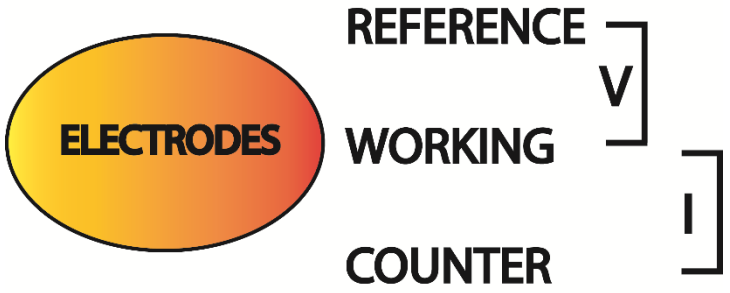
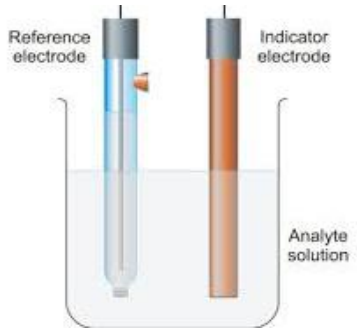
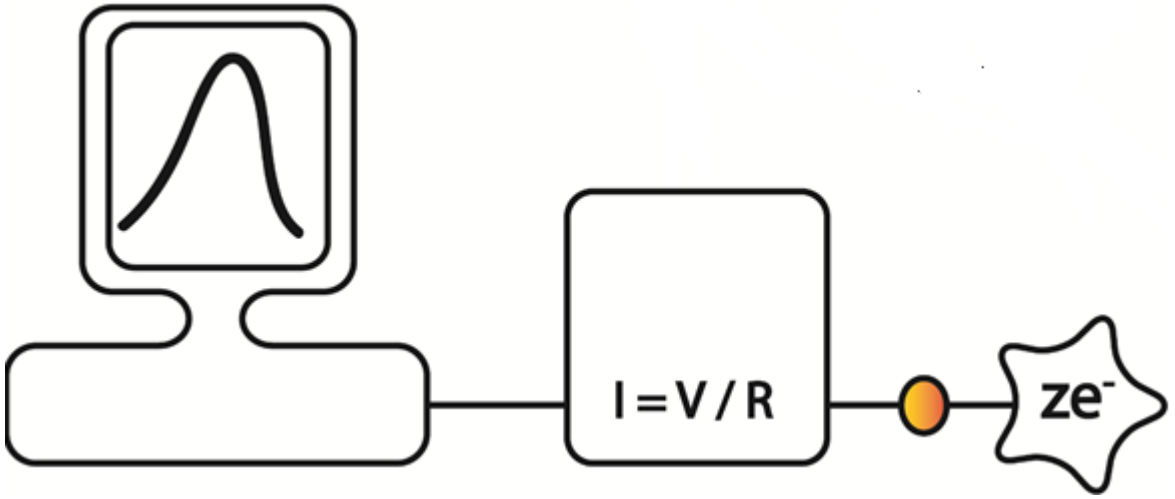
Electrochemistry

Overview: electrochemistry. Classical set-up



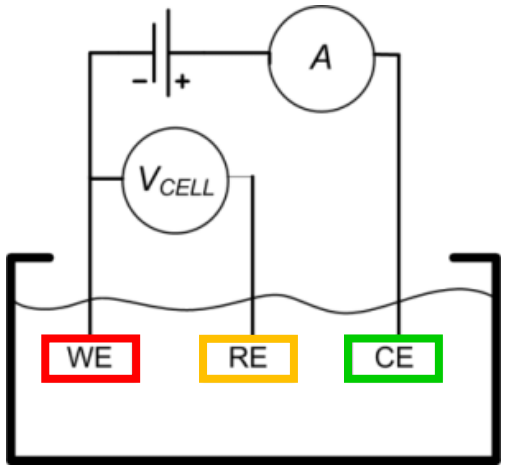


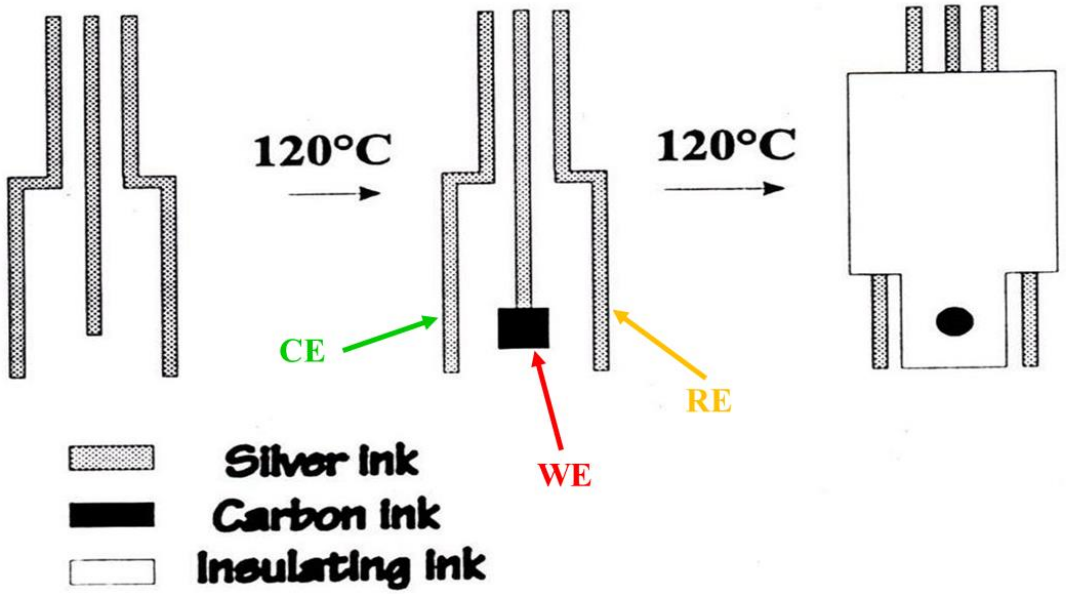
Graphite, silver, gold

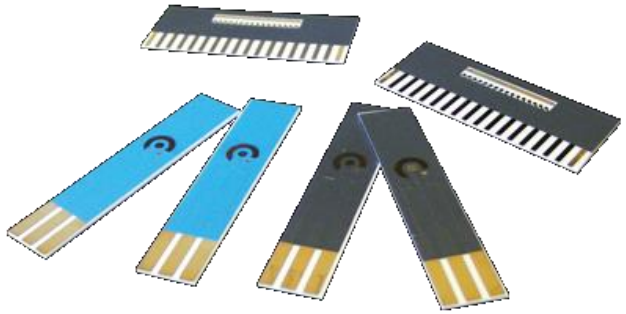


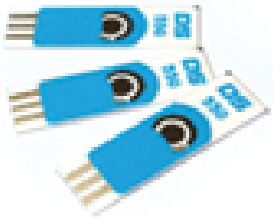
Electrochemistry

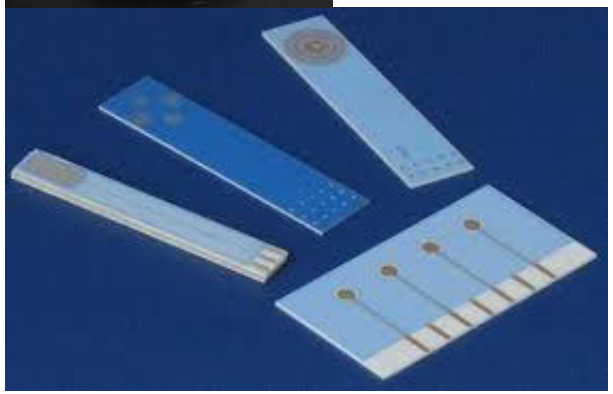
Overview: electrochemistry. Disposable Screen printed electrode



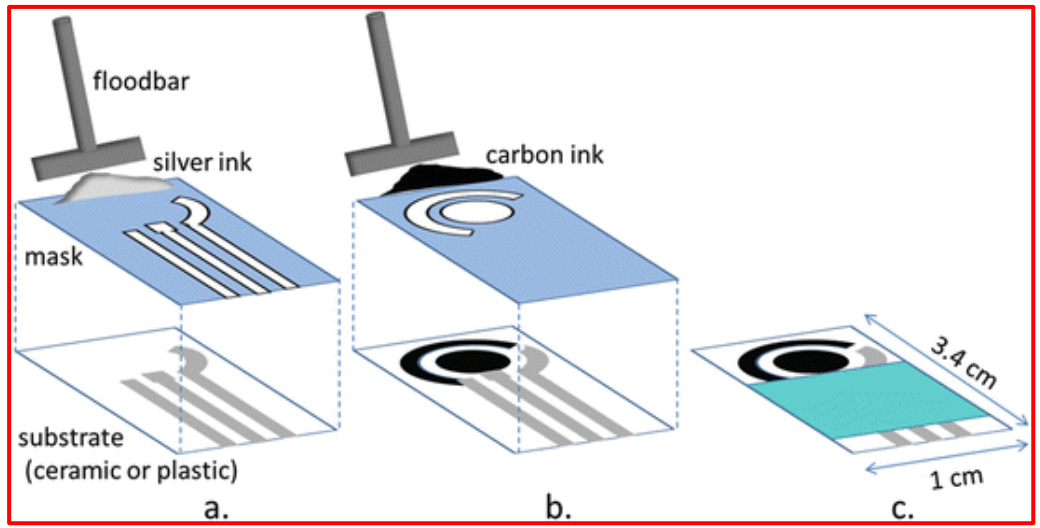






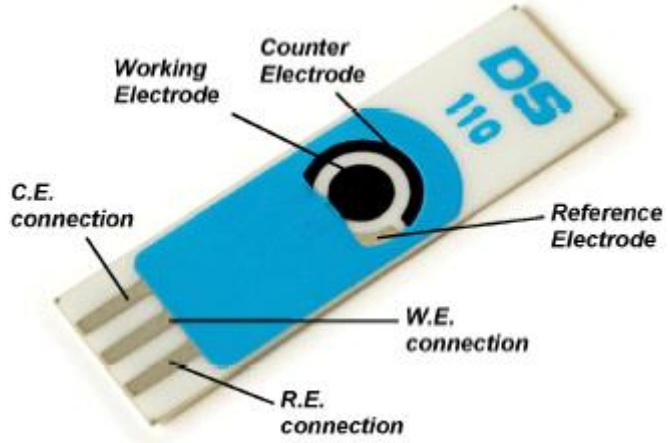


Fabrication steps →



Electrochemistry

Overview Voltametric measurement

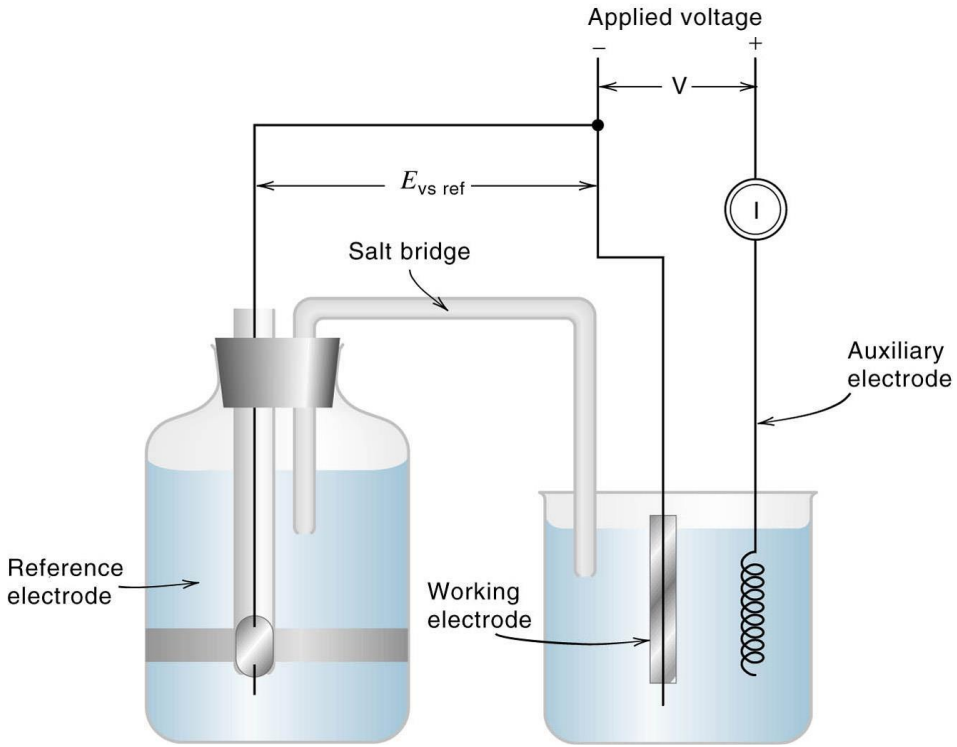


- In voltammetry, 3 electrodes (reference, work and counter electrode) and a potentiostat are used.

- In fact, since E = i R, to accurately control E during scanning it is necessary that redox reactions takes place between the working electrode and a counter electrode.

The current passes between the counter electrode (auxiliary) and the working electrode

The applied potential is between the reference electrode and the working electrode



Electrochemistry

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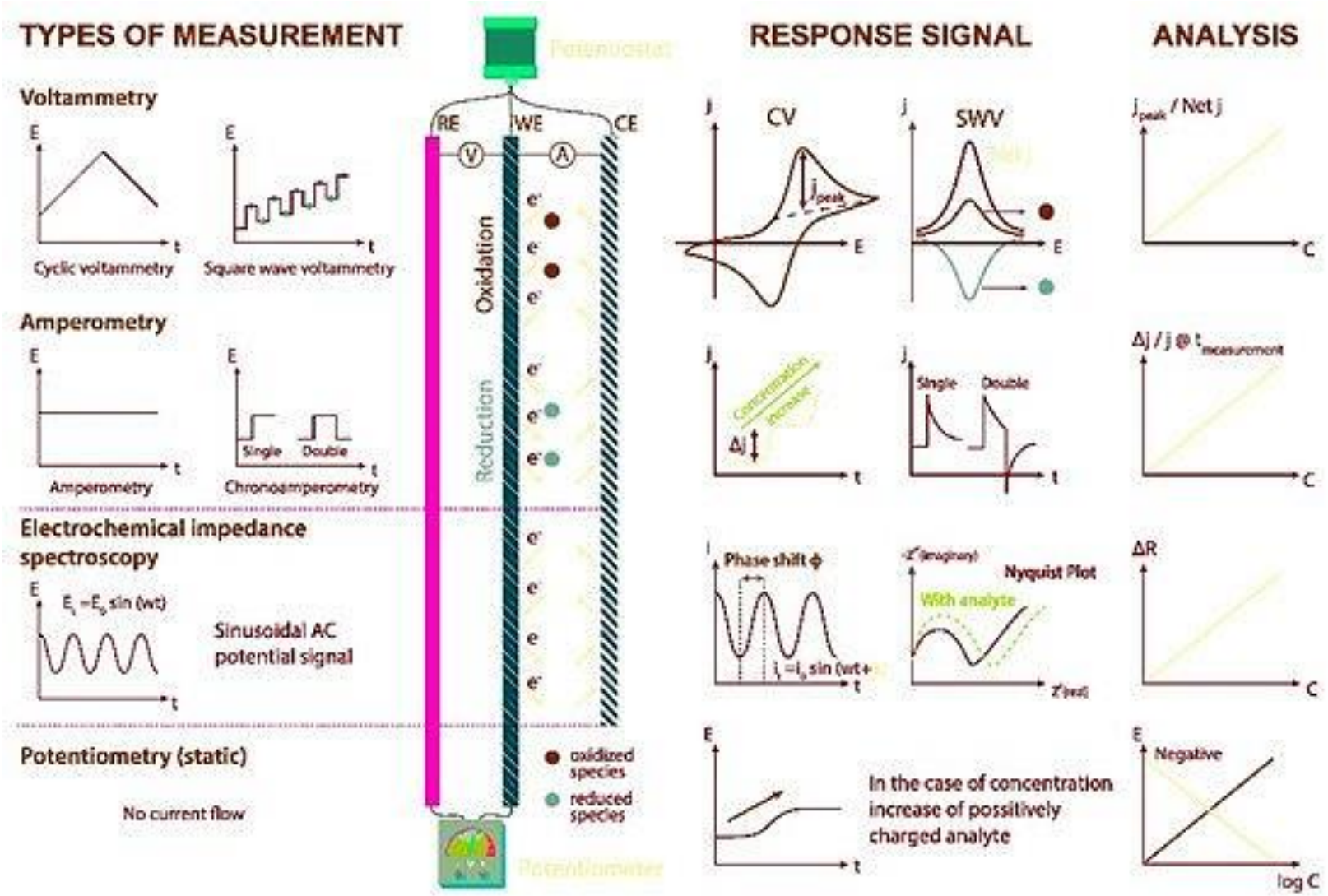
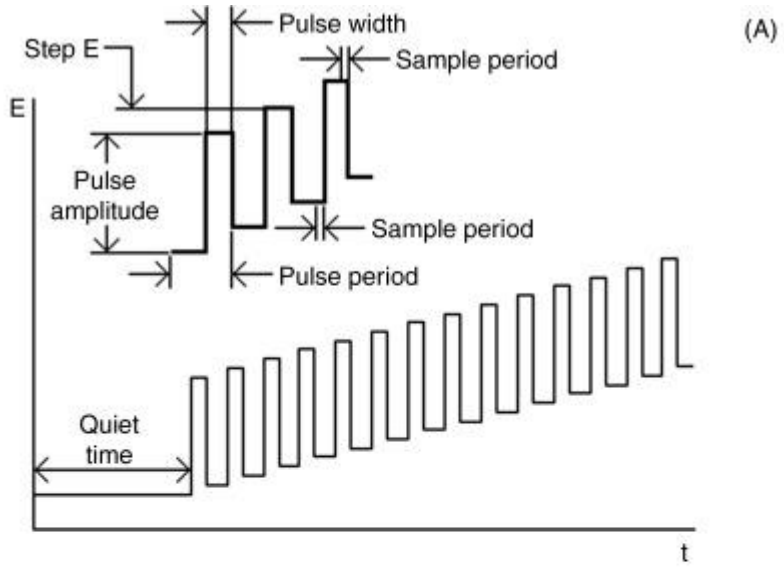
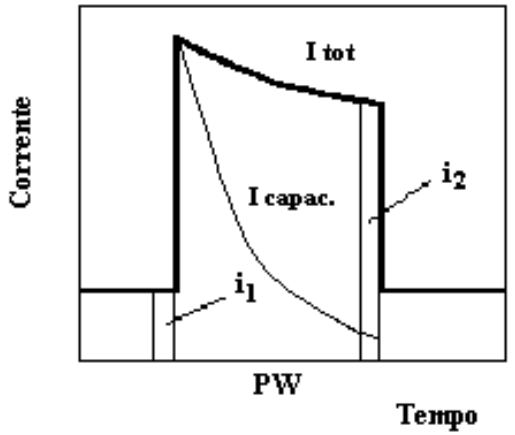
Overview: Types of measurement

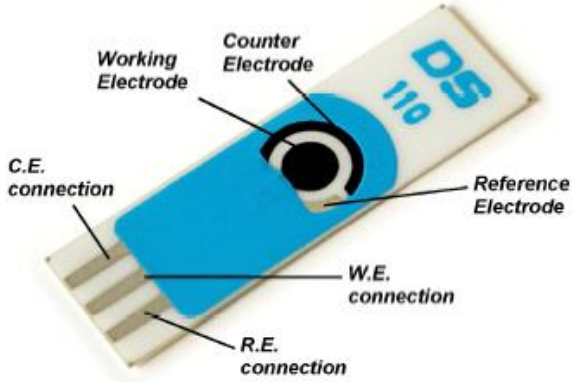


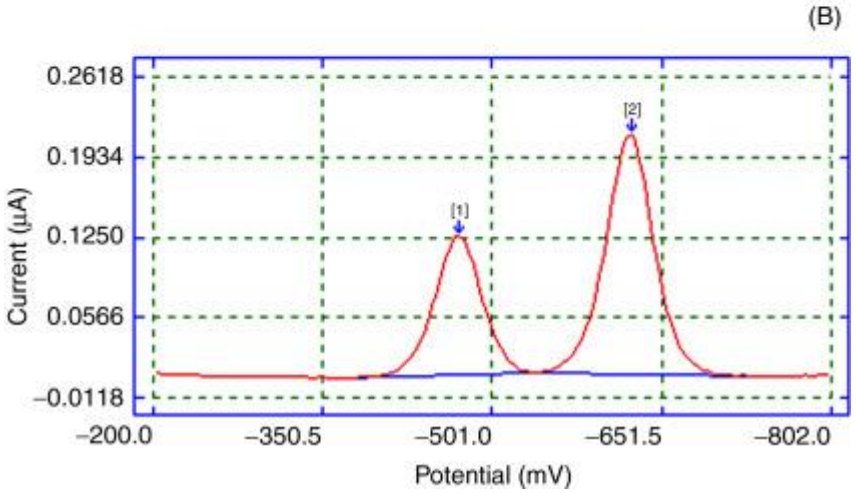
Electrochemistry

Overview: Differential pulsed voltammetry

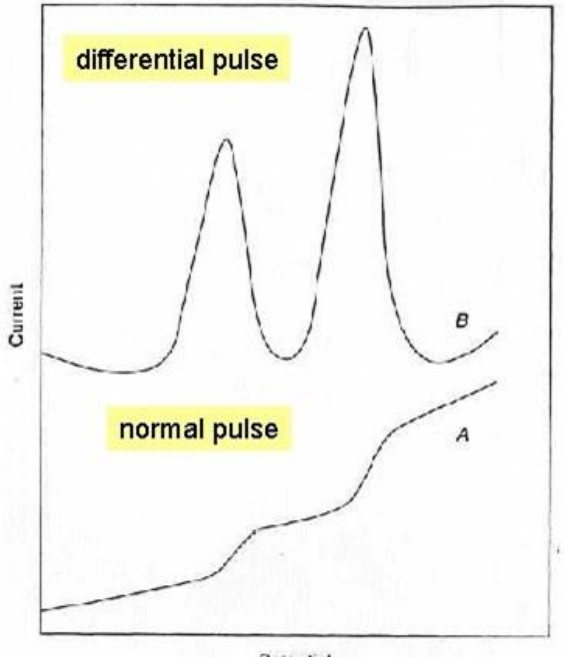








- allows measurement down to 10-8 M concentration
- improved resolution between the species with similar potential (down to 50 mV)

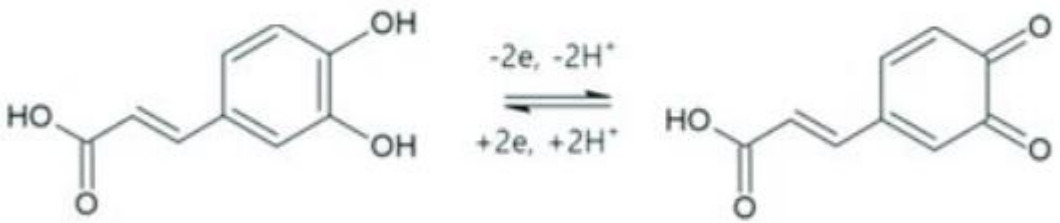


Electrochemistry

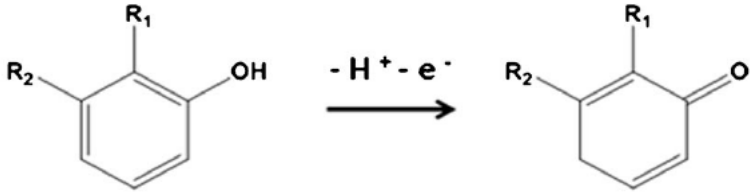
Overview: Example of DPV measurement.

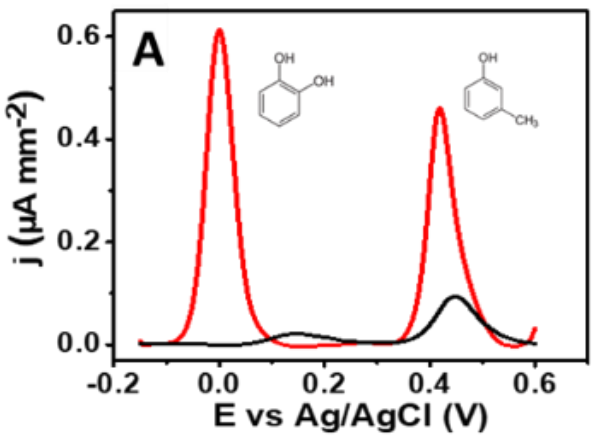
O-diphenols and mono-phenols quantification by using DPV

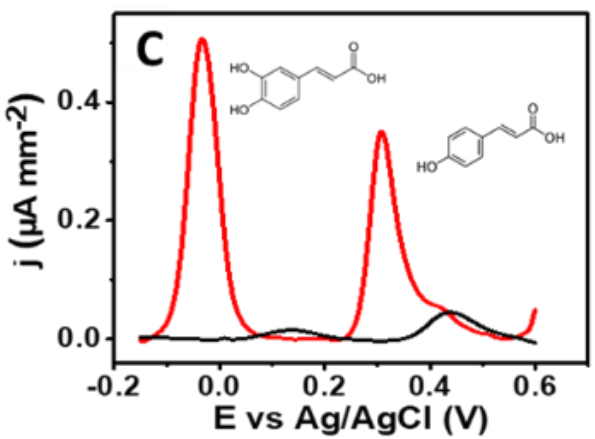
o-diphenols

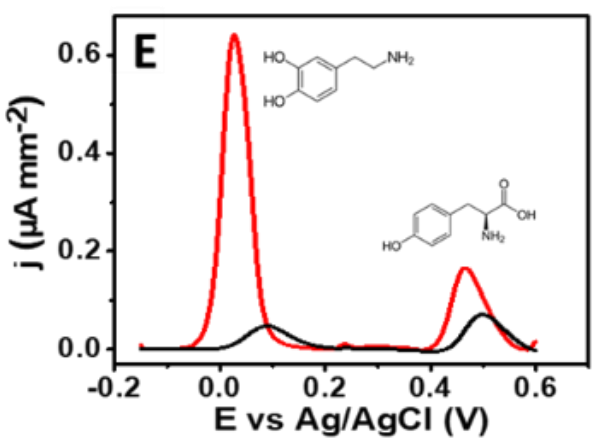


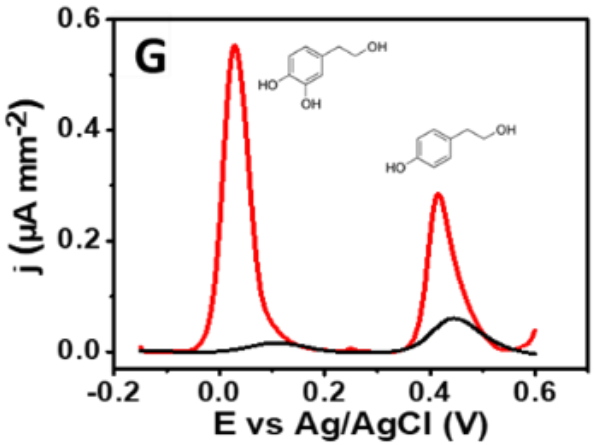
m-phenols





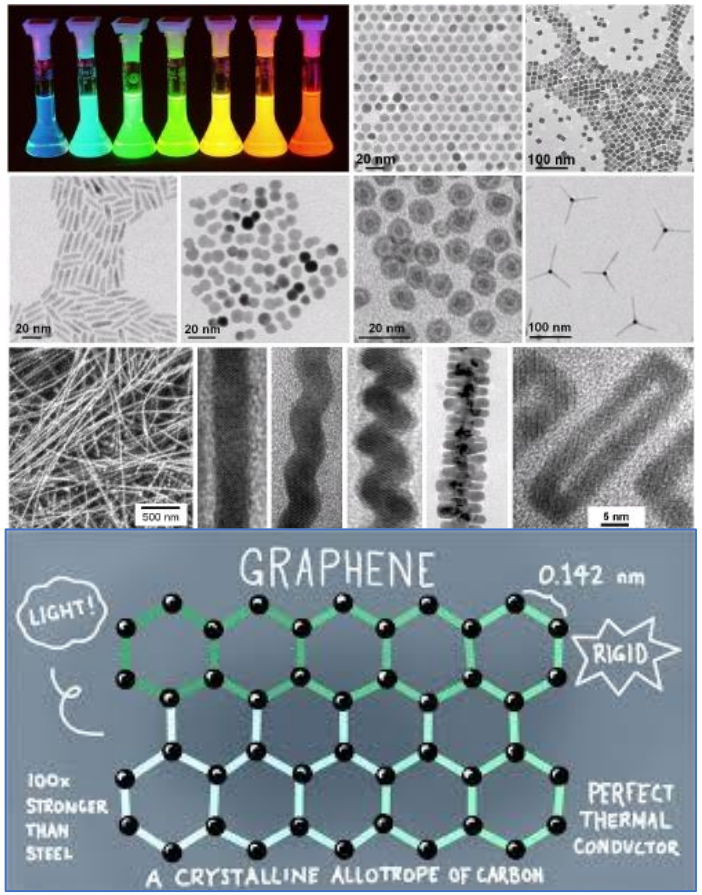






Electrochemistry

Overview: Nanomaterials employed for electrochemical sensor improvement



Nanomaterials:

Carbon based nanomaterials:

- Nanotubes
- **CARBON BLACK**
- Fullerenes
- Graphene
- Etc…

Nanoparticles:

- Metal nanoparticles
- Metal Oxide nanoparticles

Graphene-like nanomaterials:

- e.g. Tansition Metal Dicalchogenised (TMD)

The working electrode surface could be modified with nanomaterials and further modified with bioreceptor

Electrochemistry

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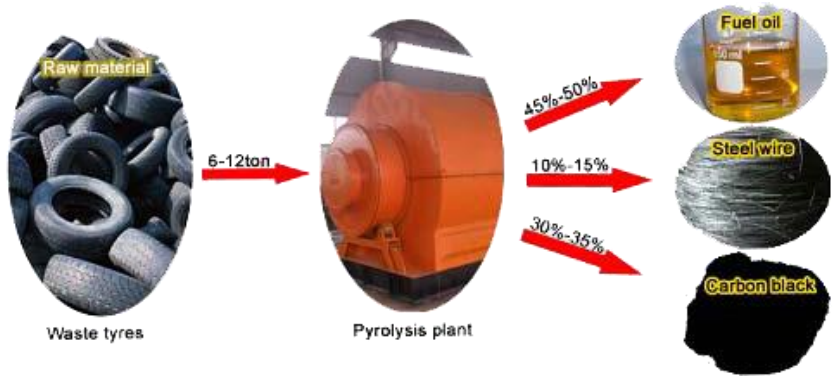
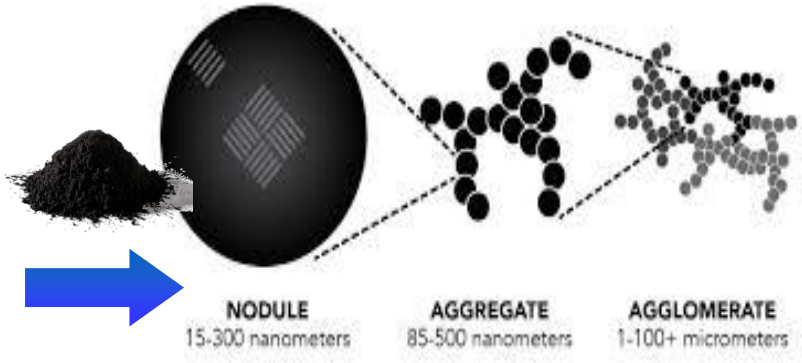
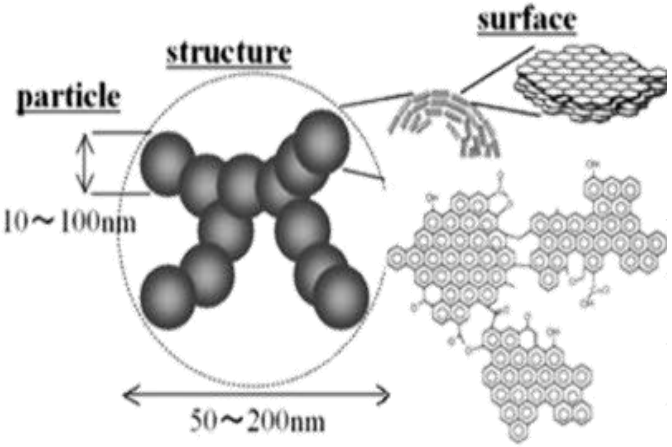
Overview: Carbon Black







CB compared with other nanomaterials:

Very low cost
No synthesis
No impurities due to synthesis

Easily dispersible
Large number of defect sites

Electrocatalysis → Selectivity

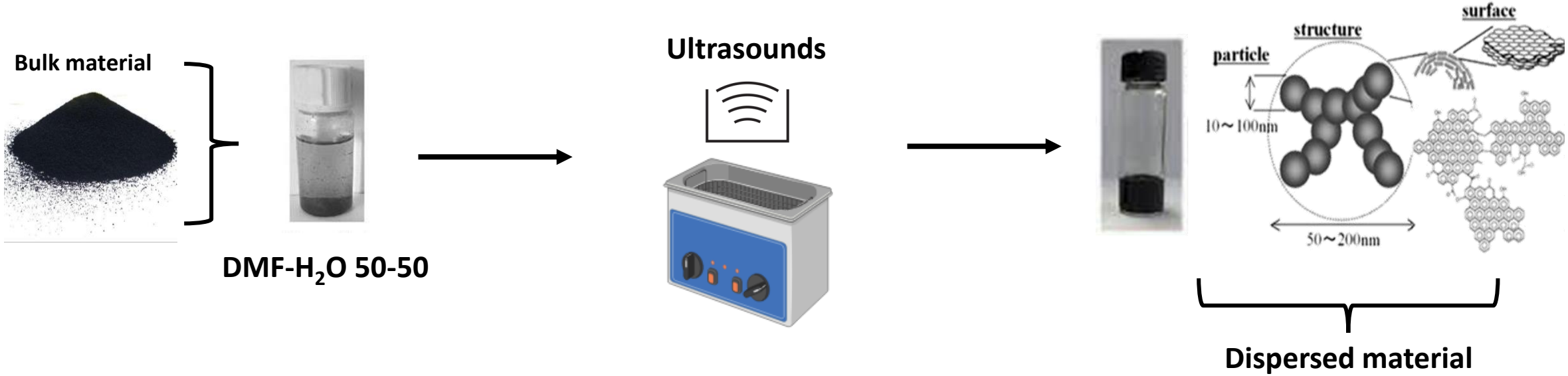
High surface → Sensitivity

Resistance to fouling → Reproducibility

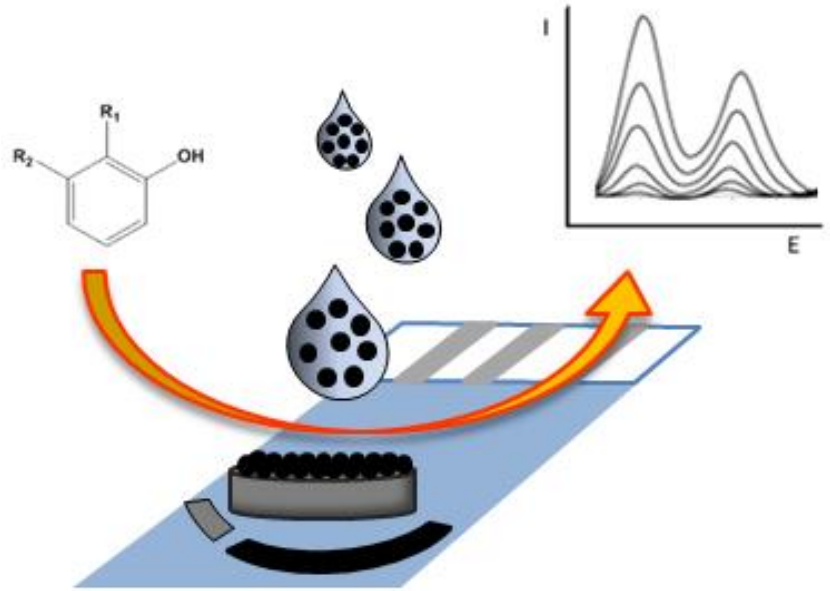
Faster eletron transfer → Improving separation performance

Electrochemistry

- Material preparation and electrode modification



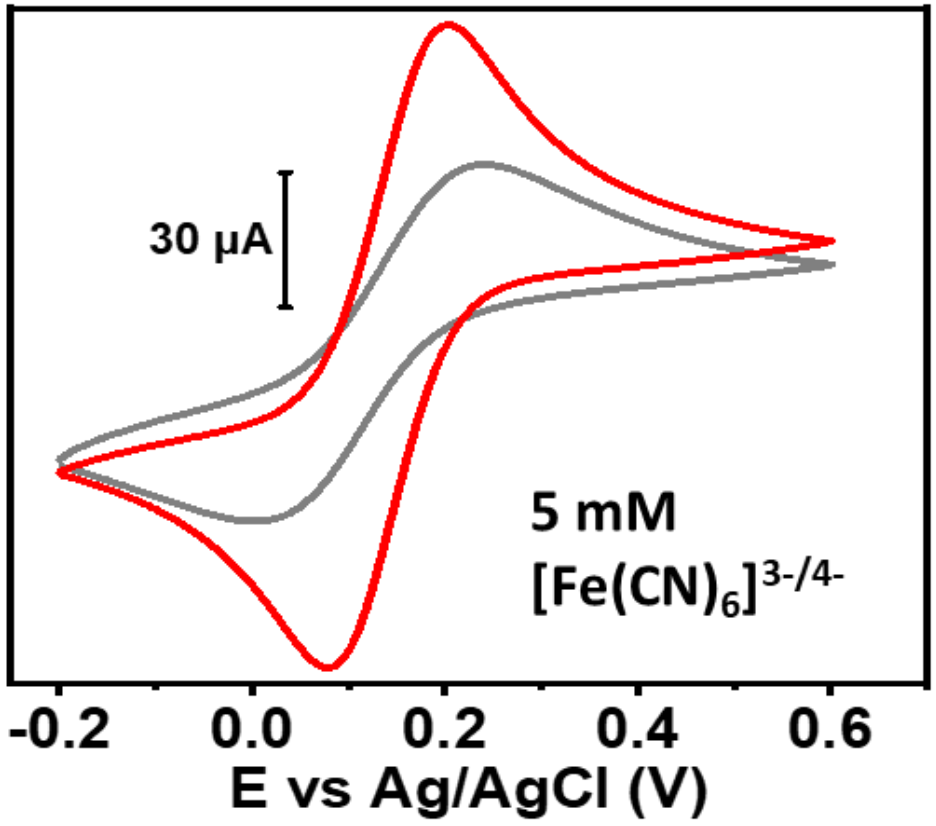
Drop-casting

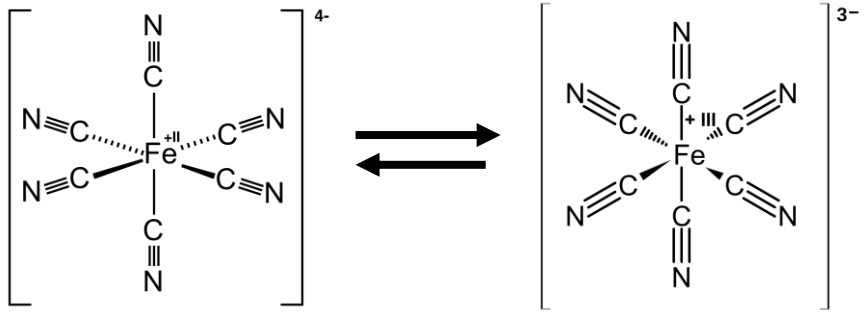


Electrochemistry

- Electron-transfer properties improvement brought by carbon black

Cyclic voltammetry with Ferro-Ferricyanide





Grey: unmodified electrode

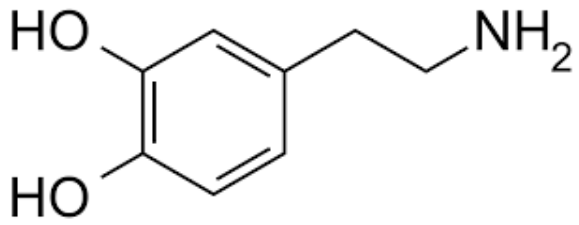
Red: modified electrode

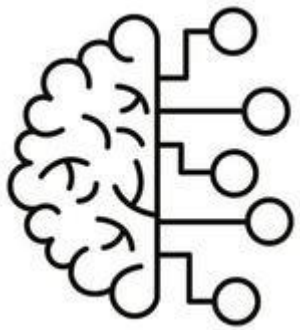
- Higher intensity current
- Better reversibility
- Overall improvement of the performance

Electrochemistry

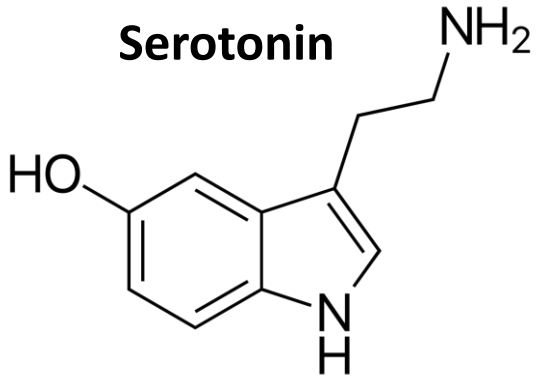
- Real application:
  Dopamine and serotonin quantification by using DPV.

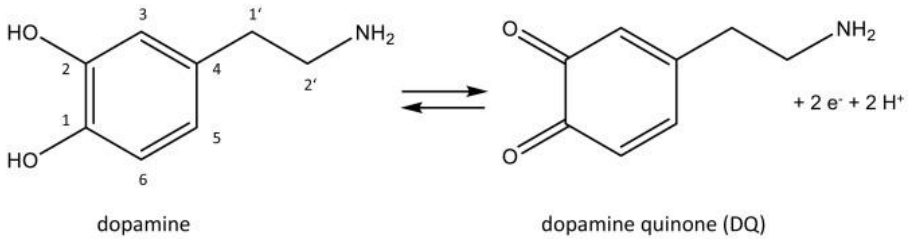
Dopamine

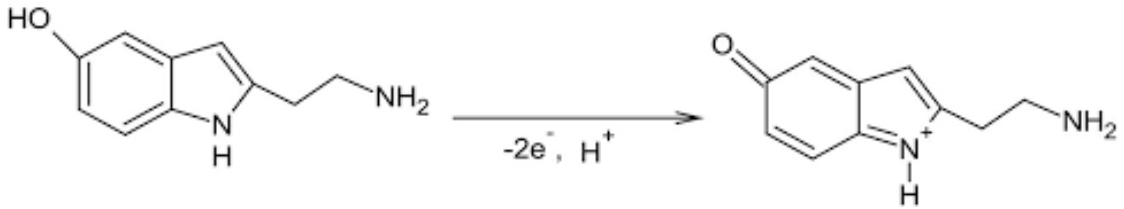




Serotonin



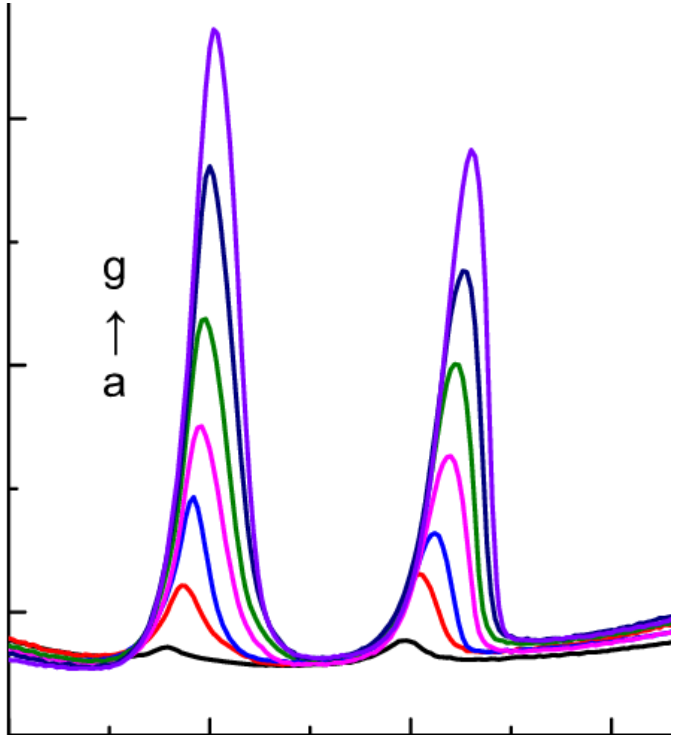




Electrochemistry

- Real application:
  Building of dose-response curve

DPV experimental signal

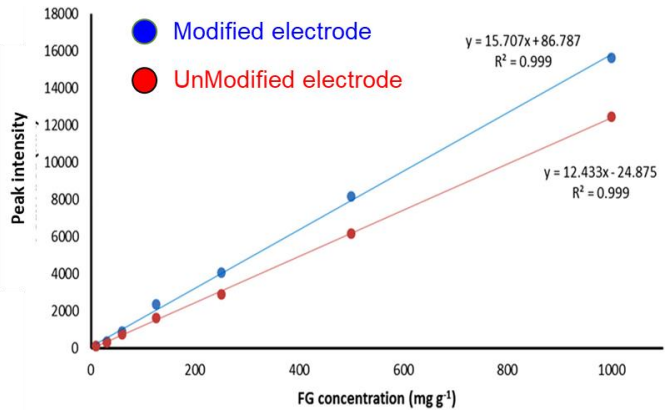


Calculations

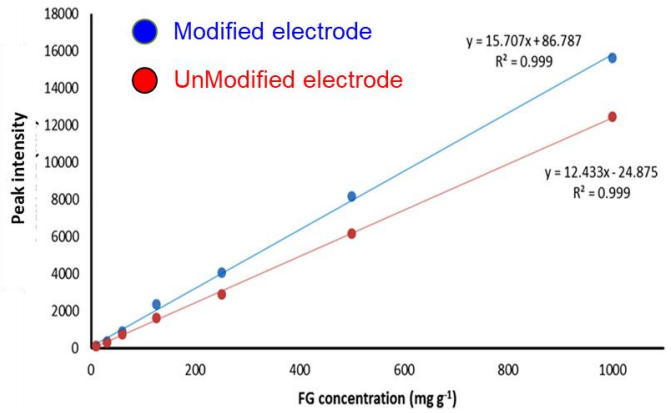
Dopamine Concentration (μM)	Dopamine volume to add (μL)	Serotonin Concentration (μM)	Serotonin volume to add (μL)	Buffer to add (μL)
0.25		0.5		
0.5		1		
1		2		
2.5		5		
5		10		

Dose-response curve
Current intensity vs. [Standard]

Dopamine

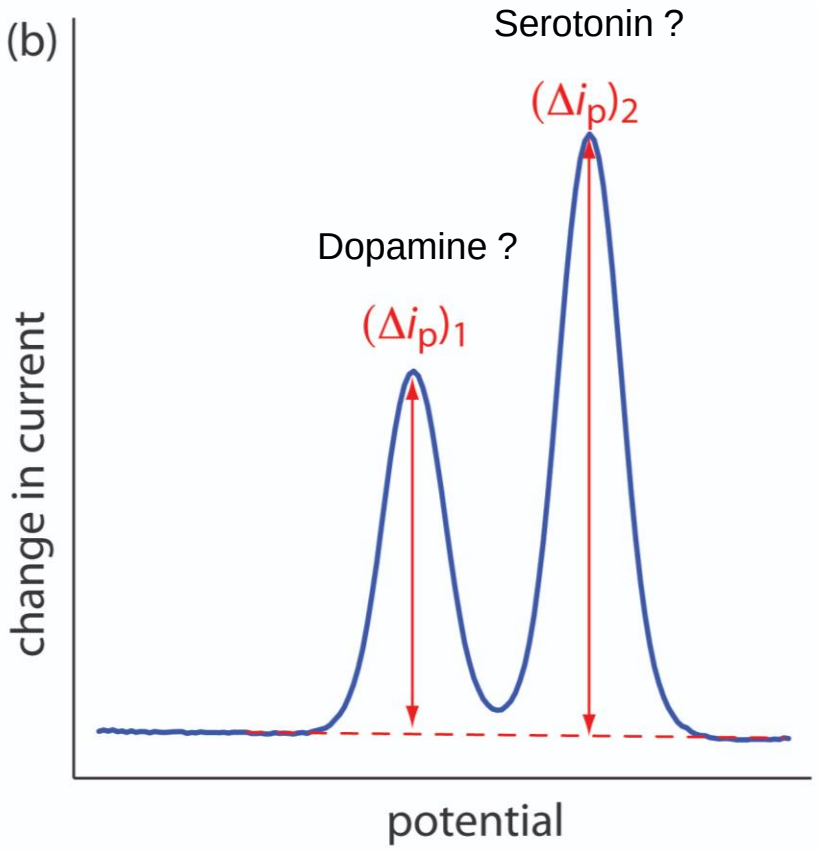


Serotonin

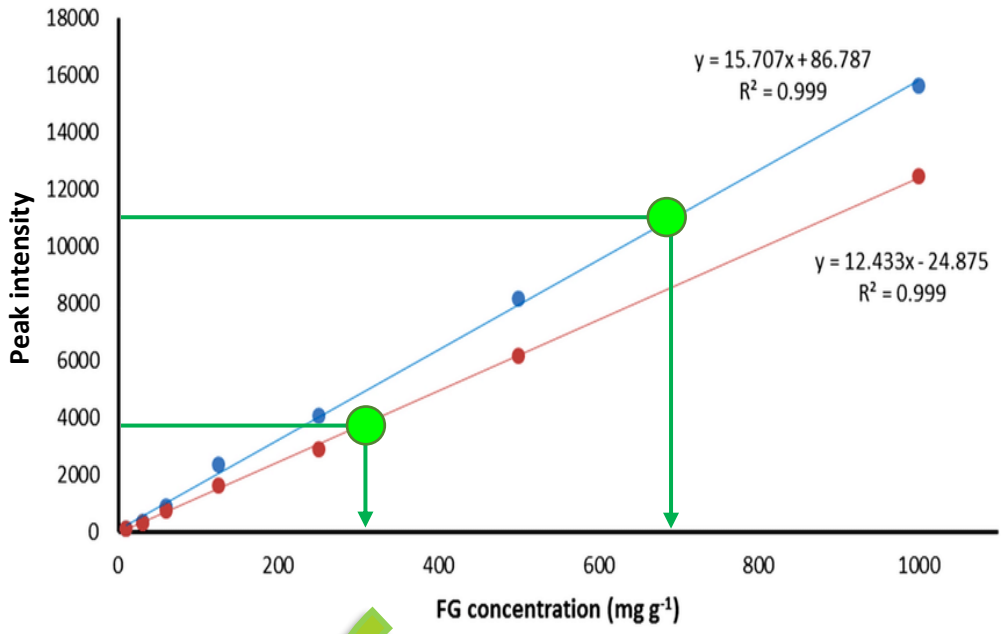


Electrochemistry

- Real application:
  Dopamine and Serotonin evaluation in real samples



Unknown sample



$$x = \frac{y +/- q}{m}$$