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# **Polarizable Non-polarizable Electrode**

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21.10.2019

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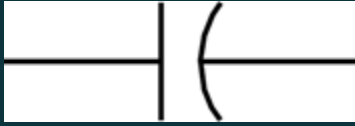
# Outline

- Polarizability
  - Polarizable Electrode/Non-Polarizable Electrode
  - Circuit model for electrode-skin interface
  - The Platinum Electrode
  - The Silver/Silver Chloride Electrode
  - Sintered Ag/AgCl electrode
  - References
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# Polarizability

Polarizability is simply a measure of the dependence of the electron transfer rate on the electrode potential.

# Polarizable Electrode



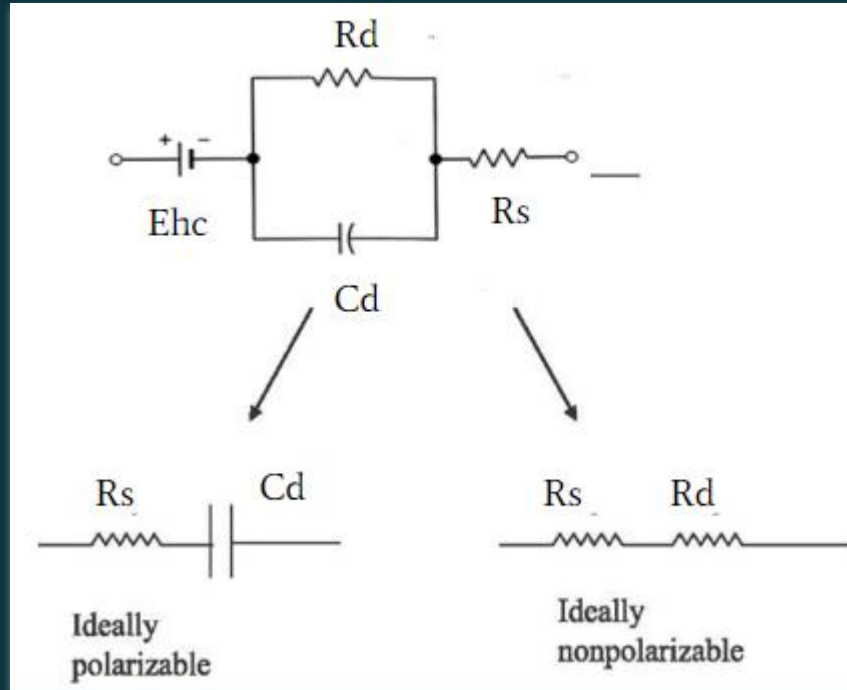
- No charge crosses the electrode when current is applied
- Current does not cross, but rather changes the concentration of ions at the interface.
- Noble metals are closest (like platinum and gold); they are difficult to oxidize and dissolve.
- Behave like a capacitor.

# Non-Polarizable Electrode



- All charge freely crosses the interface when current is applied.
- No overpotential is generated.
- Silver/silver-chloride is a good non-polarizable electrode.
- Behave like a resistor.

# Equivalent circuit model for electrode-skin interface



**$C_d$** : capacitance of electrode-electrolyte interface

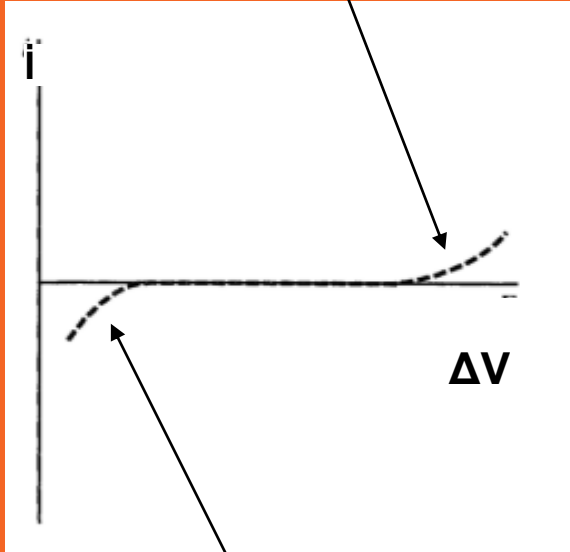
**$R_d$** : resistance of electrode-electrolyte interface

**$R_s$** : resistance of solution

**$E_{hc}$** : cell potential for electrode

# Polarizable electrode

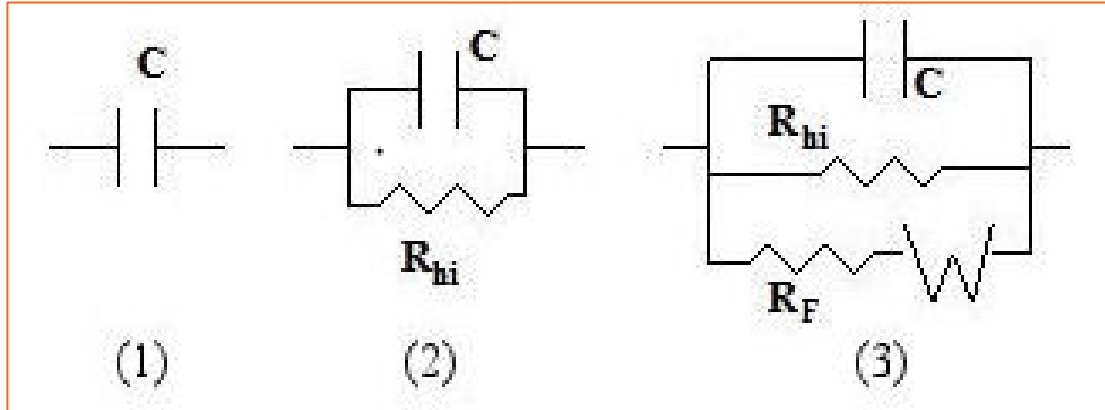
current due to the oxidation of electrolyte,electrode



current due to the reduction of electrolyte,electrode

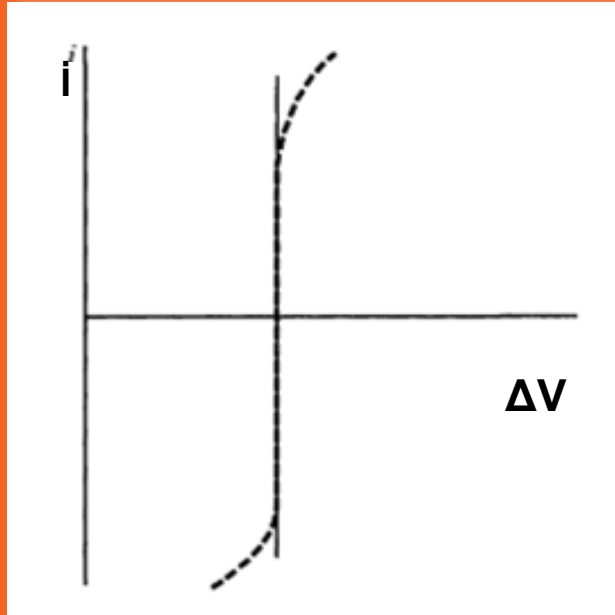
- An ideal polarized electrode shows a very large change in potential upon the passage of a small current.

# The equivalent circuit of polarizable electrodes



An ideal polarizable electrode can be represented by a capacitor (condenser) in equivalent circuit as shown in Fig. 1.

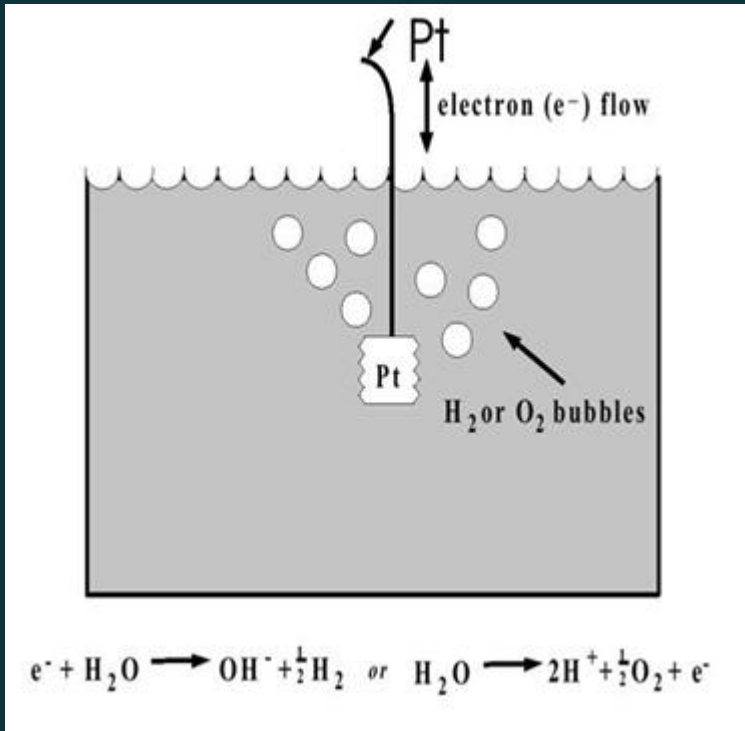
# Non-Polarizable electrode



- Ideal nonpolarizable electrode whose potential does not change upon passage of current.

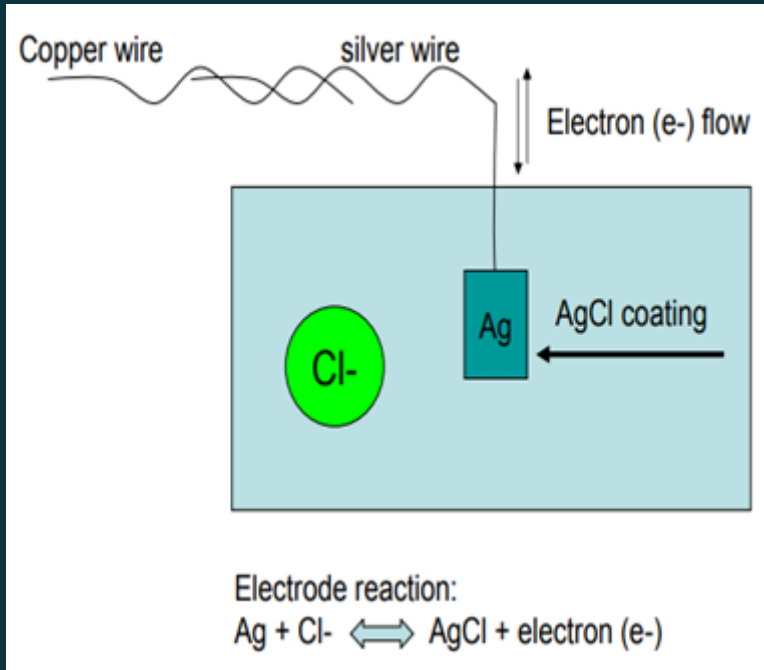


# The Platinum Electrode



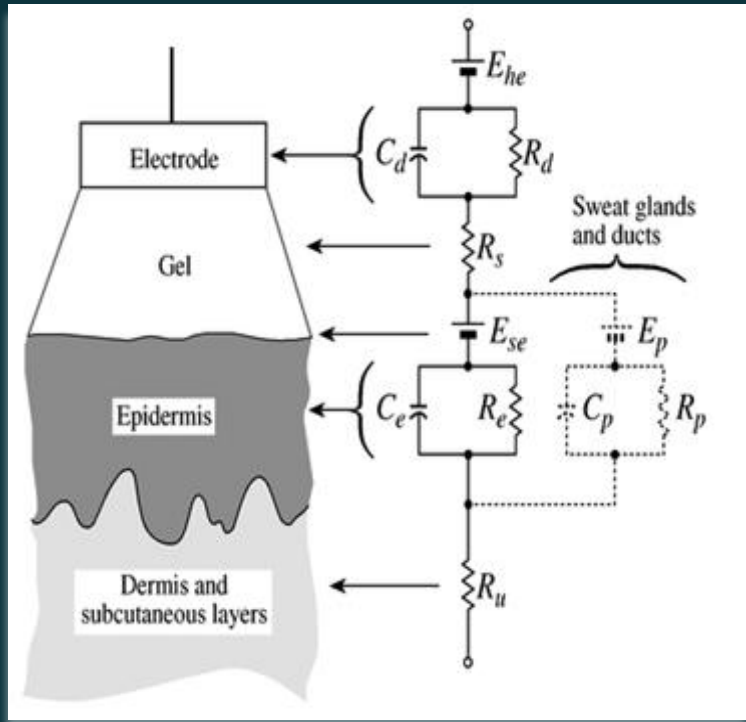
- (Pt), is irreversible but not exhaustible
- At its surface, Pt catalyzes the electrolysis of water.

# The Silver/Silver Chloride Electrode



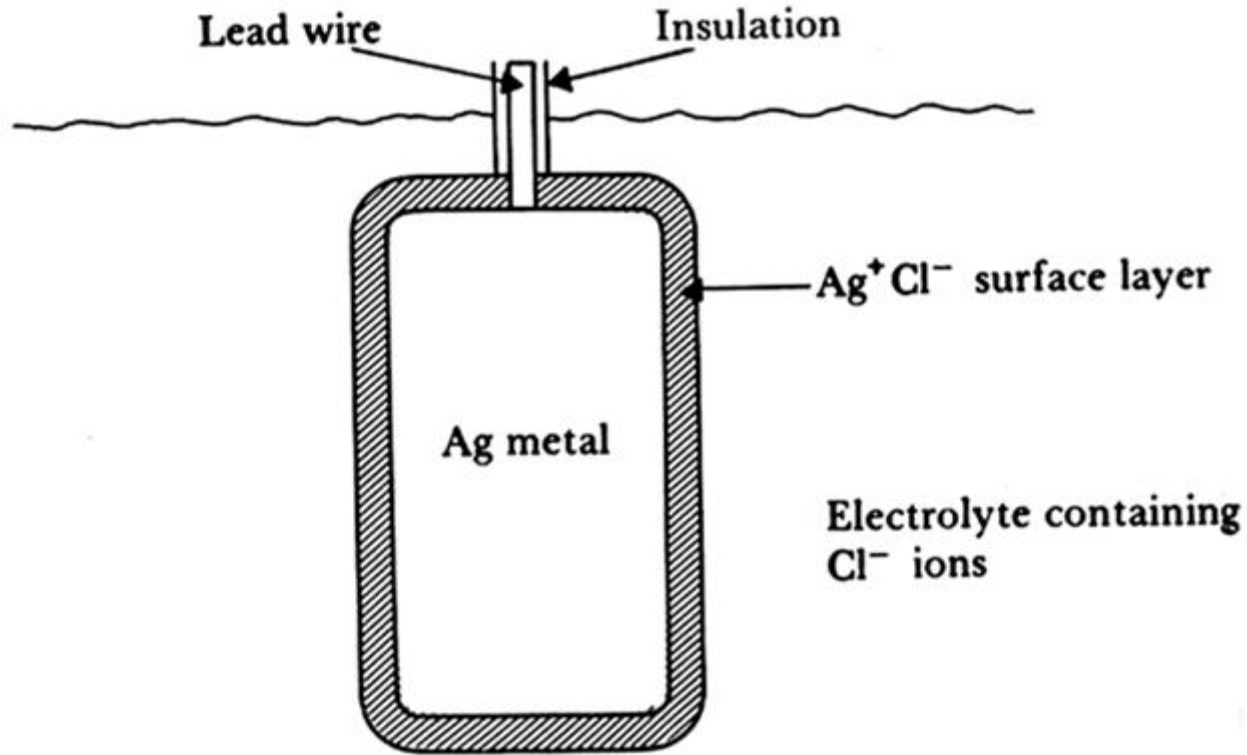
- The silver/silver chloride electrode is reversible but exhaustible.
- Practical for use in many biomedical applications
- Generates less than 10uV of noise.

# The Electrode - Electrolyte Interface



One of the most common types of electrodes is the Ag-AgCl electrode with an electrolyte containing

# Silver–silver chloride electrode



# The Silver/Silver Chloride Electrode



**(a)**

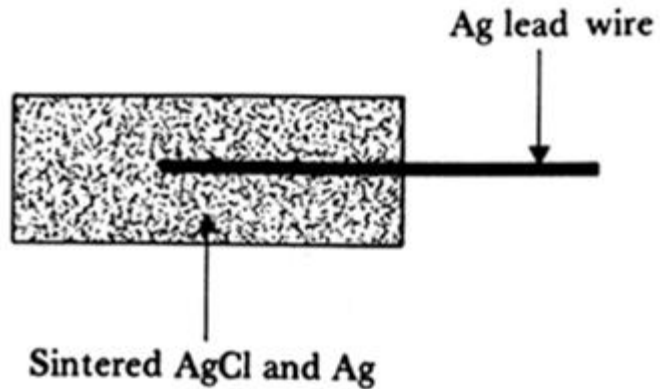
(a) Ag/AgCl electrode (electrode's snap side)



**(b)**

(b) Ag/AgCl electrode (electrode's skin side)

# Sintered Ag/AgCl electrode



# REFERENCES

- <http://www.bionanotec.org/Lectures/Membranes/Contents/IBioelectricityIonsinsolution8/ibioelectricityionsinsolution8.htm>
- [https://www.researchgate.net/post/How\\_can\\_I\\_fabricate\\_a\\_Ag\\_AgCl\\_reference\\_electrode](https://www.researchgate.net/post/How_can_I_fabricate_a_Ag_AgCl_reference_electrode)
- <https://www.als-japan.com/1766.html#sdac12>
- Principles of Measurement and Transduction of Biomedical Variables.
- Evaluating Major Electrode Types for Idle Biological Signal Measurements for Modern Medical Technology
- Medical Devices and human engineering
- Implantable Neural Prostheses 2: Techniques and Engineering Approaches (Biological and medical physics, biomedical engineering)

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*Thank  
You!*