ENGINEERING CHEMISTRY

Department of Science and Humanities

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Electrochemical Sensors

Module Content :

- ***Introduction***
- ***Types of Electrochemical Sensors***
- ***Electrochemical Sensors: Gas Sensor- O_2 Sensor***

  Biosensors- Glucose Sensor

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Class Content :

- ***Introduction***
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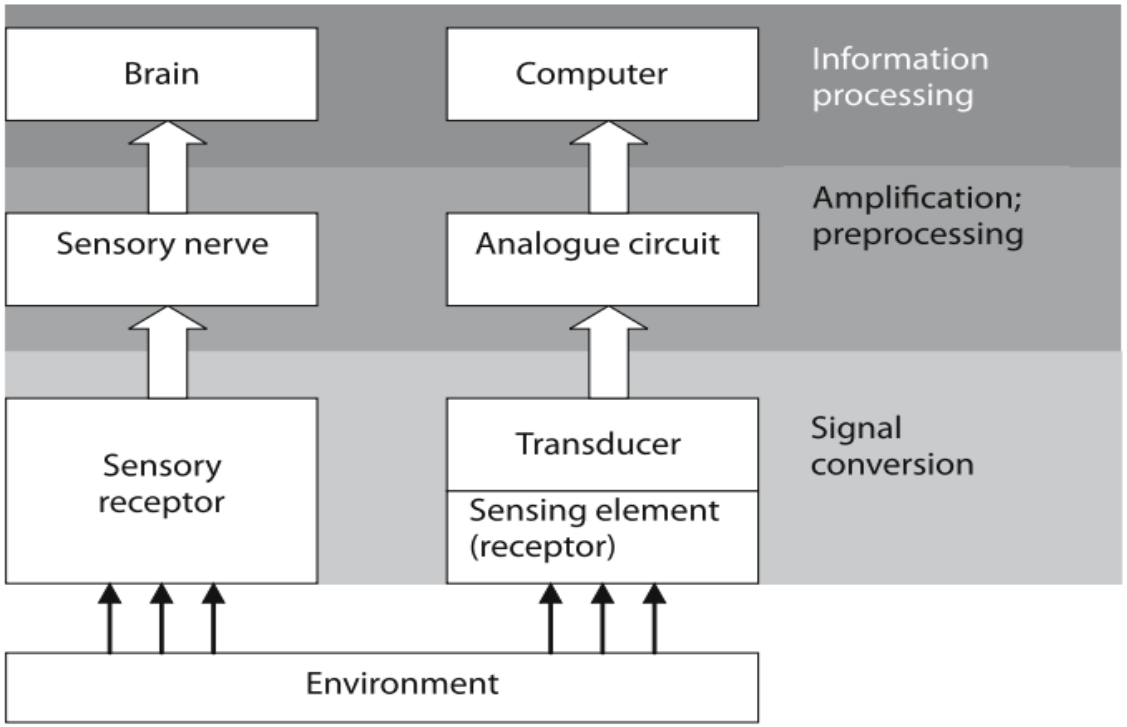
Electrochemical Sensors

- **SENSORS:** A sensor is a device that detects and responds to some type of input from the physical environment.
- The specific input could be light, heat, motion, moisture, pressure, or can be any molecule or substance such as analytes.



Signal processing in living organisms and in intelligent machines

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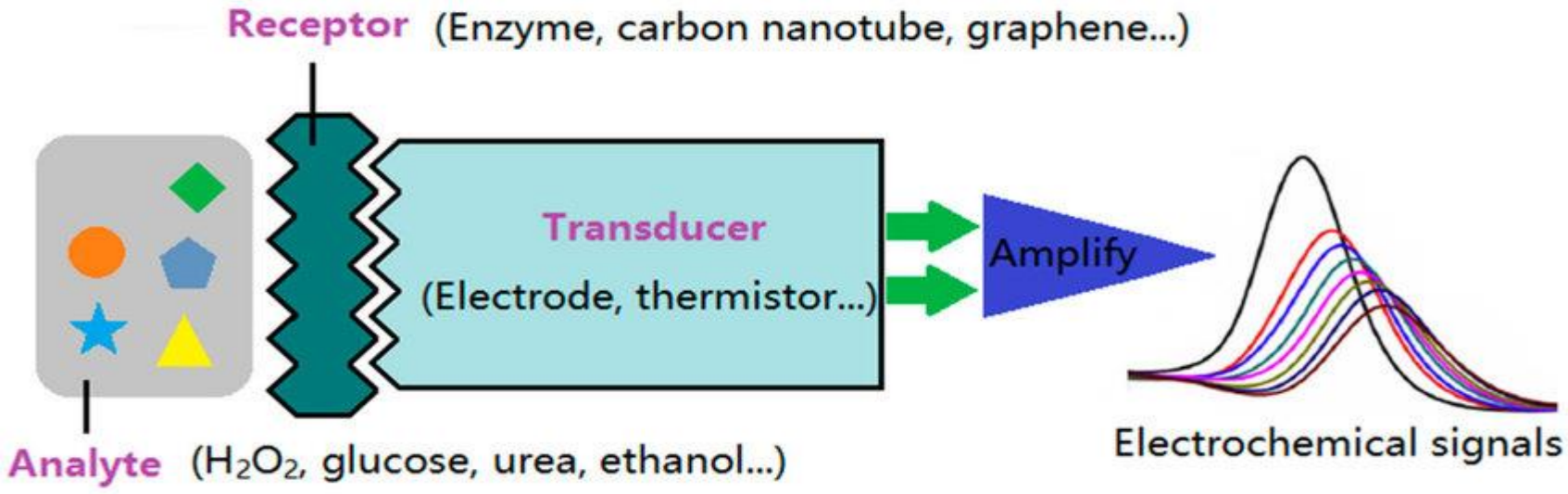
Electrochemical Sensors

- **ELECTROCHEMICAL SENSORS**: A class of chemical sensors in which an electrode is used as a transducer element in the presence of an analyte.
- Electrochemical sensors transfers the effect of the electrochemical interaction of the analyte-electrode into a useful electric signal.



https://www.researchgate.net/publication/335398612_Electrochemical_Sensors_Fabricated_by_Electrospinning_Technology_An_Overview

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Electrochemical Sensors

Types of Electrochemical Sensors

- Potentiometric Sensors
- Amperometric Sensors

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TYPES OF ELECTROCHEMICAL SENSORS

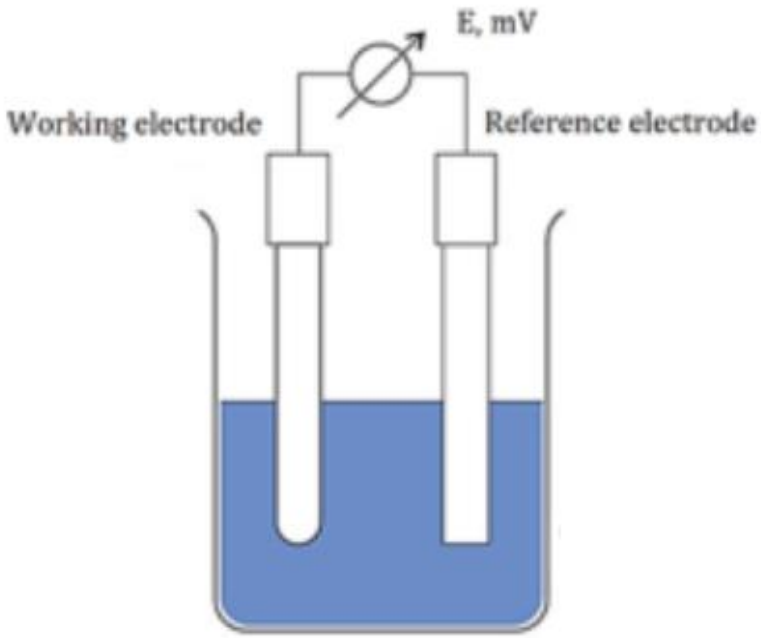
1. POTENTIOMETRIC SENSORS

- Sensors that use the effect of concentration on the equilibrium of redox reactions occurring at the electrode-electrolyte interface of an electrochemical cell.
- The redox reaction takes place on the electrode surface:

  Oxidant + ne^- → Reduced product
- Mainly determine the analyte concentration by measuring the variation of potential difference between working and reference electrodes at different analyte concentrations.

$$E_{cell} = E_o + RT/nF \log\left(\frac{C_o}{C_R}\right)$$

$$\text{At 298K}, E_{cell} = \frac{0.0591}{n} \log\left(\frac{C_o}{C_R}\right)$$



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Examples of Potentiometric Sensors

Ion Selective Electrode Sensors

- Glass electrodes (e.g. pH-meter, Na^+, K^+, Li^+ Sensors
- Solid membrane electrodes (e.g. based on AgX for X^-, and Ag_2S for other M^+).- Liquid membrane electrodes (e.g. containing a ligand for M+ complexation e.g. Ca^{2+} and K^+ sensors).

Gas Potentiometric Sensors

- pH-meter-based gas detectors (e.g. CO_2, NH_3 etc).
- Solid oxide sensors (e.g. zirconia-based O_2 sensor (λ-sensor)

Source: http://photobiology.info/Visser-Rolinski.html

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Potentiometric sensors

Advantages

- Applied to detect various analytes qualitatively and quantitatively.
- Easy to Construct and operate, more accuracy, sensitive and highly selective determination
- Smaller Volumes of analytes can be estimated
- Economically Viable

Limitations

- Requires calibration During estimation
- In Presence of other impurities can affect the potential Values
- By varying the temperature potential values also varies.

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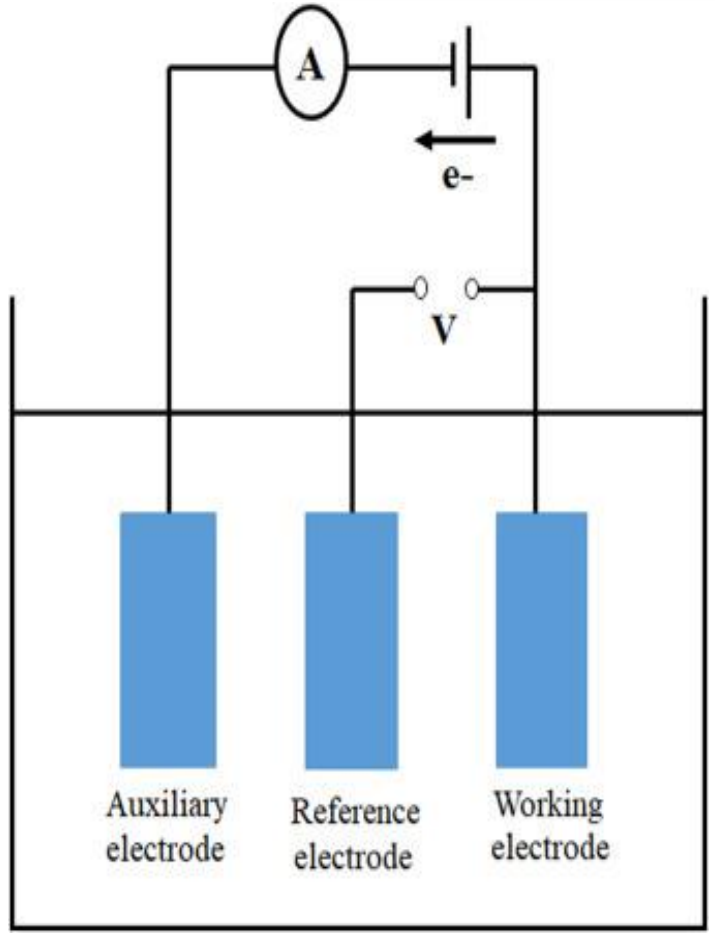
AMPEROMETRIC SENSORS

- Measure the current in response to detect the concentration of the analyte at a fixed potential.
- The applied potential drives the electron transfer reaction of the analytes, and the measured current indicates the analyte concentration.
- The sensor is usually composed of 3 electrodes, that is working, auxiliary, and reference electrode. Amperometric sensors quantify the current output between working and the auxiliary electrode.



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Working of Amperometric Sensors

- The working electrode is the electrode at which the reaction of interest occurs, the reference electrode (e.g.; $Ag/AgCl/Cl^-$, $Hg/Hg_2Cl_2/Cl^-$) provides a stable potential compared to the working electrode.
- An inert conducting material (e.g.; platinum, graphite) is usually used as auxiliary electrode.
- A supporting electrolyte is used to provide a conducting medium for movement of ions. E.g. KCl, $NaNO_3$,

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Advantages and limitations of amperometric sensors

ADVANTAGES	LIMITATIONS
• It can be used for estimation of reducible and non-reducible (Mg^{2+}, PO_4^{3-}, SO_4^{2-}) analytes	• Working potential applied should be for limited time or may lead to damage of the electrode
• More accurate and sensitive	• These sensors cannot be used with applied voltage more negative than -2V because hydrogen will be evolved

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