

# Printed biosensing platform integrated in recycled paper

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## MOTIVATION

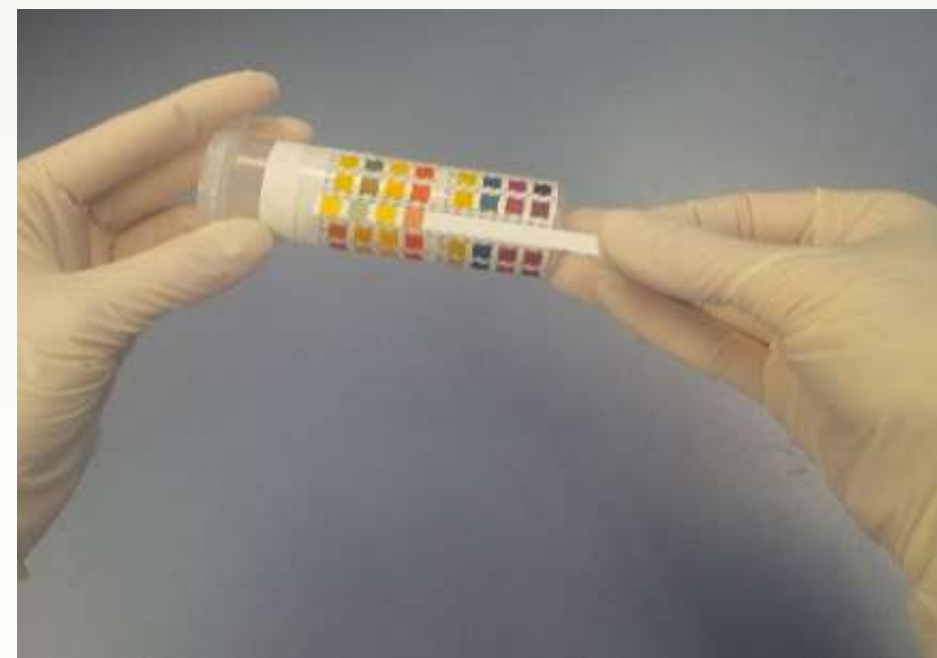
The **decentralization of the health care system**, driven by the demographic change, creates a strong demand for sustainable **high volume and low cost biosensors** that enable molecular diagnostics outside of laboratories.

To **overcome these limitations**, we aim to realise an electrochemical **single-use sensor**, which i) is based on **recycling paper** as substrate to enable environment-friendly production and disposal, ii) detects quantitatively glucose and ketone bodies in urine to permit the diagnosis of ketoacidosis, iii) is able to contactless communicate the measured values.

## State of the art: Single-use test strips using color indicators

### Urine test strips

- Plastic substrate
- Subjective visual perception
- No electronic data recording
- Detect only acetoacetic acid



➔ No present point of care system can detect beta-hydroxybutyric acid and acetoacetic acid



Paper manufacturing

- Cellulose matrix for biofunctionalisation
- Surface for electrodes



Roll-to-roll printing

- Electrodes
- Hydrophobic barriers



Microelectronics

- Printed antenna
- Assembly of bare dies

## Electrochemical biosensing for the quantification of glucose and ketone bodies (beta-hydroxybutyric acid and acetoacetic acid)

### PIONIER demonstrator

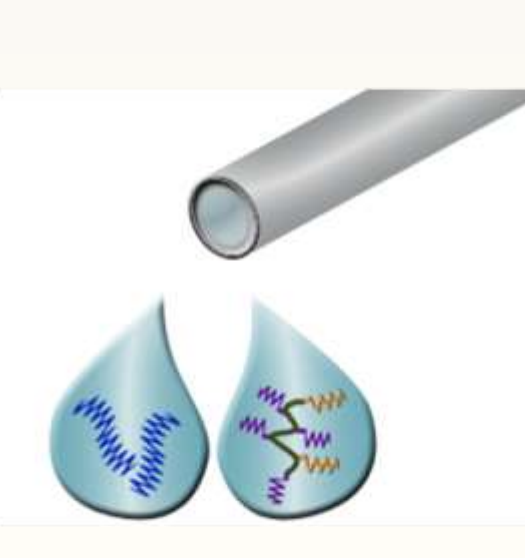
- Paper substrate
- Quantitative results
- Contactless read-out
- Battery-free
- Automatic data recording
- Environment-friendly

### Single step biofunctionalisation

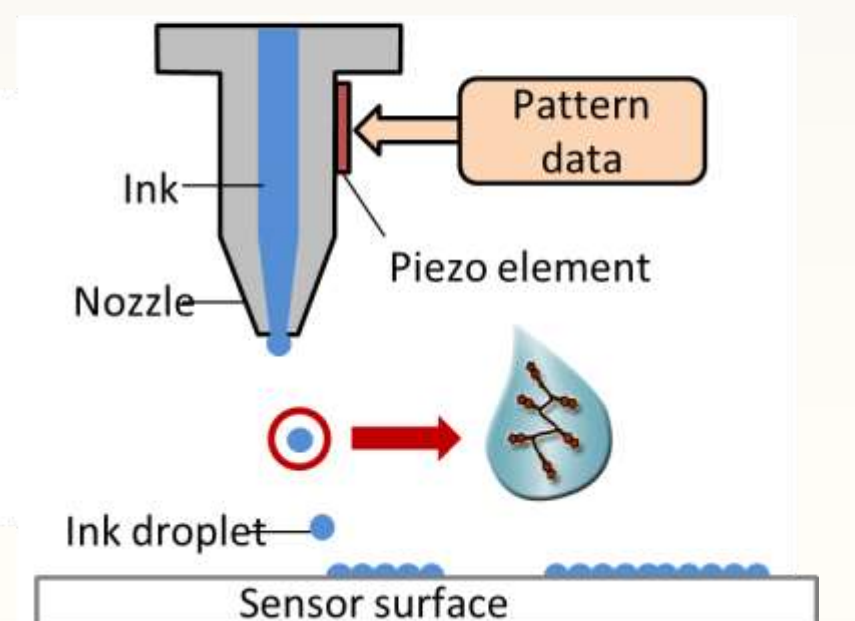
#### Material inkjet printer



#### Printable bioink formulation

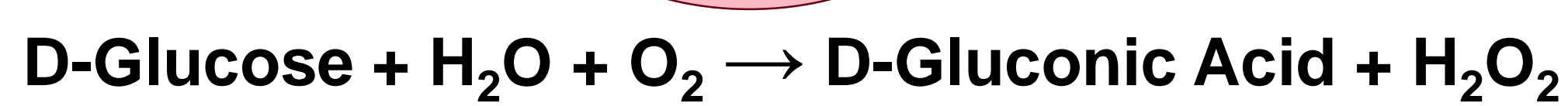


#### Direct bioink printing process

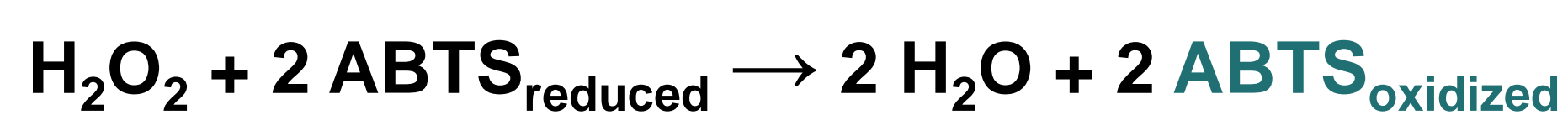


## Enzyme assay

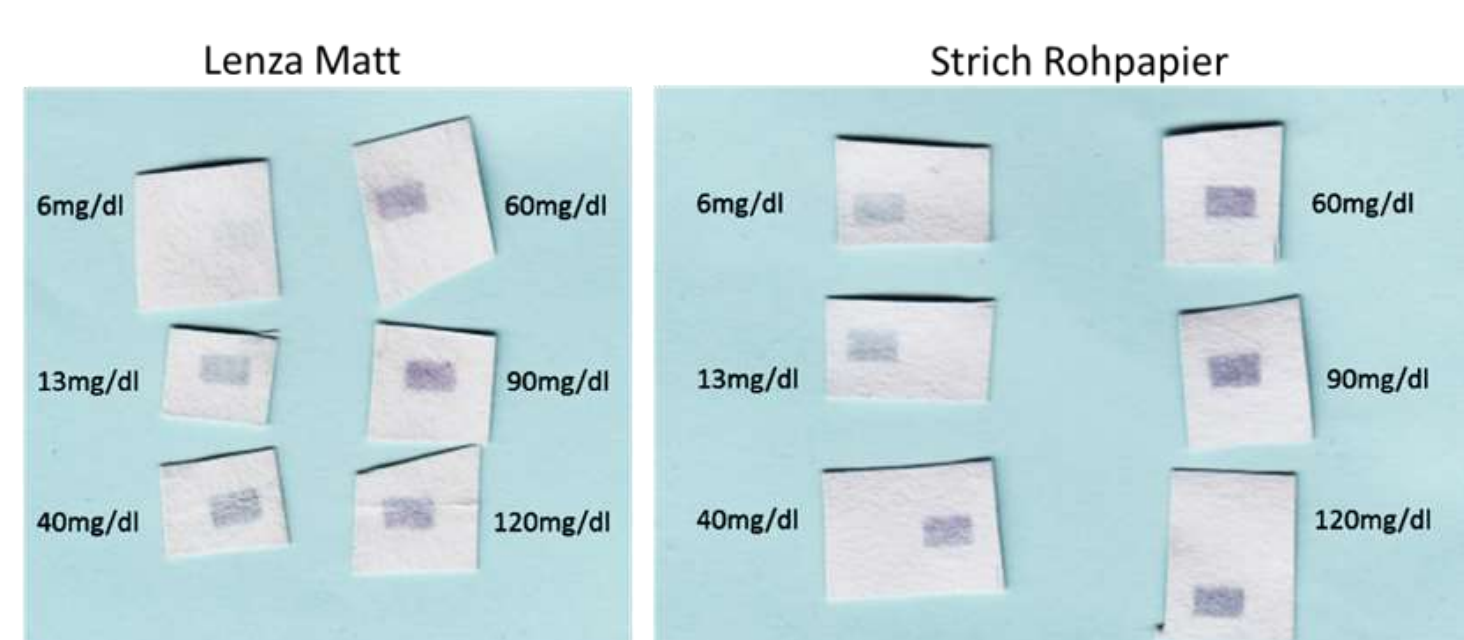
Glucose oxidase



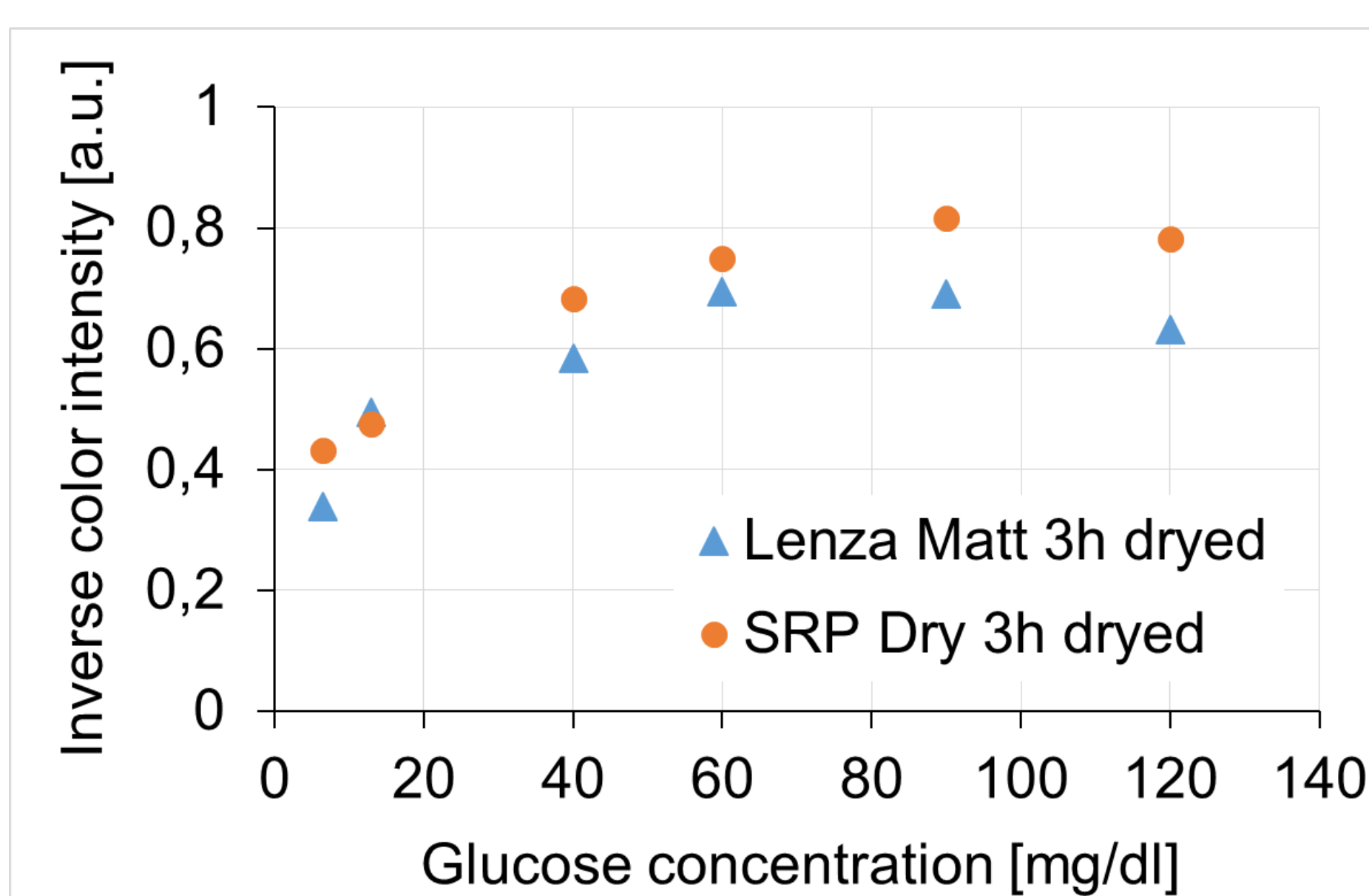
Peroxidase



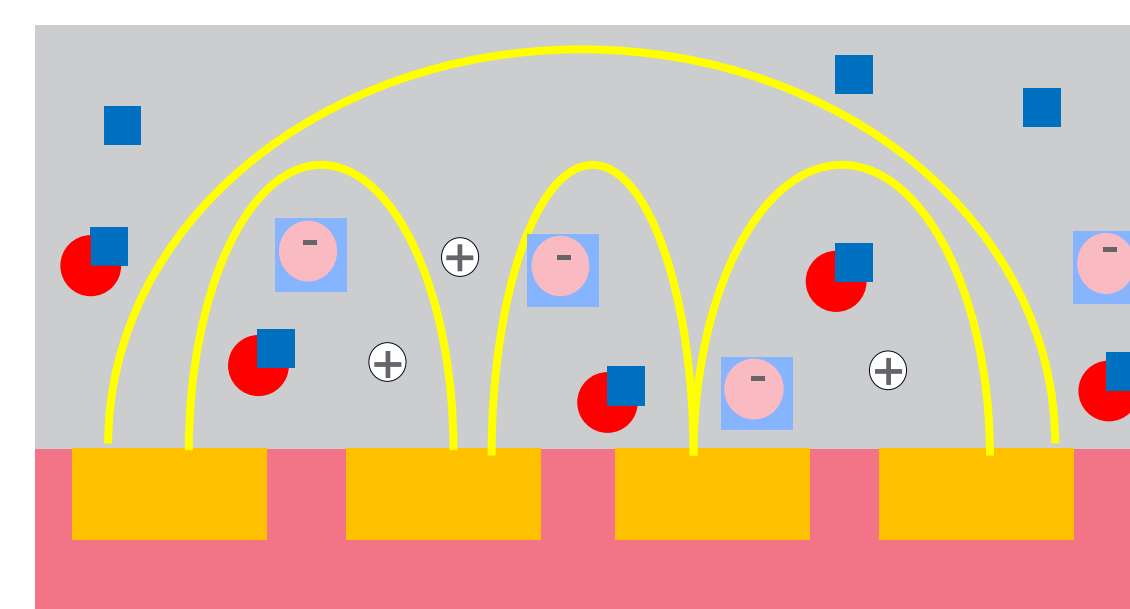
## Different glucose concentrations



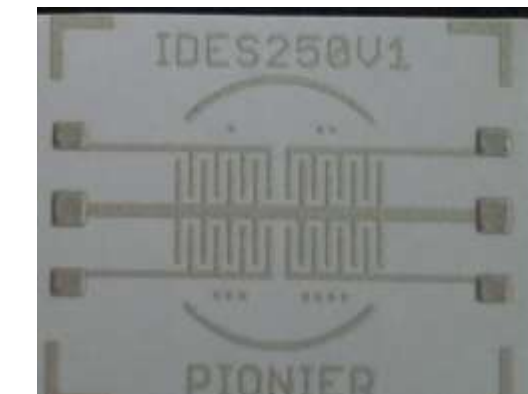
## Quantification of glucose in recycled paper



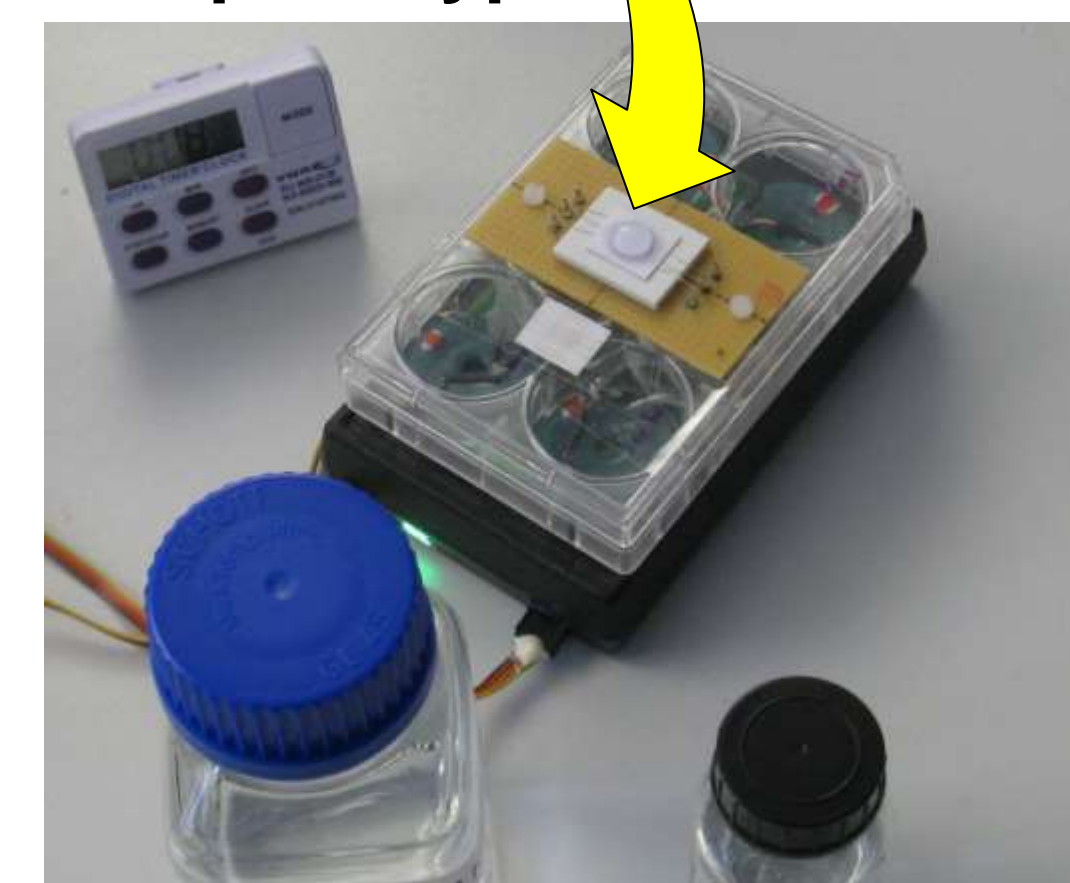
## Biosensing



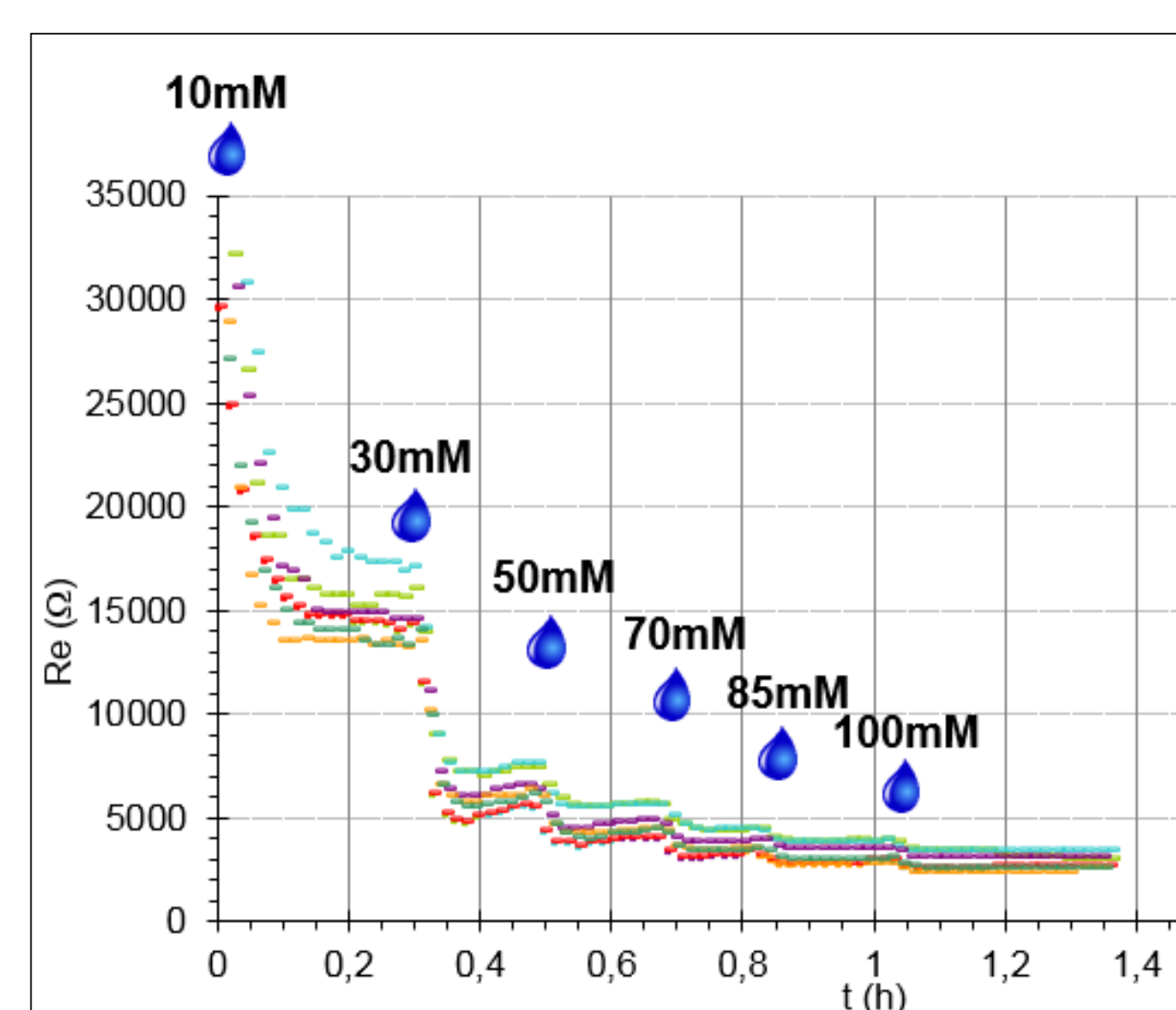
### Paper sensor



### Lab prototype

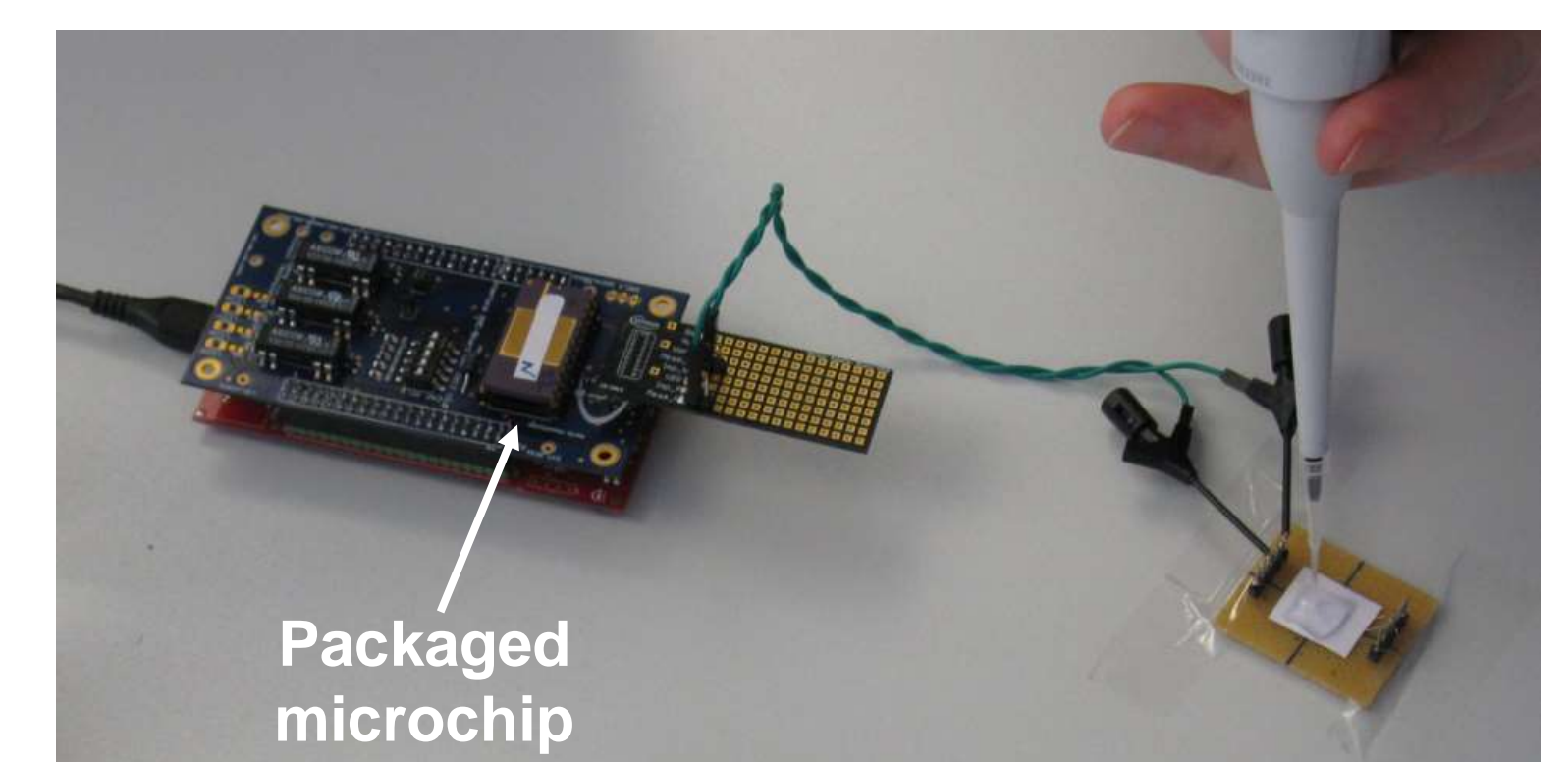


## NaCl conductivity test



## PIONIER integration levels

### USB connected read-out



### Wireless NFC read-out



Packaged microchip

Outlook: Full integration on paper  
- Unpackaged microchip  
- Wireless NFC read-out

