Fuel Cell Electrodes: Electrochemical Characterization and Electrodeposition of Pt nanoparticles

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Energy and Processes

CSIR

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Outline

- Introduction
- Types of Fuel Cells
- Polymer Membrane Fuel Cell
- Electrochemical Characterization
- Future Work

What is a fuel cell?

- Device that uses a chemical fuel such as hydrogen (or hydrogen-rich fuel) and an oxidant, e.g., oxygen to generate electricity directly from electrochemical processes

- The by-products from an operating fuel cell are heat and water

Types of fuel cells (FC)

- Alkaline Fuel Cell (AFC)

Electrolyte: alkaline potassium hydroxide

- Molten Carbonate Fuel Cell (MCFC)

Electrolyte: carbonate-salt-impregnated ceramic matrix

- Solid Oxide Fuel Cell (SOFC)

Electrolyte: hard, non-porous ceramic compound

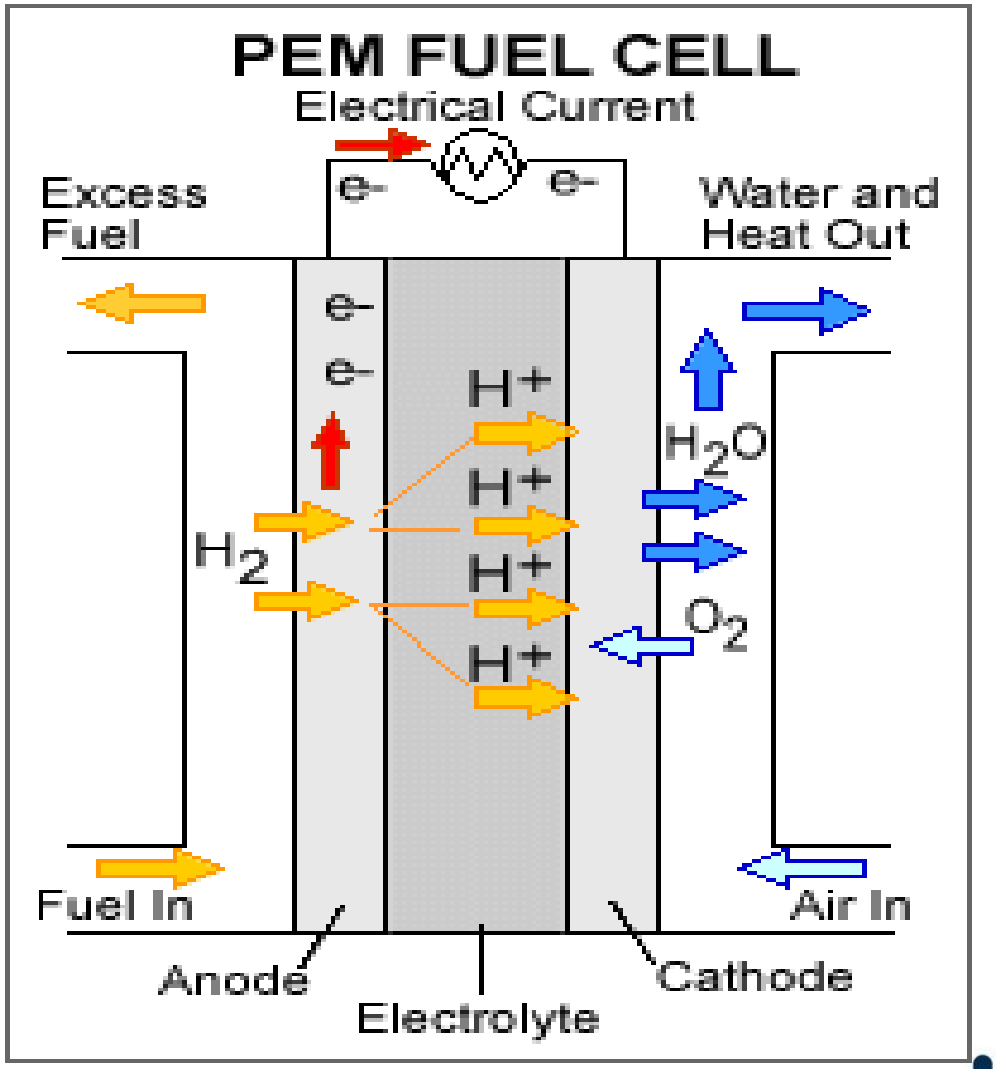
- Phosphoric Acid Fuel Cell (PAFC)

Electrolyte: liquid phosphoric acid

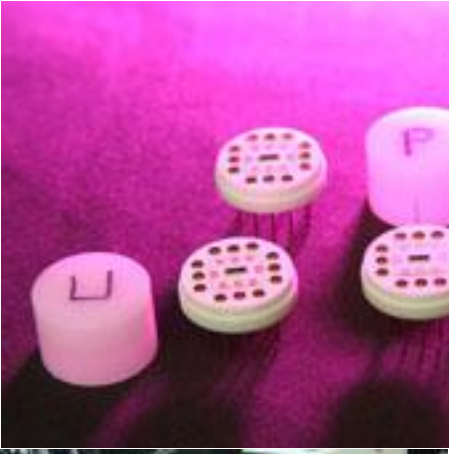
- Polymer Electrolyte Membrane Fuel Cell (PEMFC)

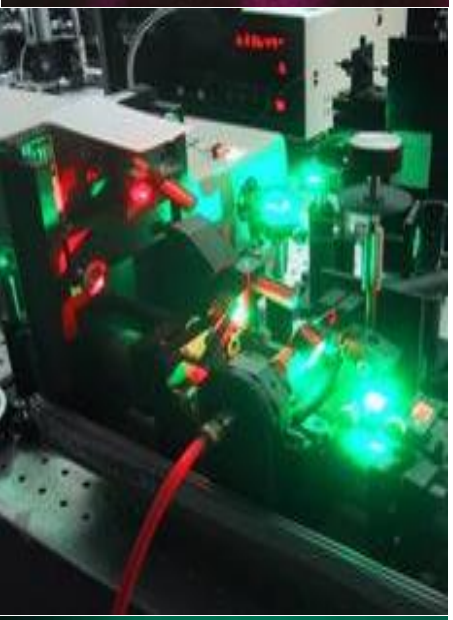
Electrolyte: solid polymer membrane (typically Nafion)

PEMFC



http://fuelcellsworks.com/

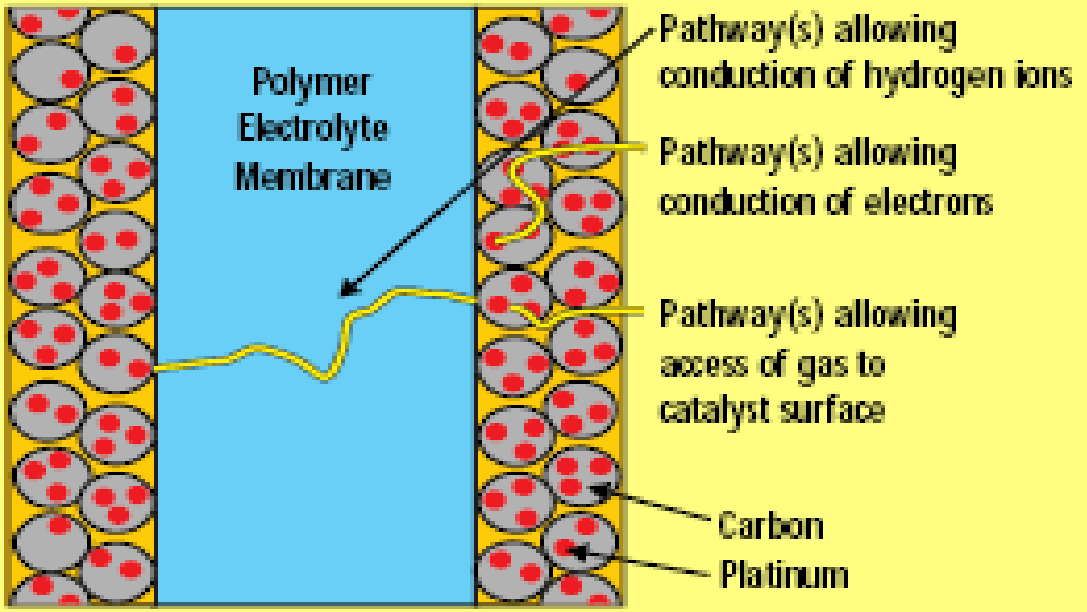




Electrodes

Anode Reactions: $2H_2 \Rightarrow 4H^+ + 4e^-$

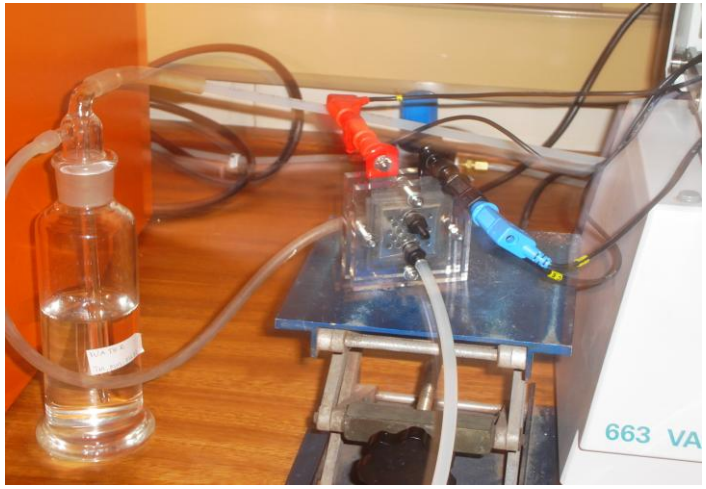
Cathode Reactions: $O_2 + 4H^+ + 4e^- \Rightarrow 2\,H_2O$

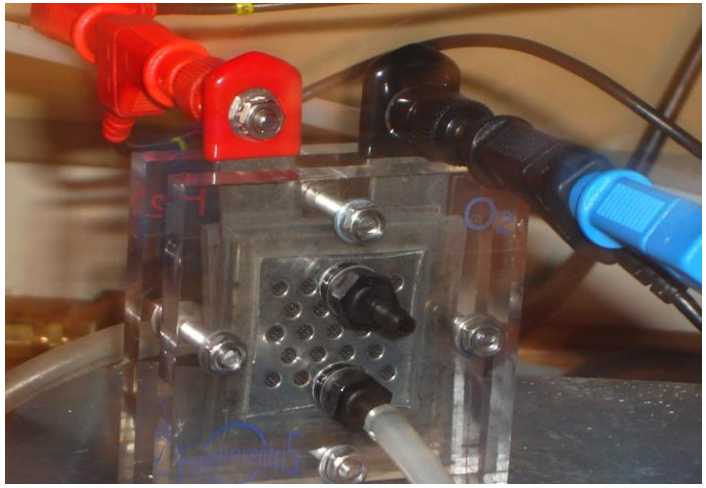


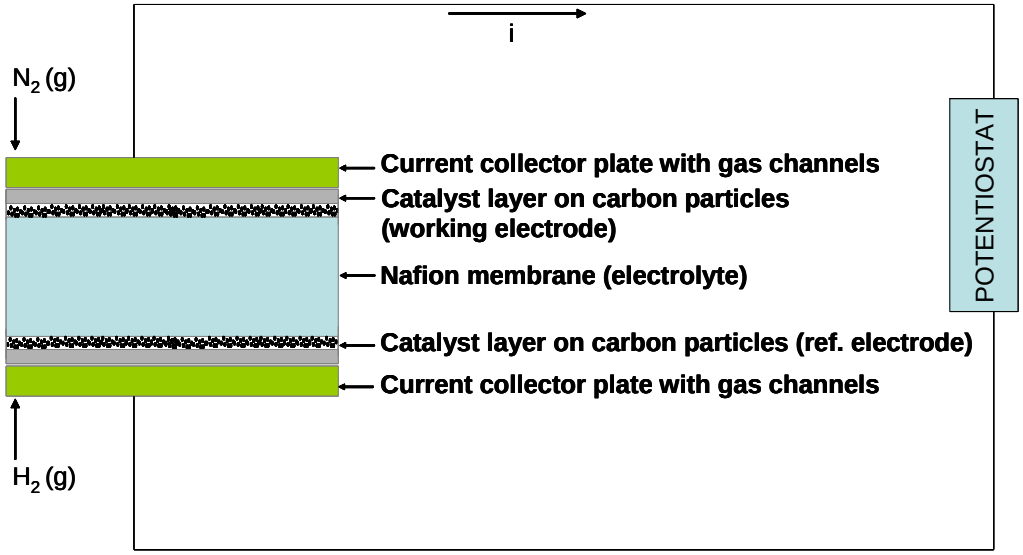
Polymer electrolyte membrane with porous electrodes that are composed of platinum particles uniformly supported on carbon particles.

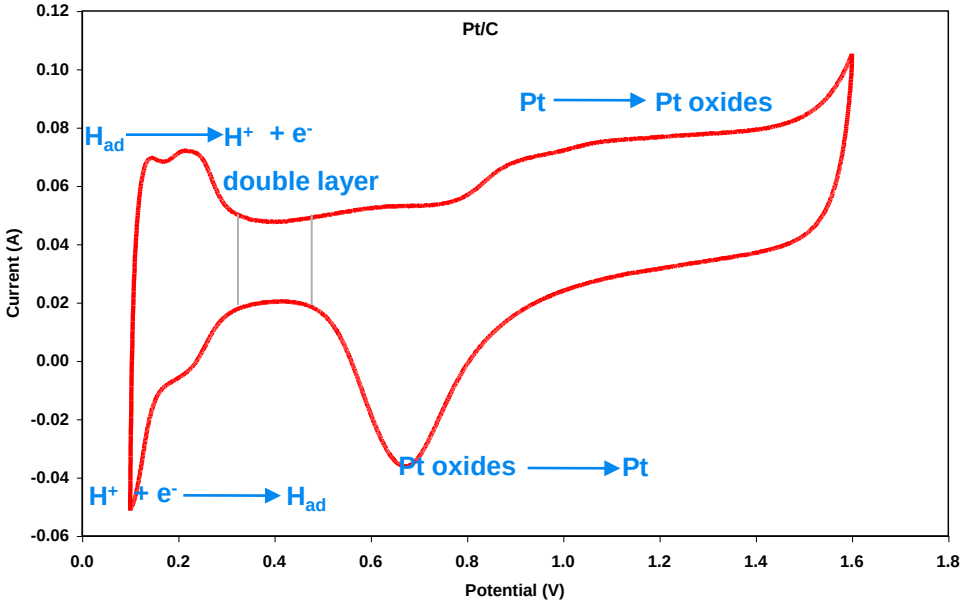
Electrochemical Characterization

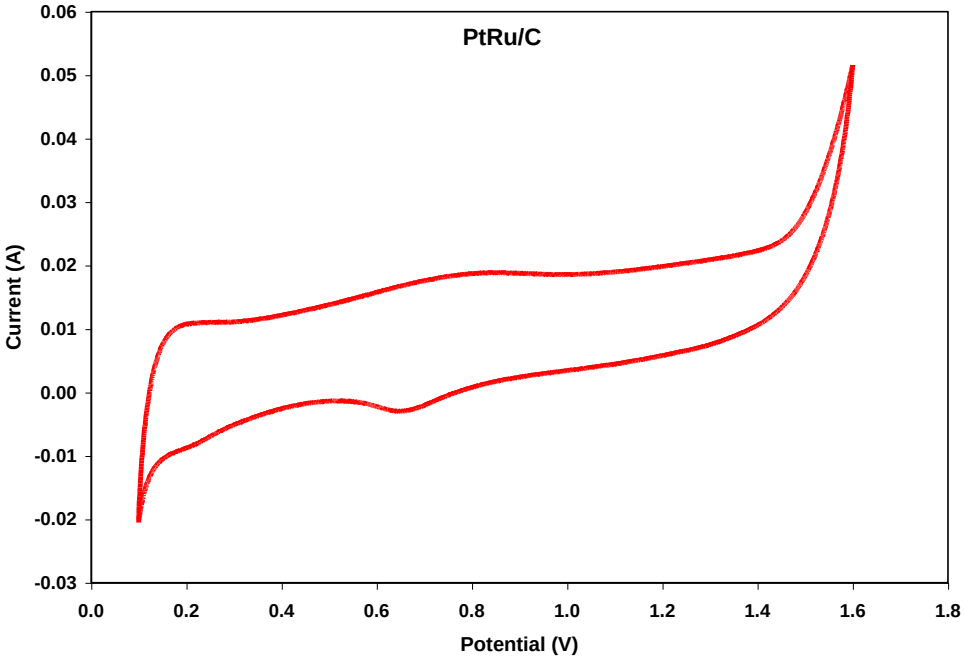
- In situ cyclic voltammetry: Active electrochemical area, Pt utilization











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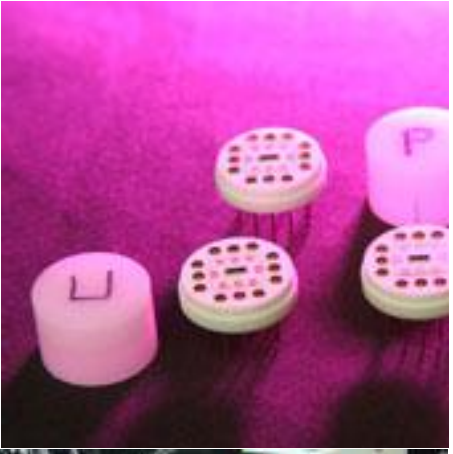
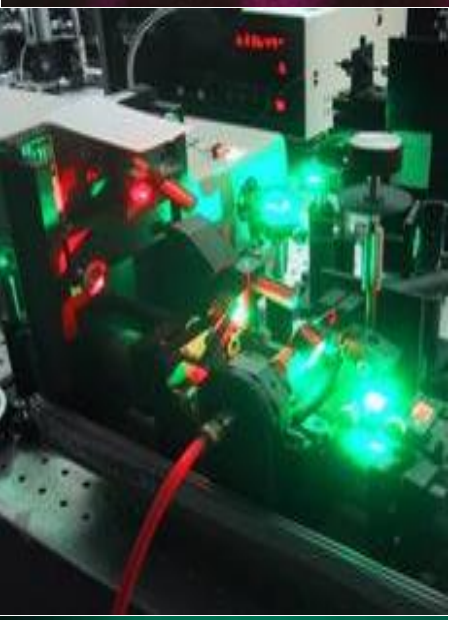


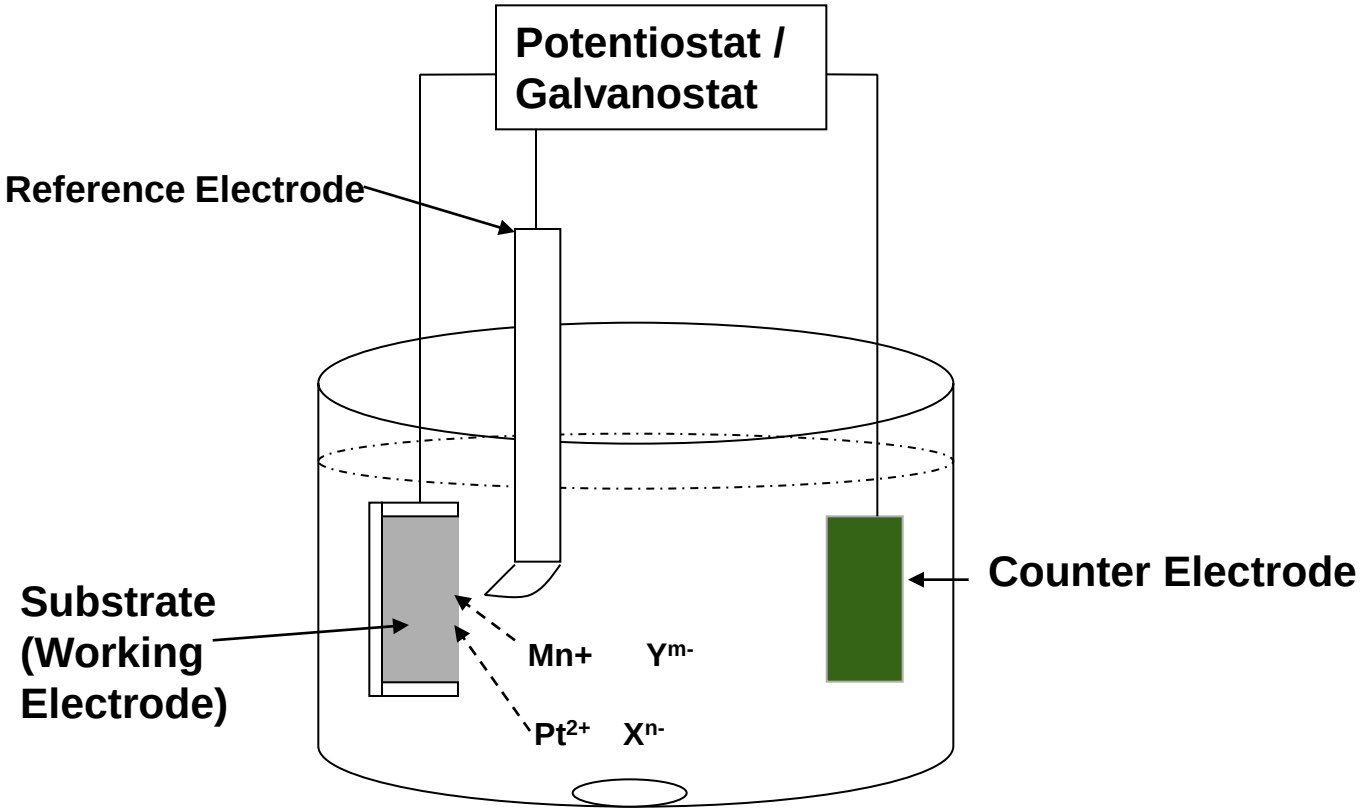


Future work

- Catalyst preparation and MEA fabrication:
  - Electrodeposition methods
  - Electrochemical Atomic Layer Epitaxy (EC-ALE)

- Characterization:
  - Cyclic voltammetry
  - Impedance spectroscopy
  - CO stripping

Electrodeposition of Pt-based nanoparticles



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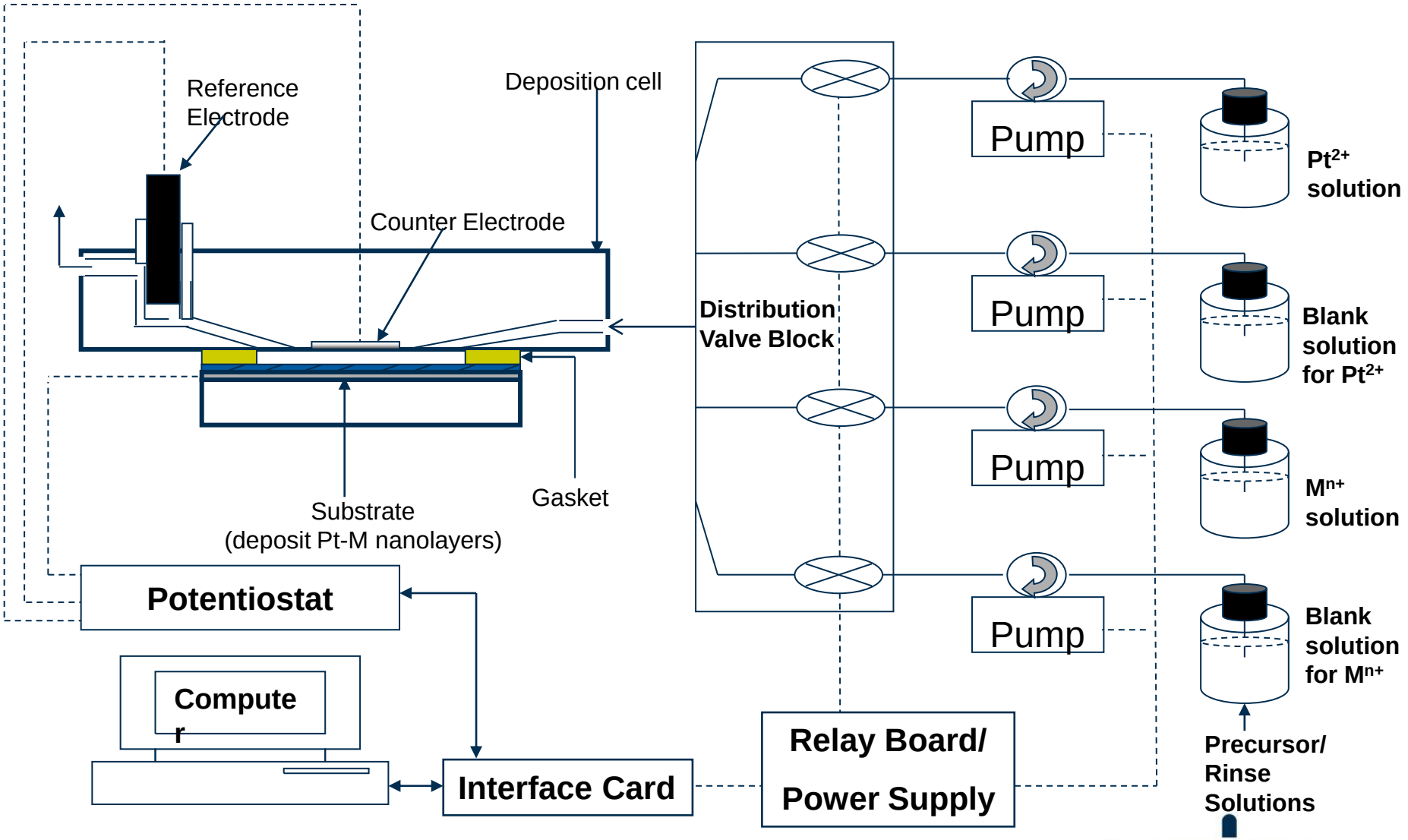
EC-ALE Reactor



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Thank you