



IIT ROORKEE



NPTEL ONLINE
CERTIFICATION COURSE

Lecture 1: Introduction

Sensors & Biosensors: Components & Characteristics

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Outline

- ❑ Sensors and Biosensors
- ❑ Market overview and need of biosensors
- ❑ Components and their functions
- ❑ Optical parameters for transduction

Sensors

A device which measures a change in one physical parameter in terms of magnitude of a second different parameter which can be measured more conveniently and perhaps more accurately.



Thermometer



Old time coal miners' biosensor
(Yellow Canary)



Glucometer



Pregnancy test kit



Infectious disease biosensor

Biosensor Definitions

IUPAC, 1996

A biosensor is a self-contained integrated device that is capable of providing specific quantitative or semi-quantitative analytical information using a biological recognition element which is in direct spatial contact with a transduction element

Another one

A sensor that integrates a biological element with a physiochemical transducer to produce an electronic signal proportional to a single analyte which is then conveyed to a detector.

A simple one

Any device that uses specific biochemical reactions to detect chemical compounds in biological samples.

Importance of (Bio)Sensors Research



Cancer



Diarrhoea



Bacterial Infection



Contaminated
Food



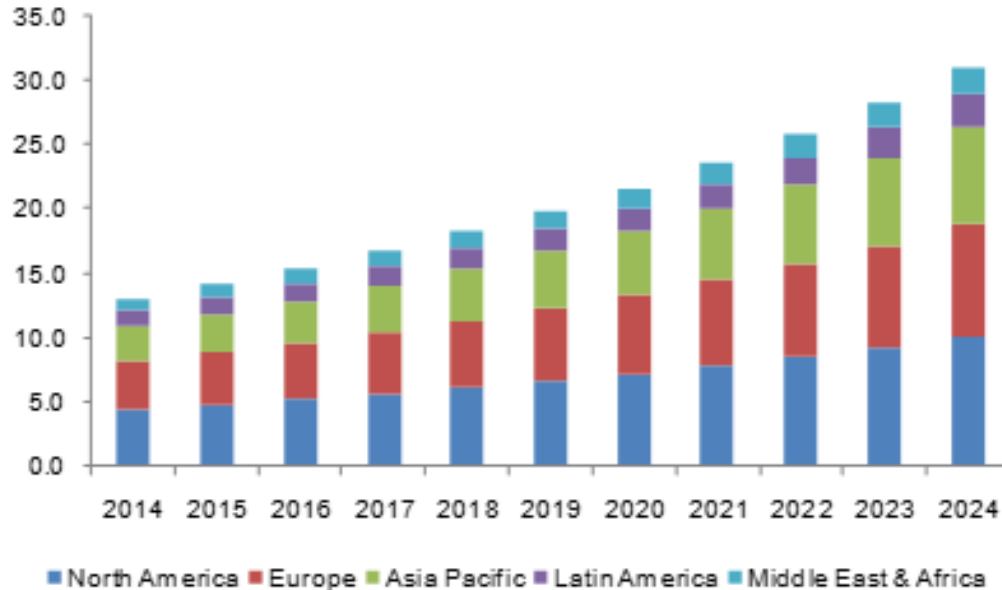
Growth
inhibition



Diabetes



Importance of (Bio)Sensors Research: Market Overview



Global Market:

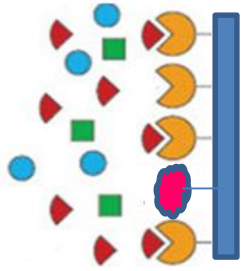
~ 16 bn US\$ (2017)

- 32 bn US\$ (2024)

<https://www.ameriresearch.com/wp-content/uploads/2017/05/Biosensors-Market-2024.png>

Components of Biosensors

Sensor Surface → **Transducer** → **Measurable signal** → **Detector**



pH Change
Refractive Index
Change
Mass Change
Heat Transfer.....



Optical
Electrical
Acoustic
Dimensions

 **Analyte**

 **Bio-recognition Element
Or Bioreceptor**

 **Antifouling agent**

Analytes

Chemical, biological or environmental elements that need to be sensed

- natural hazards,
- blood/urine analytes,
- environmental pollutants, industrial/chemical/biochemical/biological waste,
- warfare agents,
- ambient conditions,
- gases, liquids, solids,
- endocrine disruptors, pathogenic bacteria or other food related issues, etc.

For example, some chemical vapors and gases which commonly need to be sensed are: hydrogen, oxygen, ammonia, carbon dioxide, hydrogen sulfide, chlorine, ethanol vapor, methane, etc.

Receptors/Biomolecular Recognition Elements (BREs)

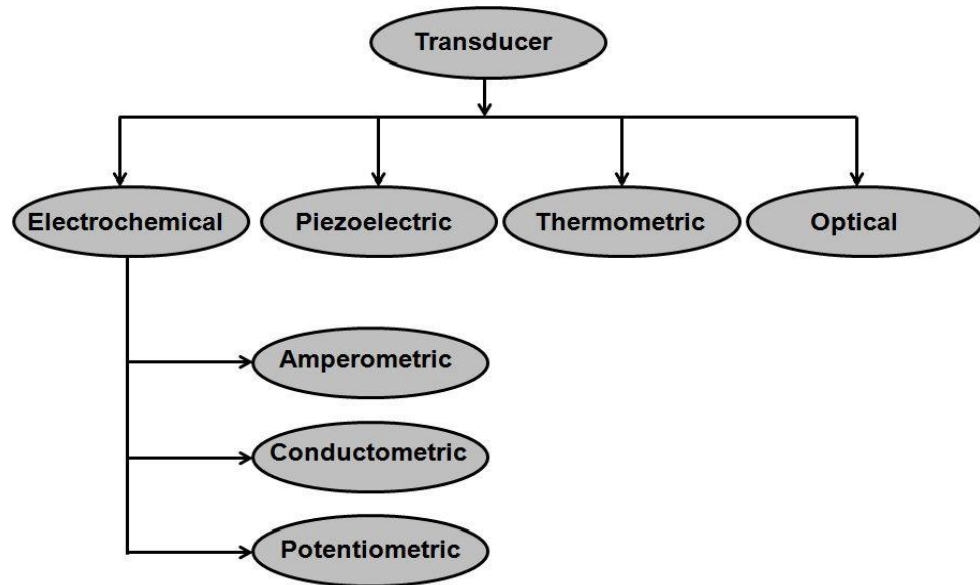
- A receptor can be defined as the heart of a biosensor. It is designed for the interaction of the analyte with it to produce significant signal which is to be measured.
- A receptor has to be selective and specific to interact with the biomolecule/analyte of interest

Kinds of Receptors

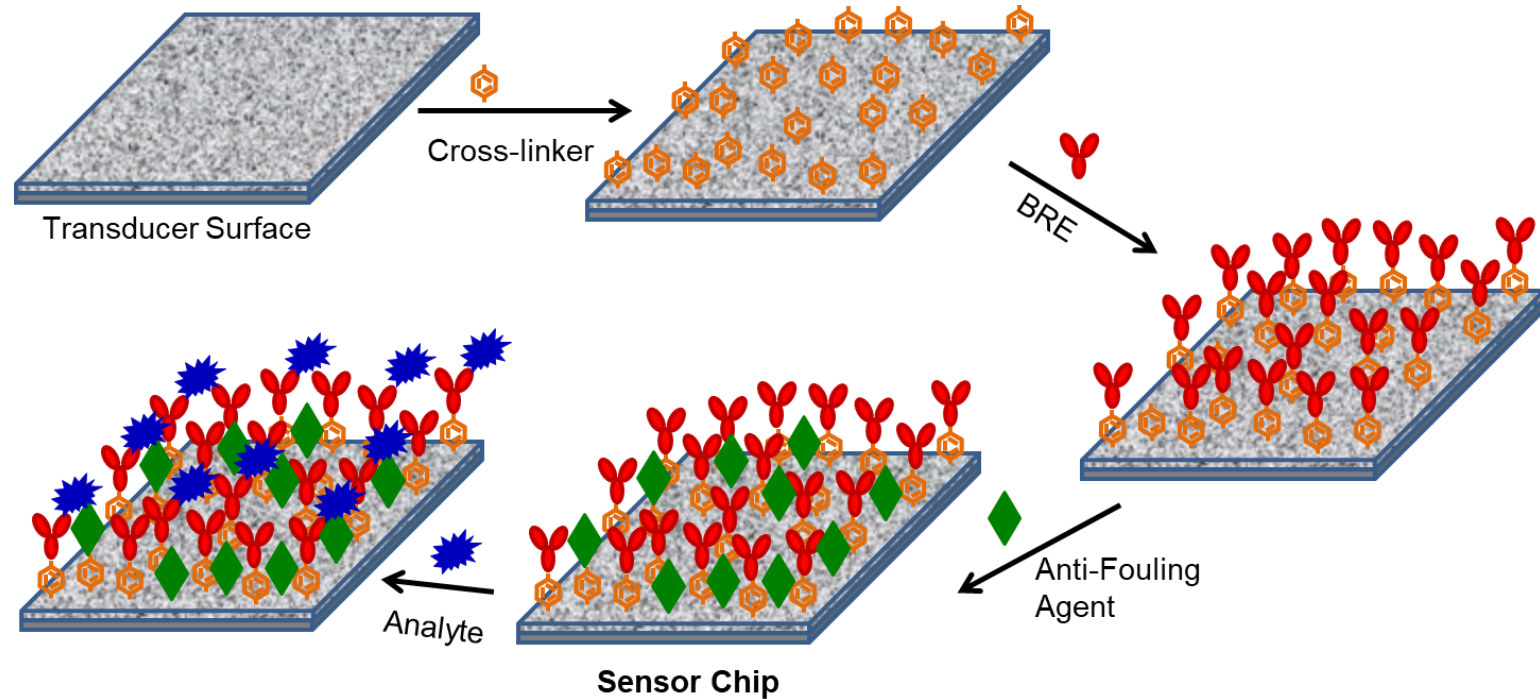
- (i) enzyme based,
- (ii) antibody/antigen based,
- (iii) nucleic acids,
- (iv) cell based,
- (v) tissue based

Transducers

- Convert one form of energy into another form of energy
- Transform the input/chemical energy change occurring at the receptor surface into a measurable output signal



Schematic of a sensor surface / chip fabrication



Optical Sensors

Generally based on Measurement of changes in following optical properties

- Absorbance in chemical reaction
- Reflectance /Transmittance
- Refractive index
- Phase shift
- Polarization
- Light Energy (wavelength) : Fluorescence , Raman, etc.

Why Optical Biosensors?

Advantages

- Small
- Flexible
- Fast
- Safe, no electrical device interacts with the body
- Good biocompatibility (fibers are glass, noble metals)

Disadvantages

- May be Invasive
- Optical signal (e.g. fluorescence) may not be strong enough

Summary

1. Definitions and introduction of Sensors and Biosensors were presented.
2. Components of a sensor, their working and types were discussed in detail.

Thank You