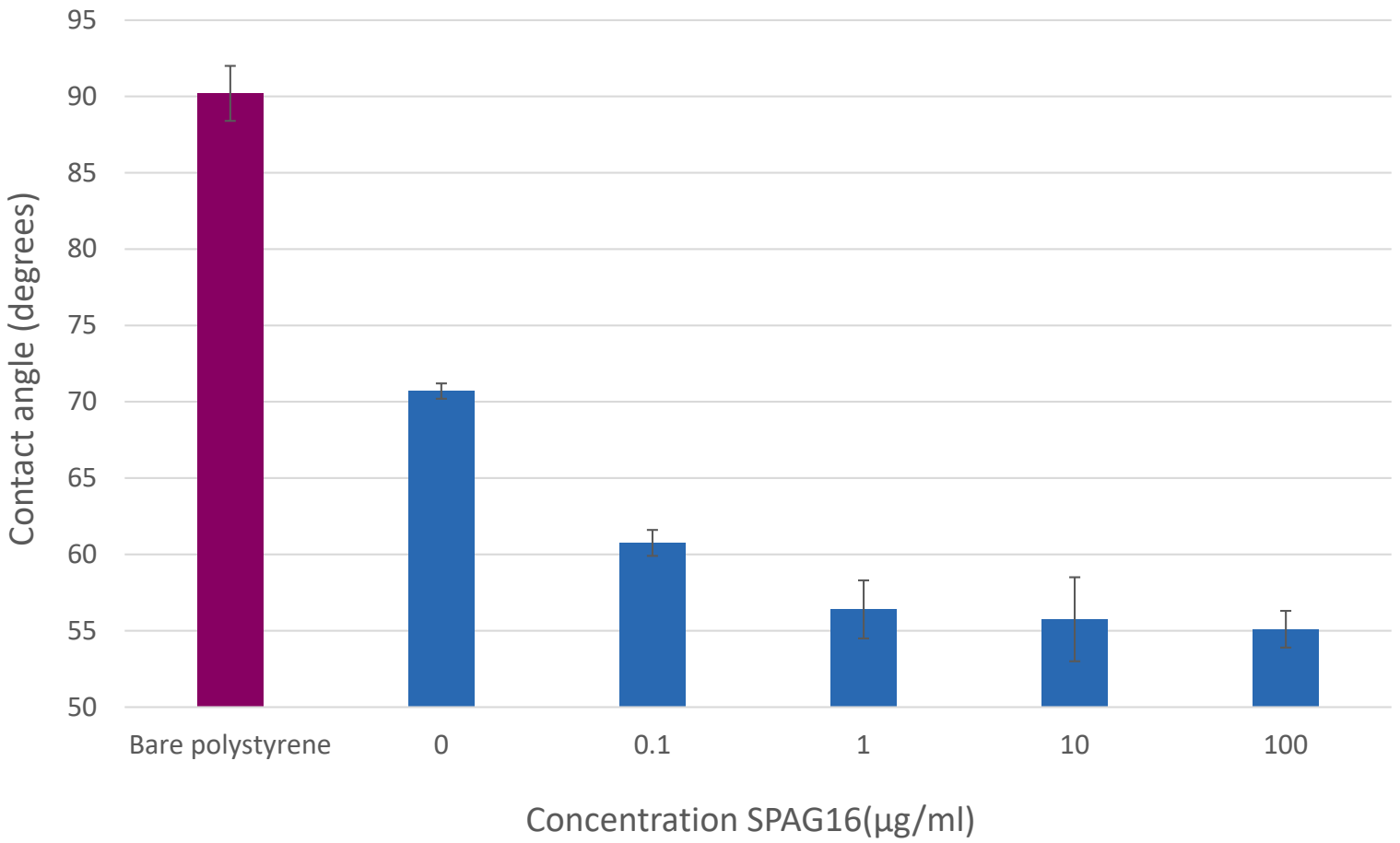
Characterization: Antigen coating on substrates

- Polydimethylsiloxane(PDMS) substrate
  - Silicone typically used for microfluidics
  - Hydrophobic
  - Biocompatible
  - Difficult to apply in thin layers
- Polystyrene substrate
  - Same polymer as microplates(MICROLON® 200 96W)
  - Easy to spincoat in layers of ±200nm
- Glass
  - Typically the bottom substrate of microfluidics
  - Bad measurements with golden standard

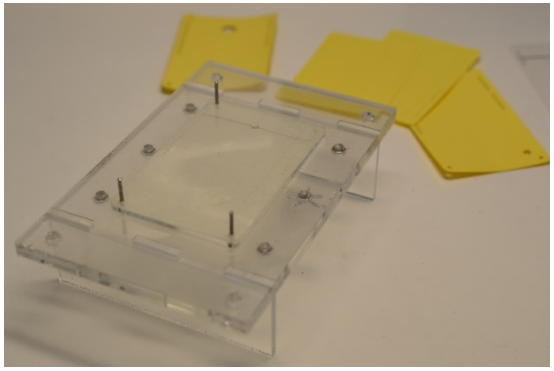
Characterization: Antigen coating on substrates

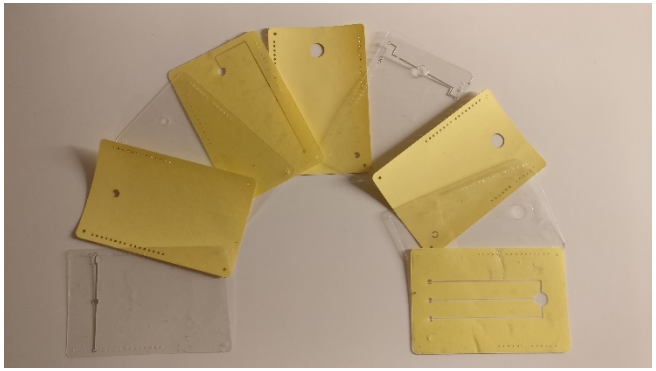


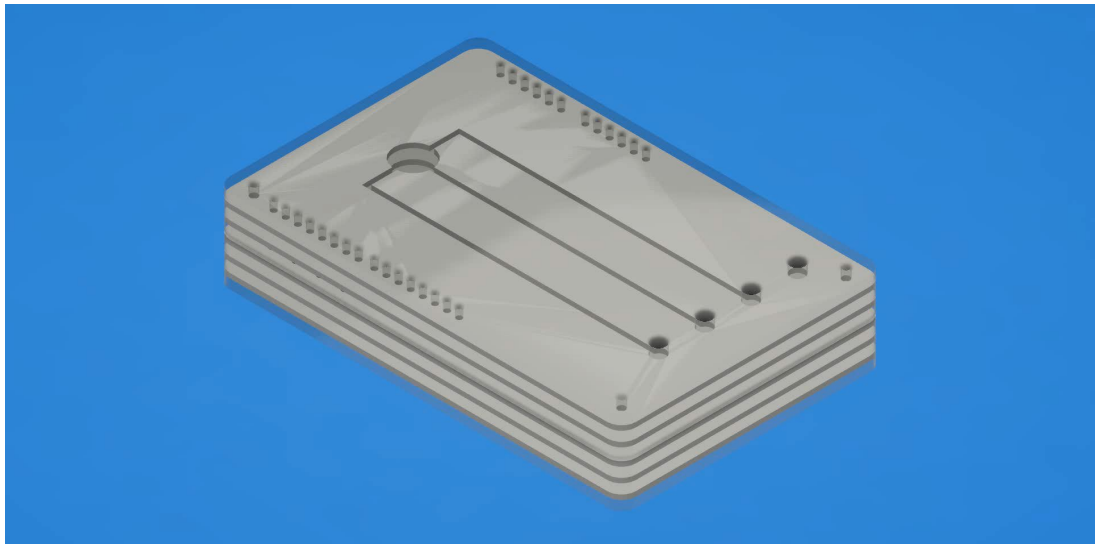
Characterization: Antigen coating on substrates



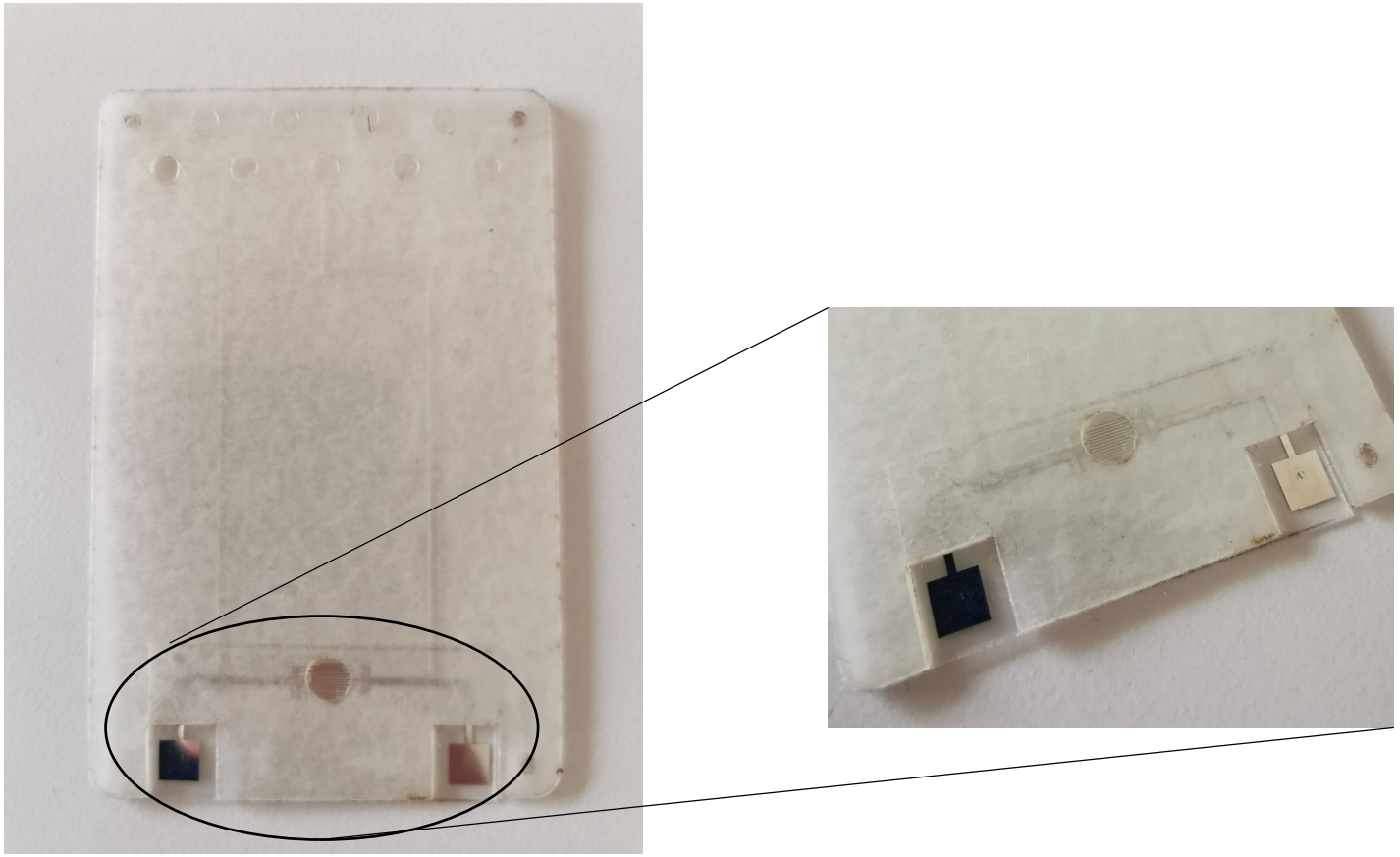
Sensor development: Lab-on-card principle



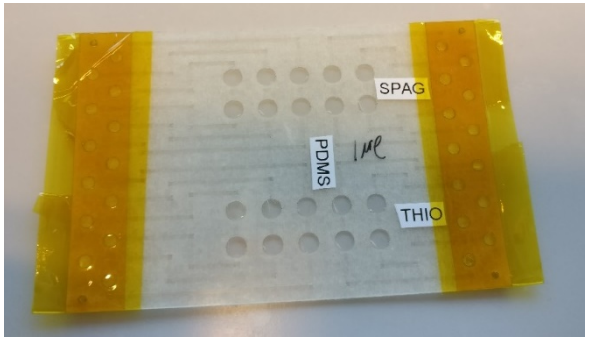


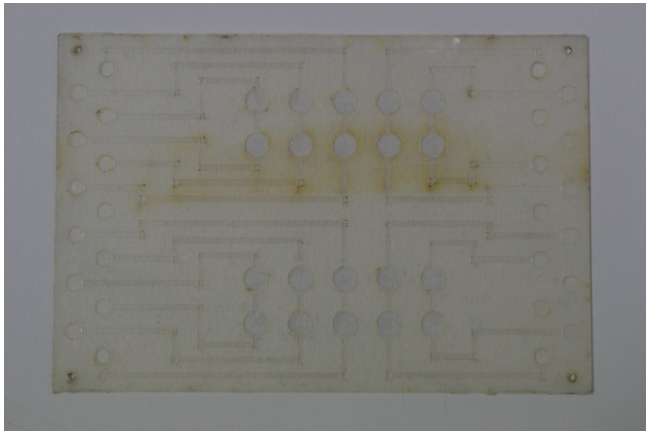


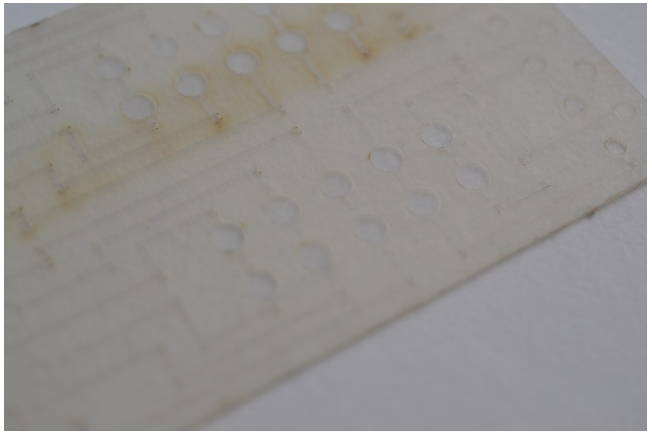
Sensor development: Lab-on-card with impedimetric cell



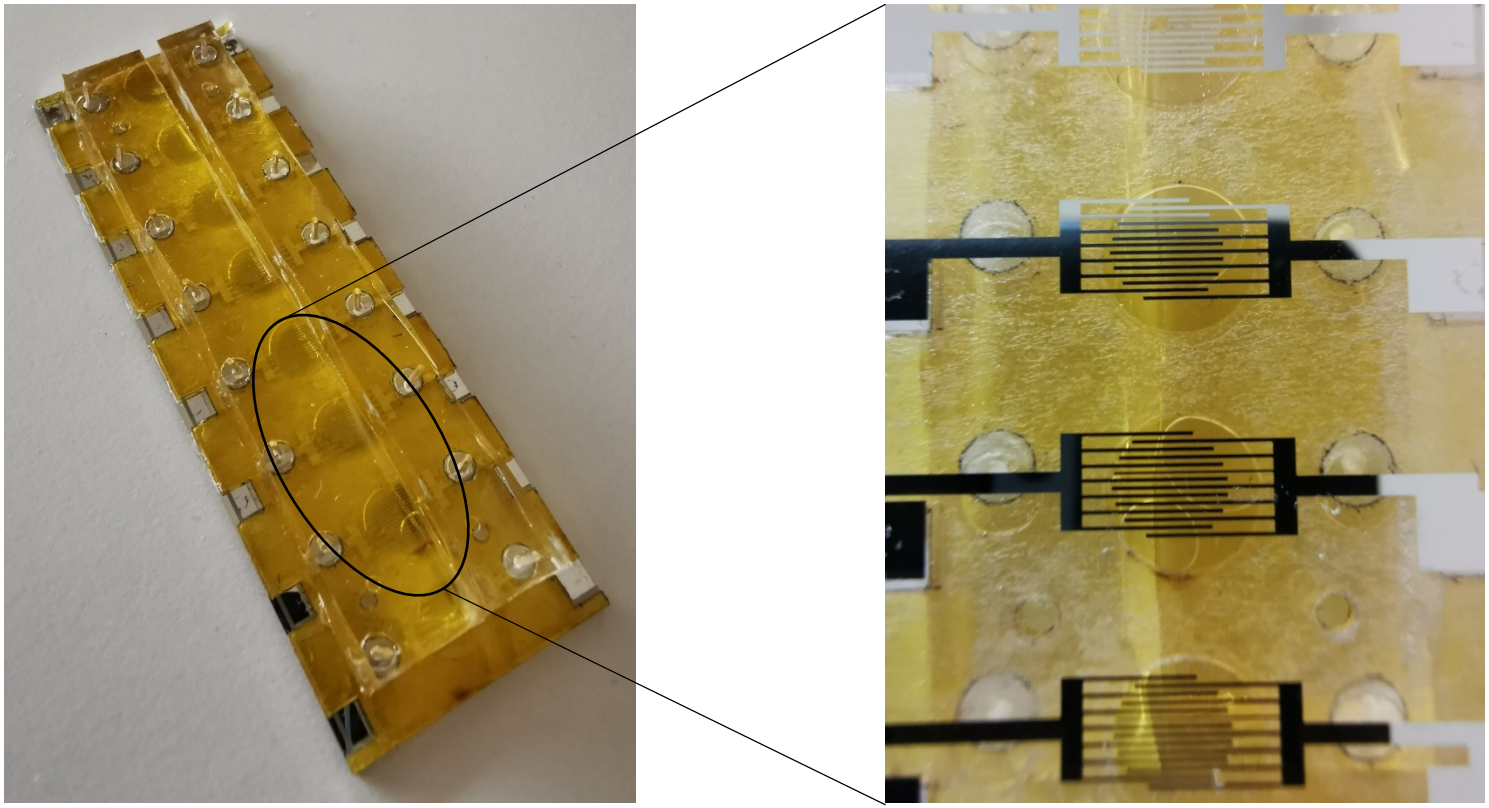
Sensor development: Lab-on-card with microplate format



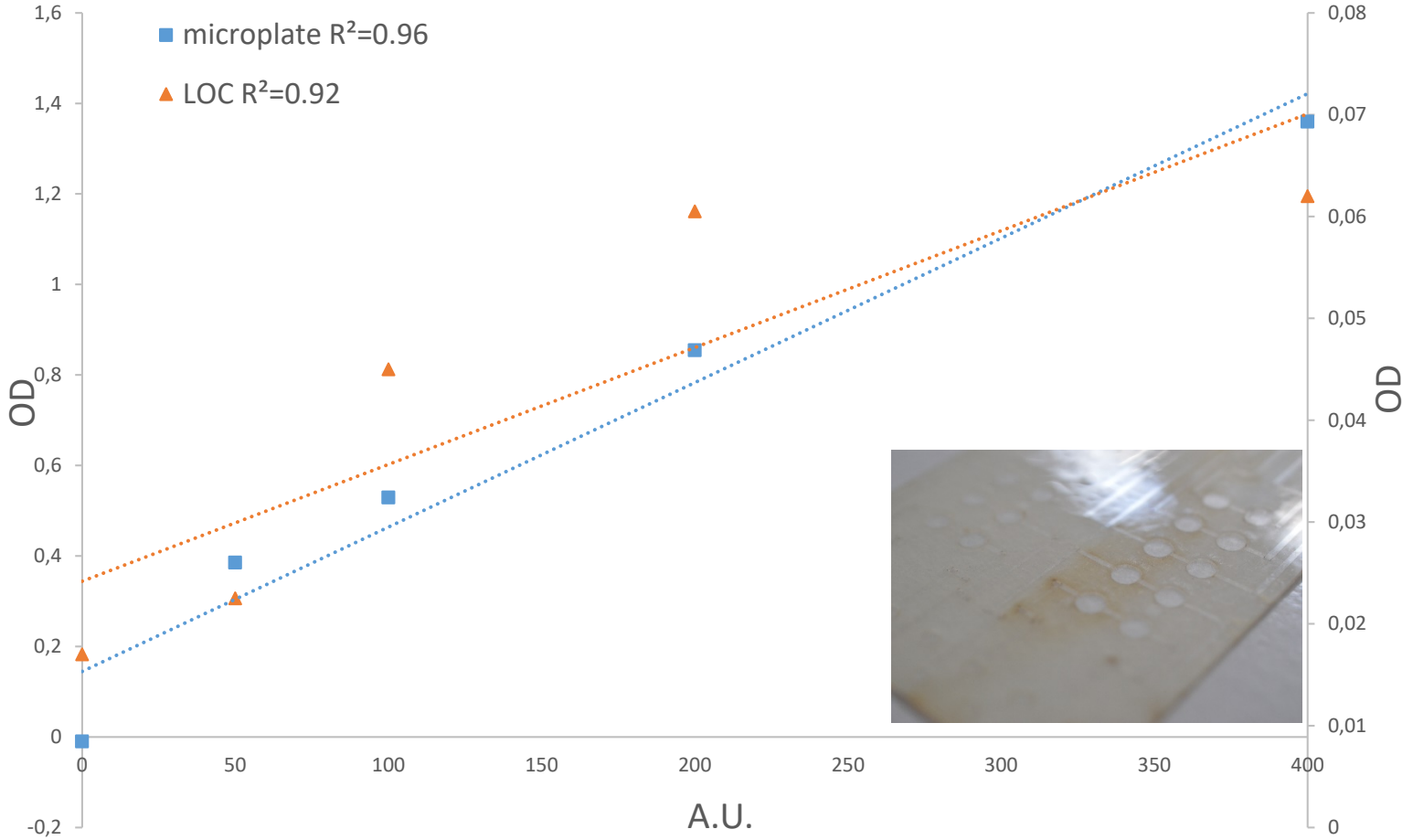




Sensor development:
Multichannel impedimetric cells on glass

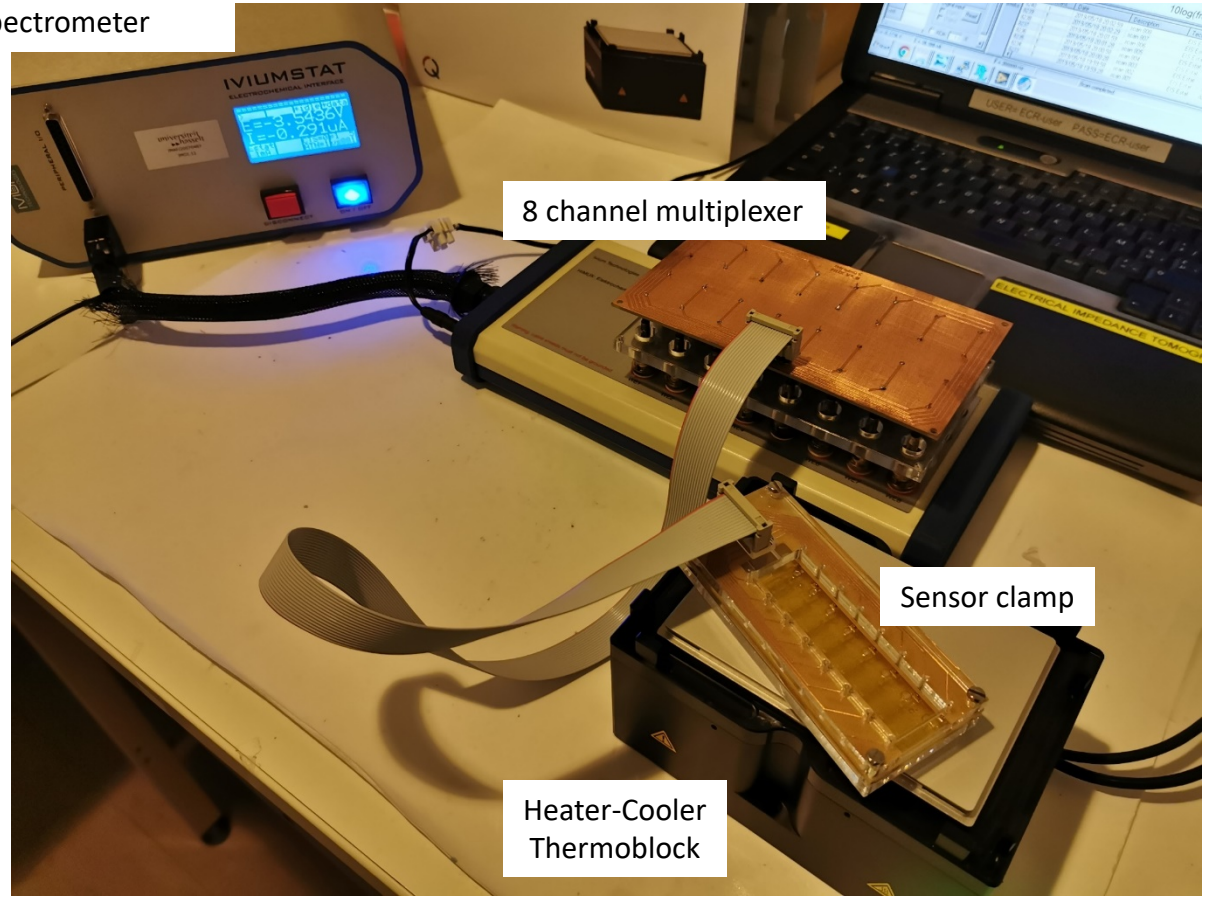


Reference measurement: ELISA as golden standard

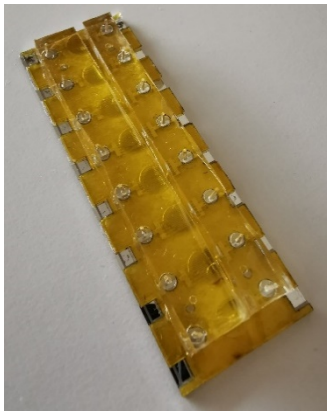


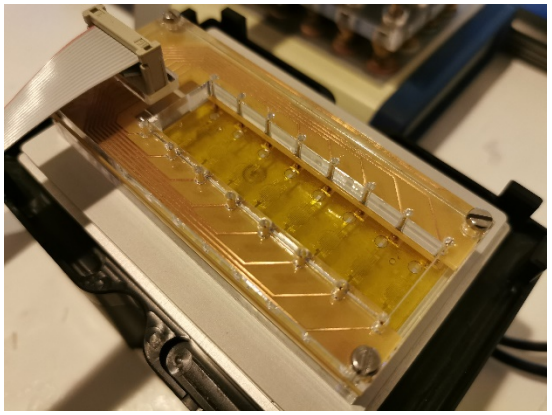
Measurement setup

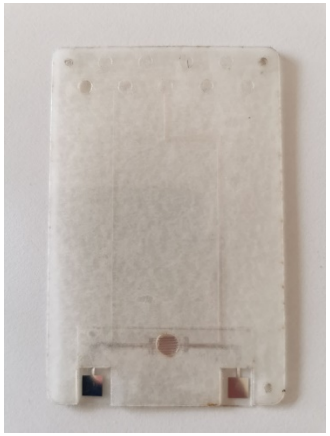
Electrical impedance spectrometer

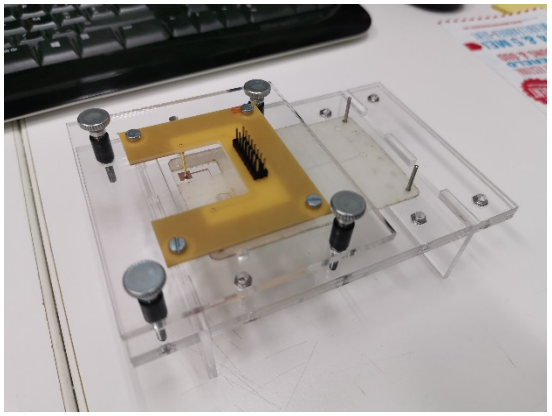


Measurement setup: Sensor clamp

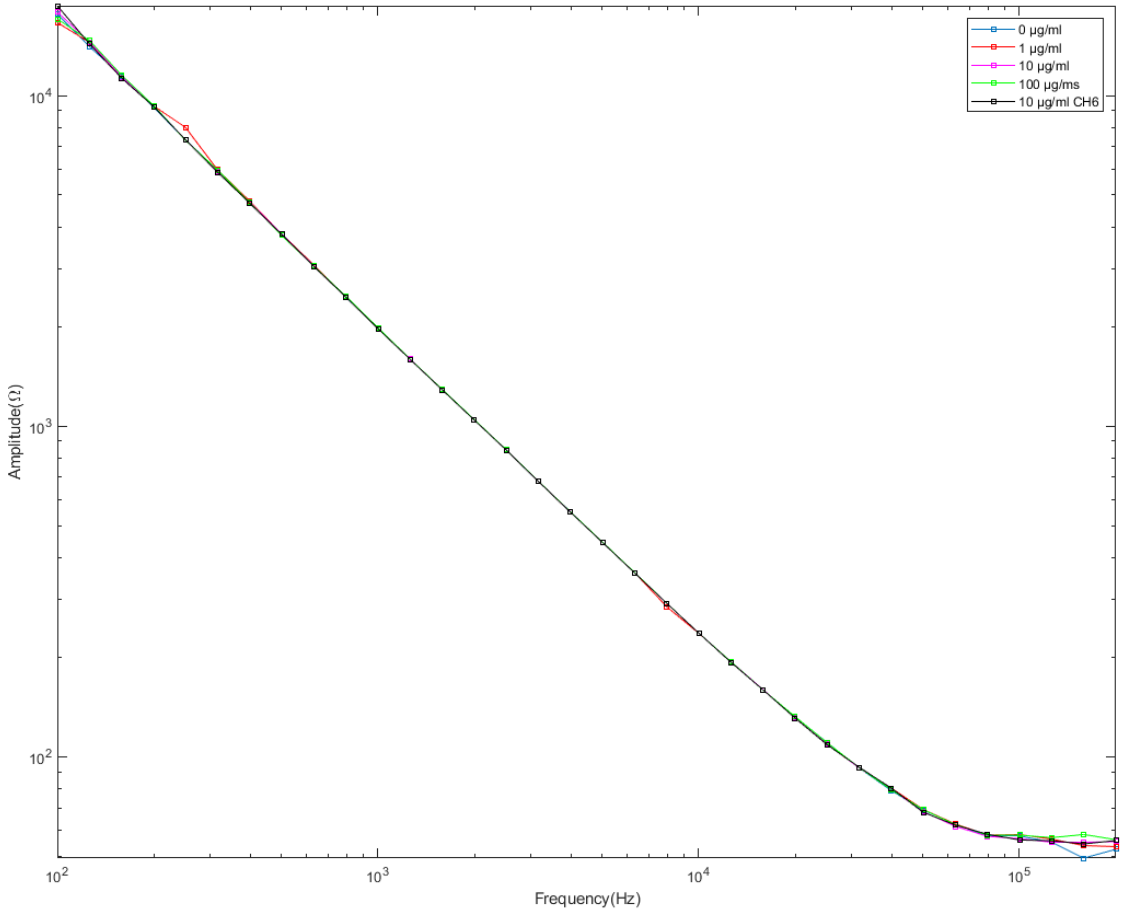




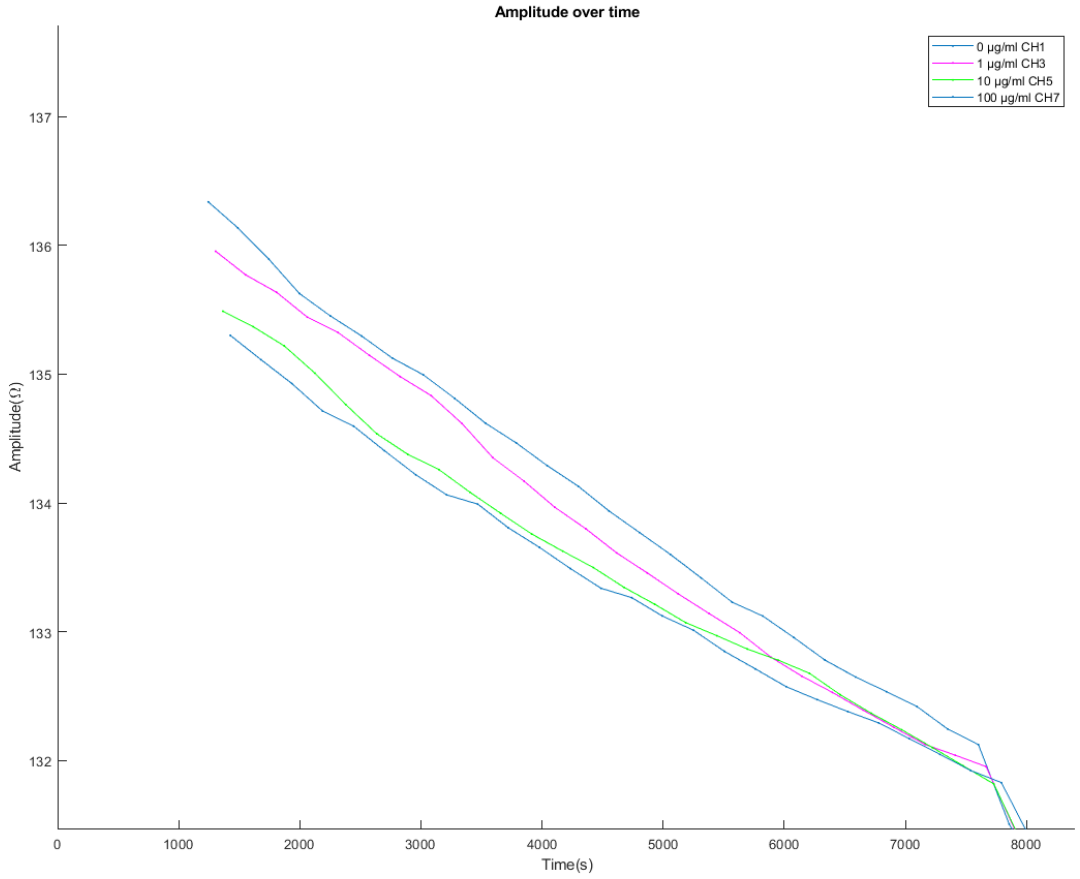




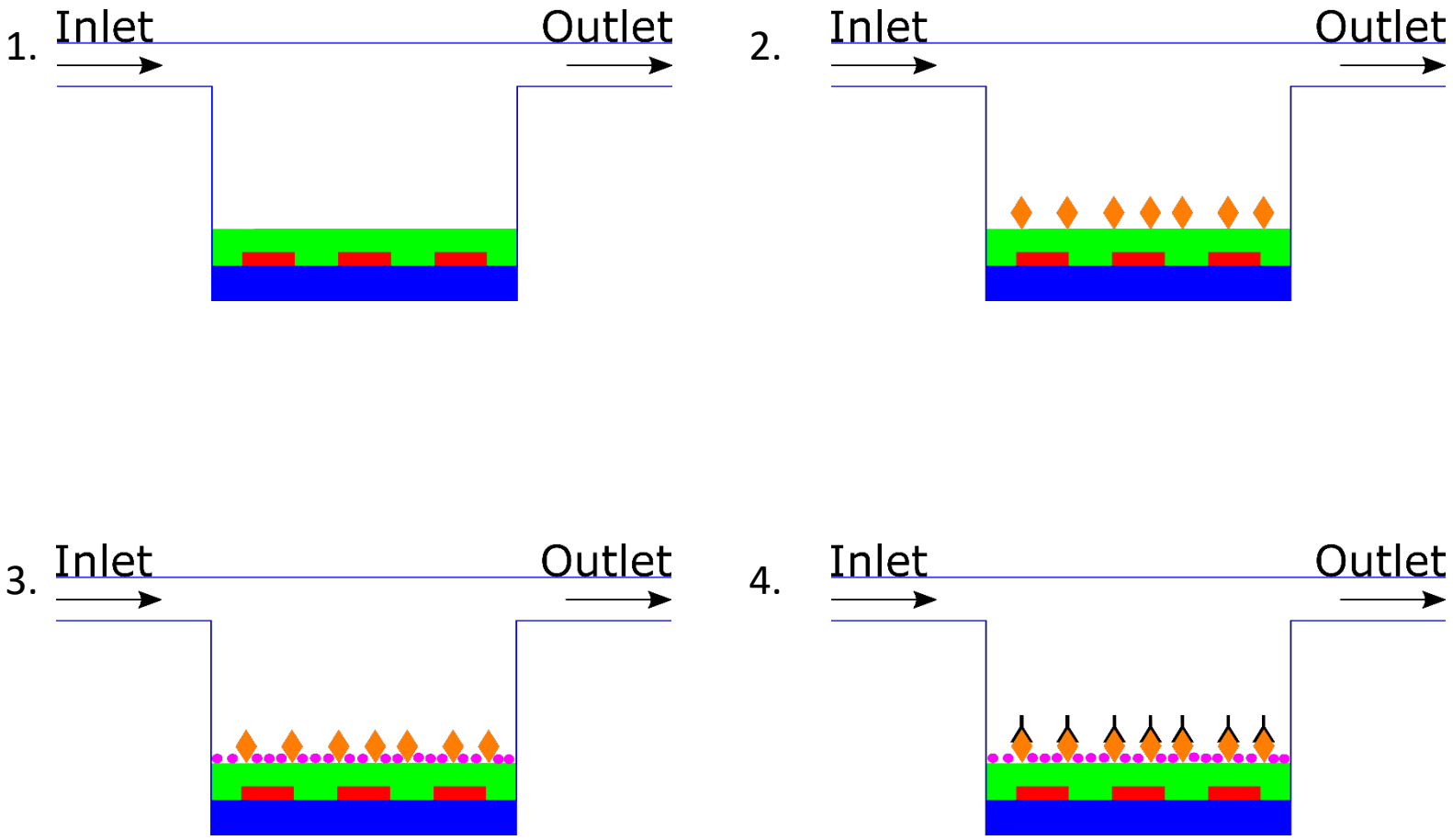
Electrical impedance spectroscopy of SPAG coating



Electrical impedance spectroscopy of SPAG coating



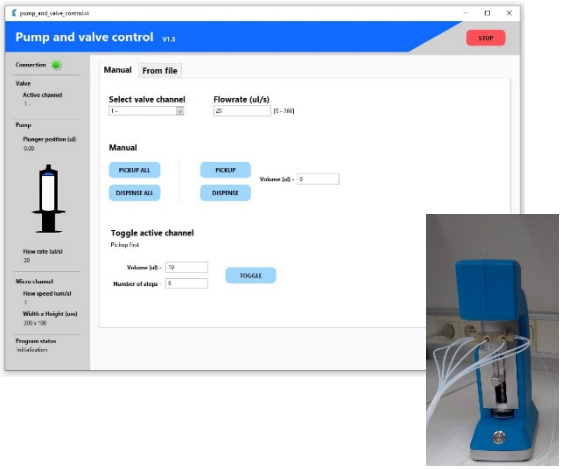
Outlook



Outlook:
Fully automated immunoassay

Temperature controller

Liquid handler



Electrical impedance spectrometer

Conclusion

- Characterization proves stable coating on polystyrene layer
- Golden standard(ELISA) proves the sensitivity of a measurement in a card
- Full ELISA protocol tests in a card are successful
- Impedance measurements give stable spectra
  - Performing characterization on the interdigitated electrodes, e.g. measuring Silica particles

End of the presentation

Thank you for your attention!