Electrochemical paper-based analytical devices for biomedical aplications

Dmitry Galyamin

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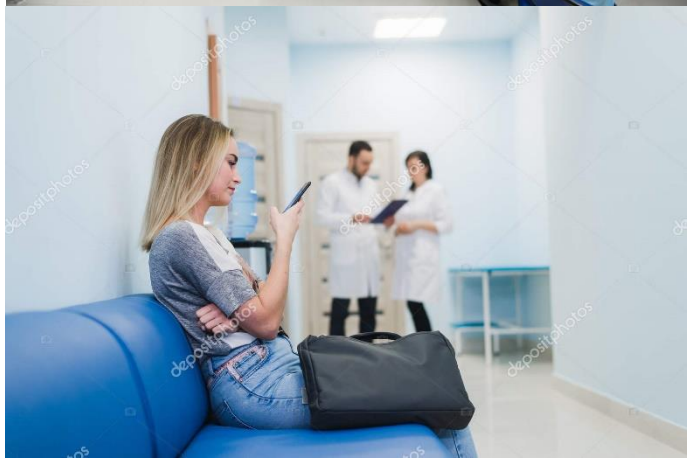
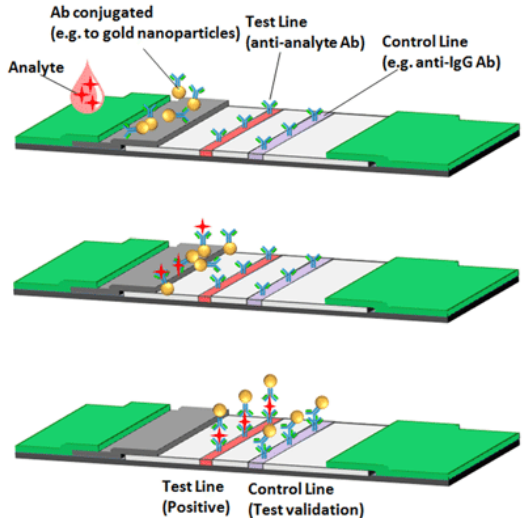
If we want a diagnosis of a desease…



Expensive
Days
Trained worker…

Portable reader

Paper-based Analytical Devices (PADs)



Naked-eyed
Not reliable

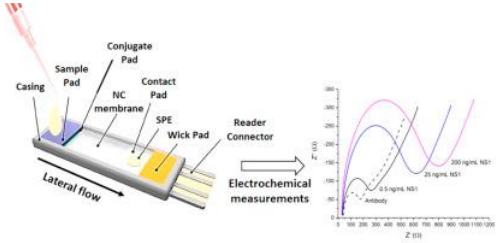
Portable reader – Lateral Flow

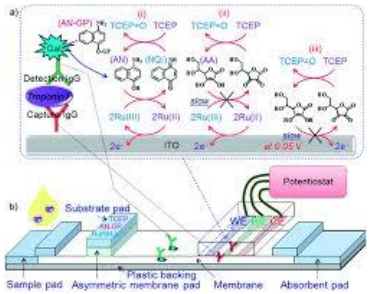
Colorimetric:

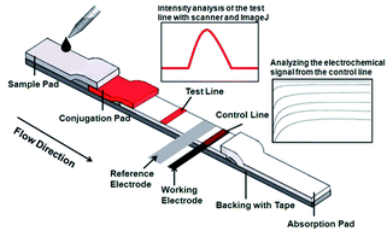
- Leds
- Mobile phone
- Expensive…
- High power
- Complicated electronic

Electrochemical lateral-flow

Integrable
Low-cost
Digital (current)



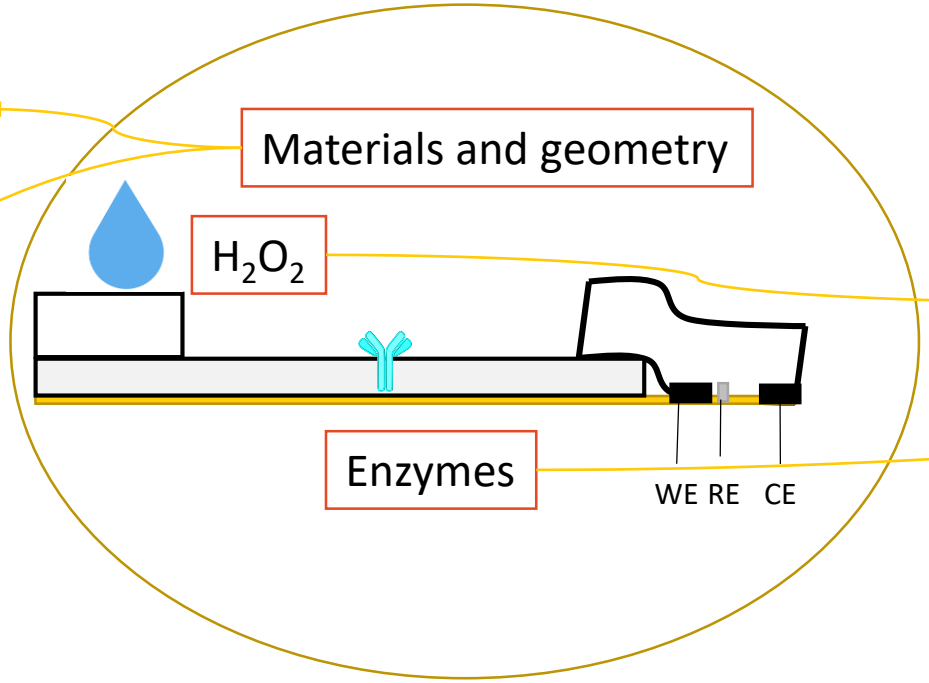




Enzymes
H_2O_2
Same materials as in optic…

To obtain a low cost digital electrochemical paper-based test device for point-of-care applications

To study different papers (flow, electrochemistry, absorbity…):
- Cellulose
- Glassy fiber

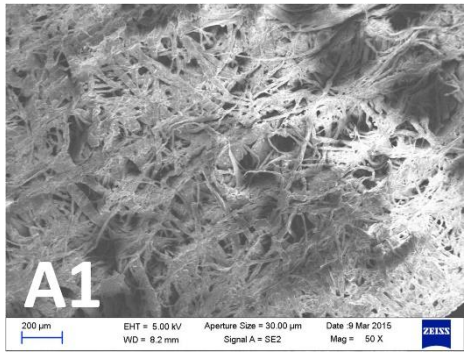


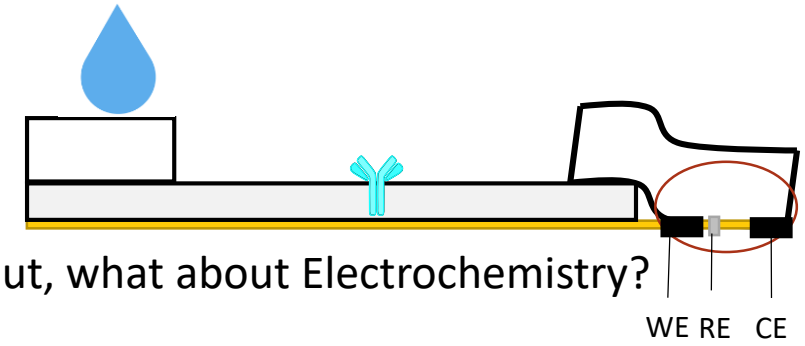
The use of CeO_2 nanoparticles as a catalysts

To design a new geometry more adapted to electrochemistry

Cellulose:

- Can be modified (e.g. nitrocellulose)
- Adsorbent
- High cappilary flow



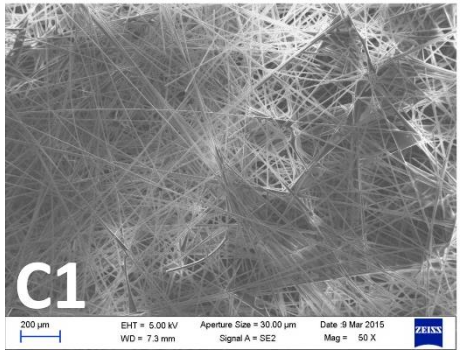


But, what about Electrochemistry?

- Hydroquinone (HQ)
- Ferro/ferricyanide ($K_3[Fe(CN)_6]/K_4[Fe(CN)_6]$)
- Ferrocenemethanol (FcMeOH)

Glassy fiber:

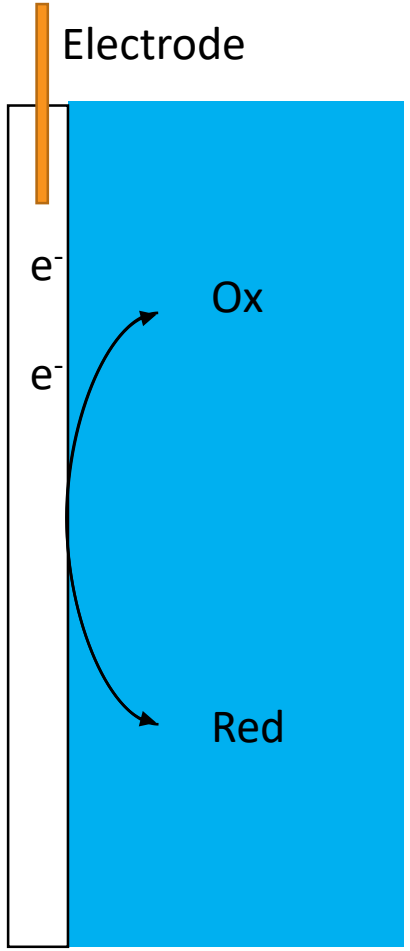
- More porosity
- Not absorbe as cellulose
- Less cappilary flow



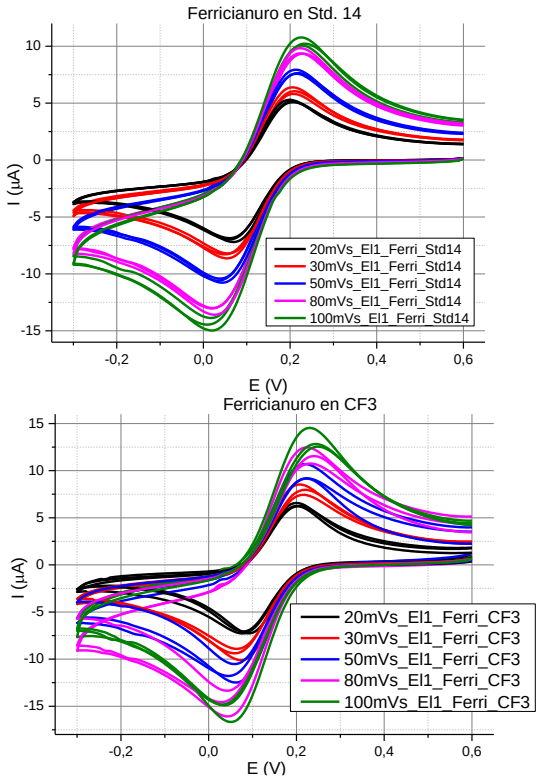
It will be presented as a poster in:
69th Annual ISE Meeting

Grupo de Investigación de Electroquímica Teórica y Aplicada de la Universidad de Murcia

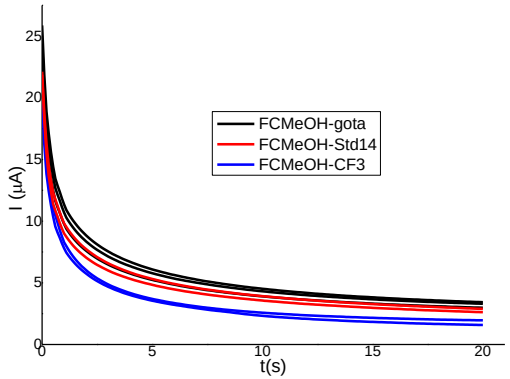
How is the effect of the paper matrix in an electrochemical reaction:



Cyclic voltammetry:
- At different scan rates

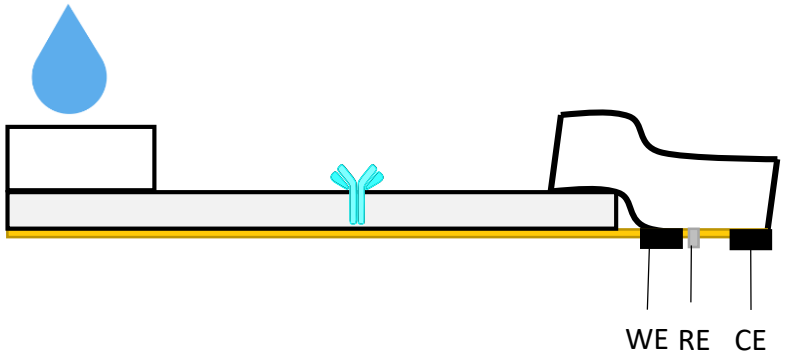


Chronoamperometry:
- At control diffusion potential



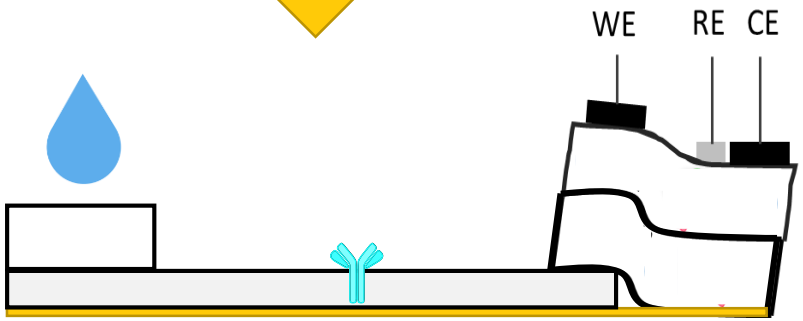
Cellulose has worst electrochemical response:
- Keep studying and future simulations will be done
- We will use glassy fiber as electrochemical matrix and cellulose as an adsorbent and cappilary material

New design for lateral-flow electrochemical device



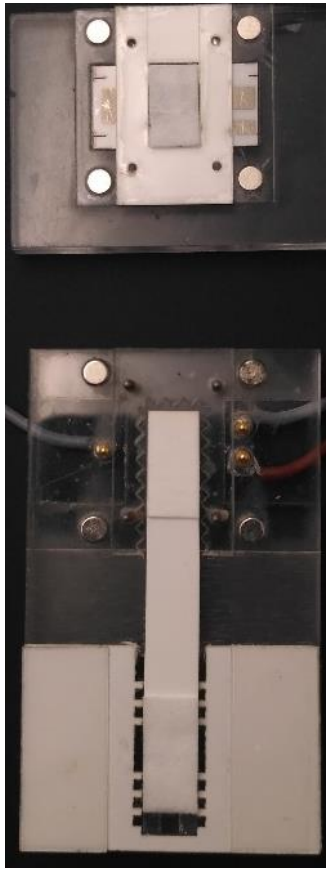
Cellulose

Enhancment of the response



Glassy fiber

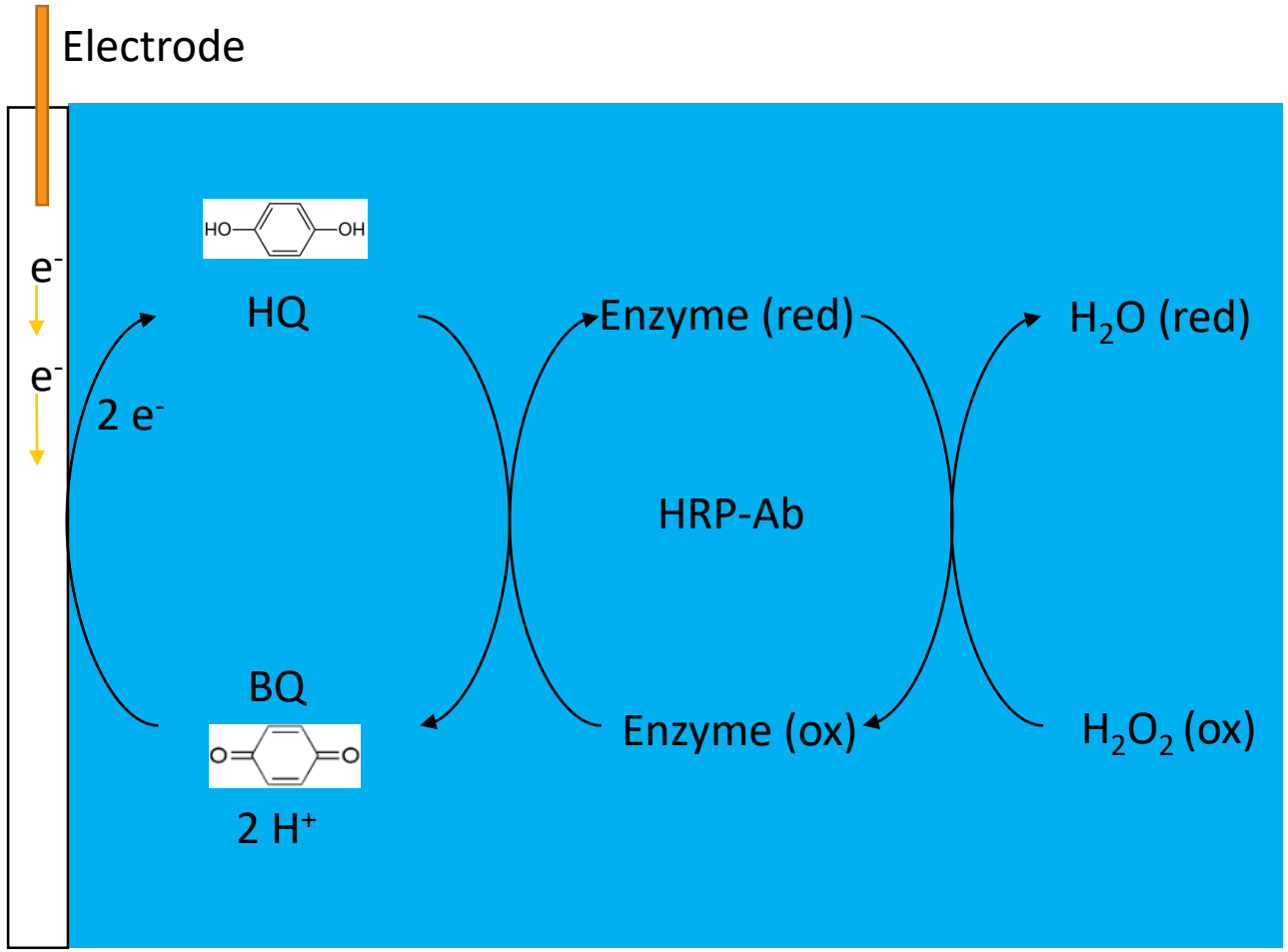
Cellulose



Glassy fiber:
- Good matrix for electrochemical reaction

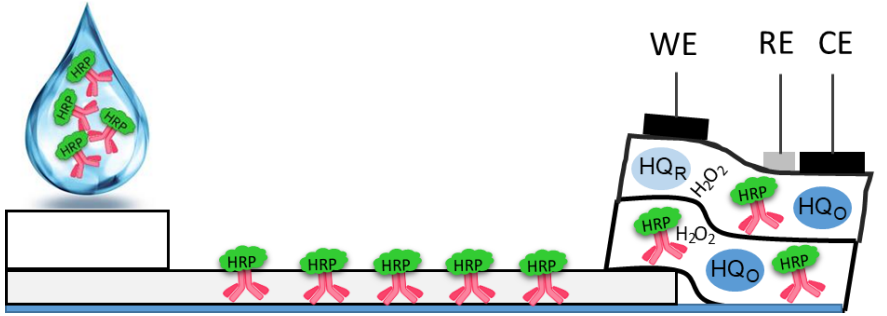
Cellulose:
- High capillary flow

What we will use to measure electrochemically a desease in a lateral-flow device:

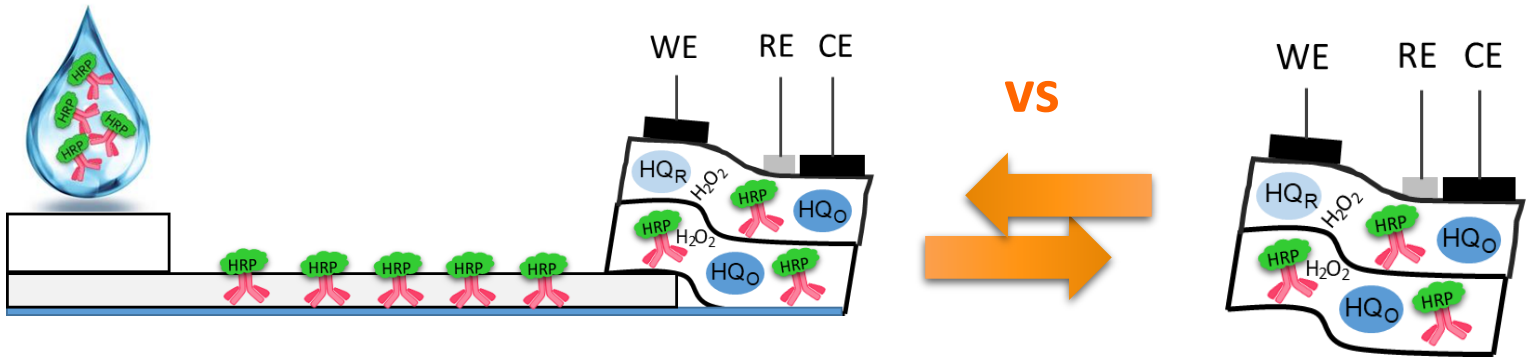


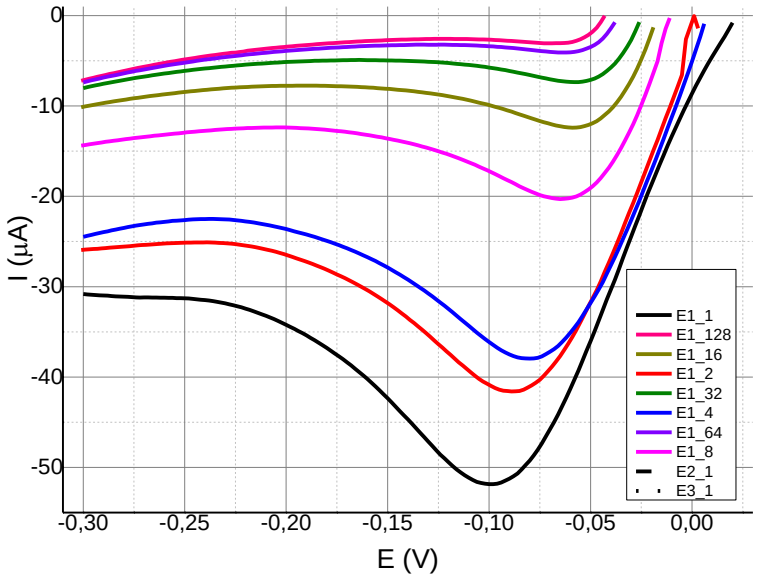
Glassy fiber:
- HQ
- H_2O_2

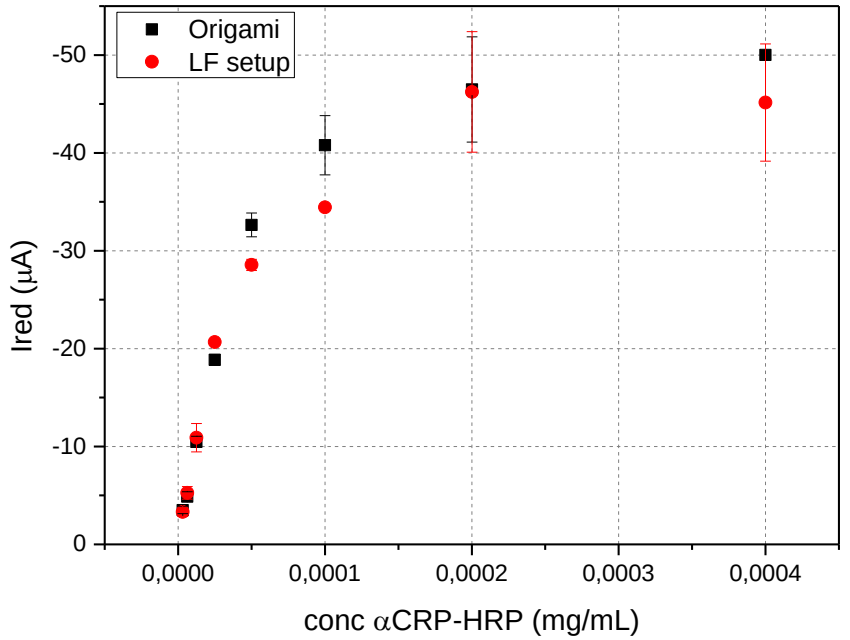
Cellulose:
- Sample (with HRP-Ab)



How to know if this new geometry works:







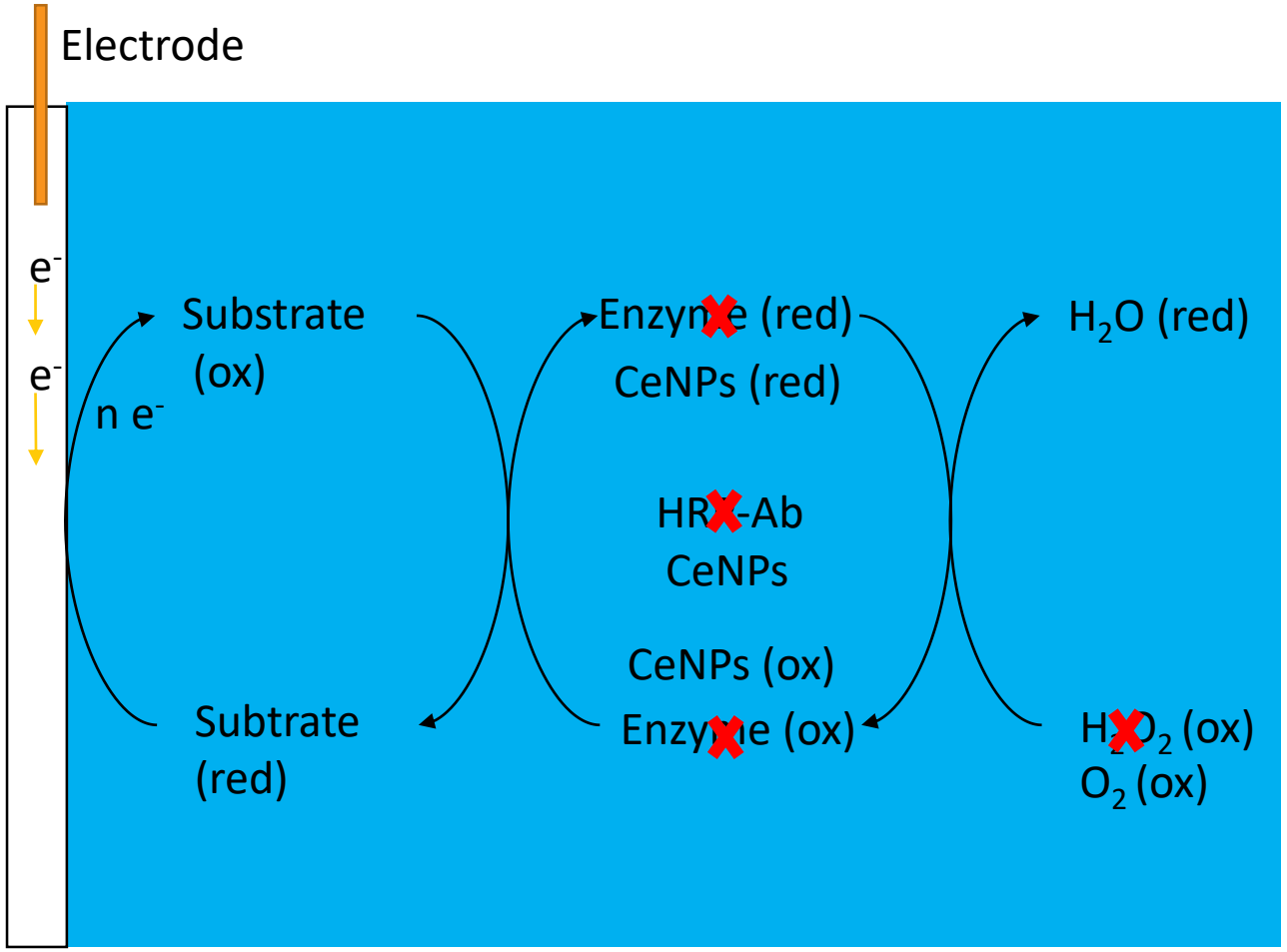
We have the same response

To measure by cyclic voltammetry:

Since now:

- It is better to use glassy fiber as electrochemical matrix
- Cellulose as adsorbent
- Origami system

In collaboration with:
Inorganic Nanoparticles Group

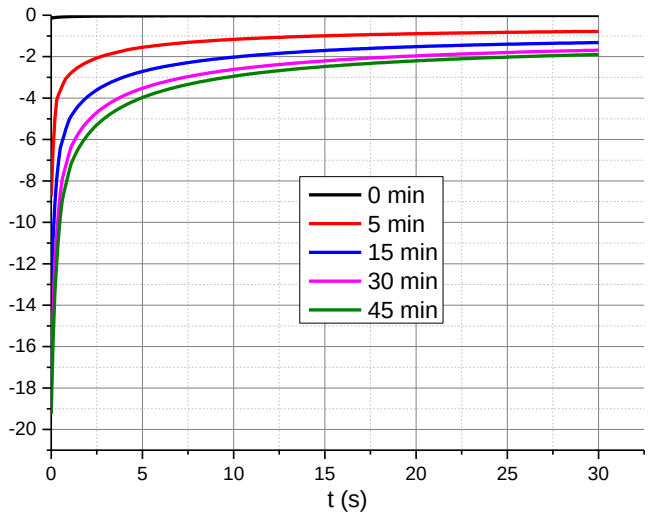


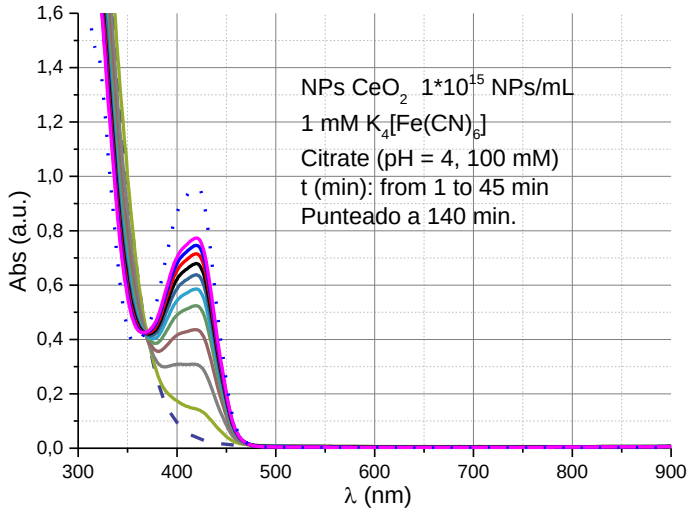
CeO_2 NPs
3nm diameter

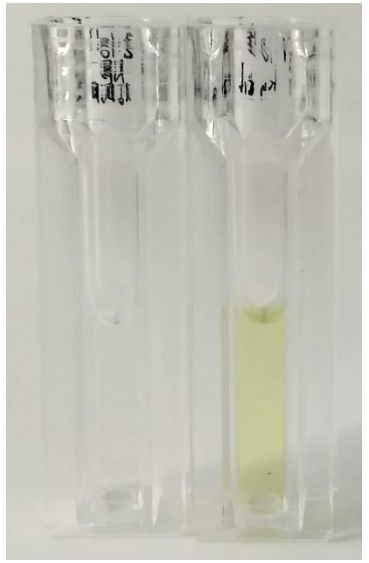
To do preliminary test we compare electrochemistry response (chronoamperometry) and absorbance **in solution**:

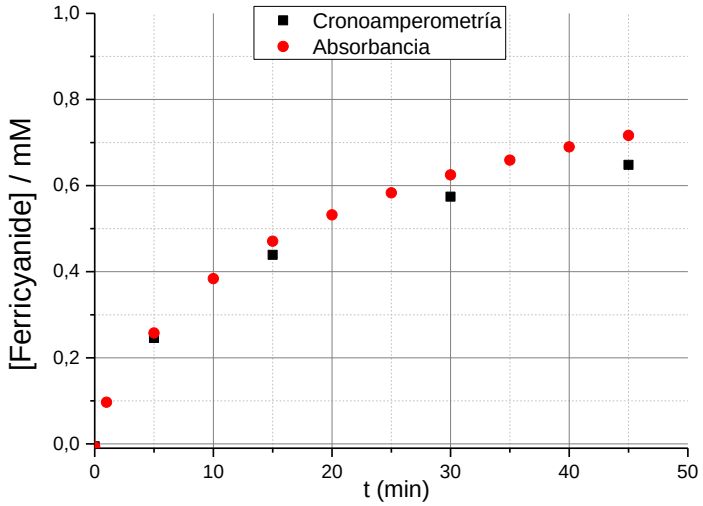
$$\underset{\text{Colorless}}{\boxed{K_4[Fe(CN)_6]}} + 2H^+ + \frac{1}{2}O_2 \xrightarrow{CeO_2\ NPs} \underset{\text{Yellow}}{K_4[Fe(CN)_6]} + H_2O$$

1. Calibration curve of $K_3[Fe(CN)_6]$
2. CeO_2 NPs + $K_4[Fe(CN)_6]$ at optimum conditions



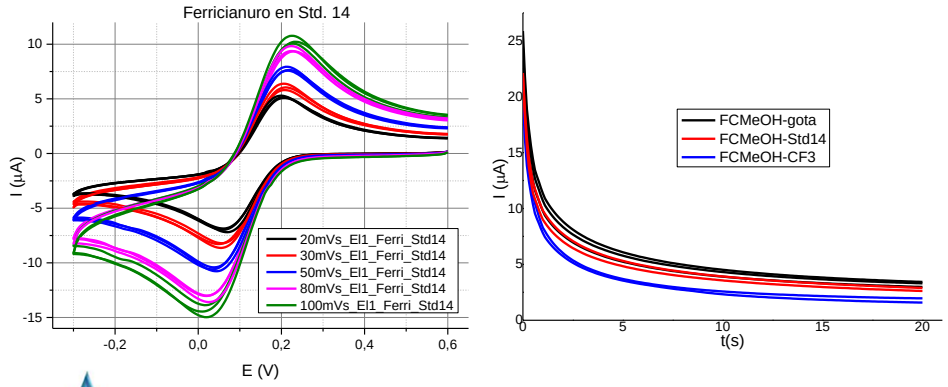




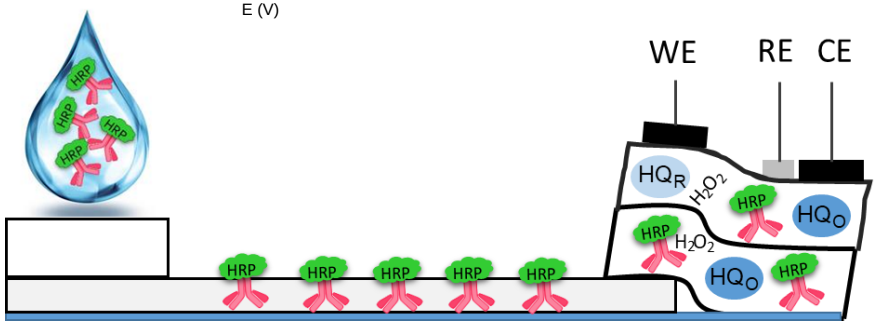


Conclusions of the 1st year

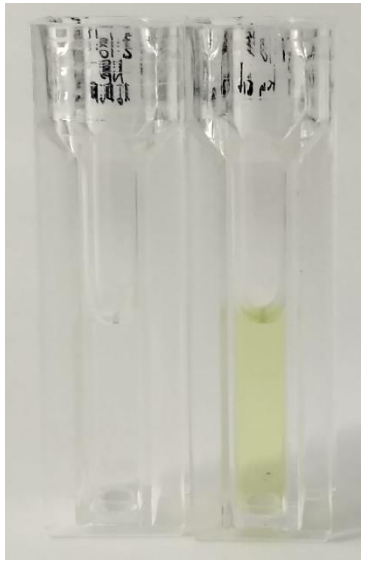
1. Glassy fiber is a better matrix for electrochemical reaction in comparison with cellulose



2. The optimization in geometry adding a new platform to optain better response has the same response in lateral-flow and without it



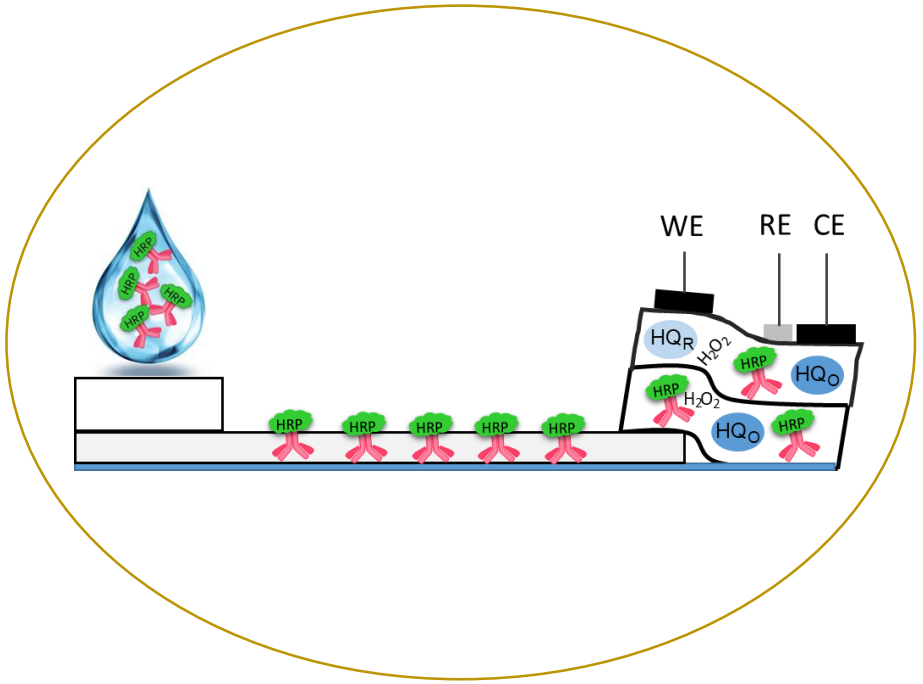
3. Preliminary tests with CeO2 NPs confirms us that we can use it to substitute enzyme



Future work

To study the activity of NPs in paper

Test the NPs-Ab in paper and in the optimized design



Conjugate antybodies to NPs (NPs-Ab)

To create completly new geometry and not based on lateral-flow