ELECTROCHEMICAL TRANSDUCER

Electrochemical transducer reports changes in form of electrical signal which is directly proportional to the concentration of analyte.Binding of analyte results in ionic discharge, which can then be measured in the form of current or voltage, using suitable transducers.

Principle

Electrochemical reactions take place at electrode-electrolyte interfaces and provide a switch for electricity to flow between two phases of different conductivity, i.e. the electrode (electrons or holes are the charge carriers) and solid or liquid electrolyte (ions are the main charge carriers)

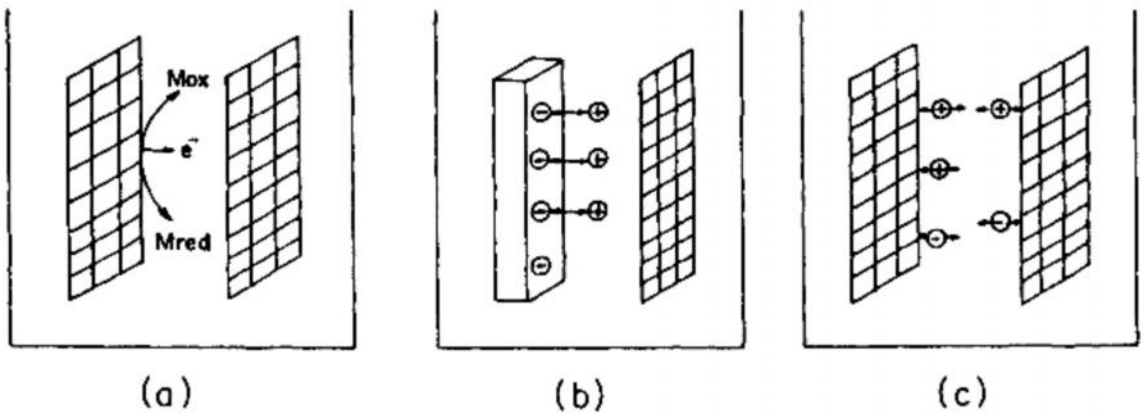


Figure 2. **Principle of (a) amperometric, (b) potentiometric and (c) conductimetric biosensors; M_{red}, reduced mediator; M_{ox}, oxidised mediator; ⊖, anion; ⊕, cation.**

[Source: Advances in Biosensors, B.D. Malhotra& A. P. F. Turner]

Applications

Glucose Oxidase

$$Glucose + O_2 \rightarrow Gluconic\ Acid + H_2O_2$$

The product, H_2O_2,is oxidized at +650mV vsaAg/AgCl reference electrode.Thus, a potential of + 650mV is applied and the oxidation of H_2O_2measured. This current is directly proportional to the concentration of glucose.

An electrochemical method for monitoring biotin–streptavidin interaction has been developed. This is based on the use of colloidal gold as an electrochemical label. Biotinylated albumin is adsorbed on the pretreated surface of a carbon paste electrode. This modified electrode is immersed in the colloidal gold–streptavidin labeled solution. Adsorptive voltametry is used to monitor colloidal gold bound to streptavidin. The analytical signal is highly reproducible sequential competitive assay.

Disposable immunochromatographic sensor for on-line quantitative determination of human serum albumin (HSA) has been developed. The sensor used conductimetric detection and 20 nm gold colloid particles modified with polyaniline (a conducting polymer) for signal generation. The reaction between the conjugate and analyte took place immediately and this complex was carried up into the next membrane that had the immobilized antibody. The second antigen−antibody reaction formed a sandwich-type immune complex at the electrode and polyaniline-bound colloidal gold generated a conductimetric signal.

A novel array-based electrical detection of DNA with nanoparticle probes has been developed that could be used to detect target DNA at concentrations as low as 500 fM with a point mutation selectivity factor of 100,000:1.

The modification of electrochemical transducers with carbon nanotubes (CNTs) has recently attracted considerable attention in the field of DNA sensing technology.

MAGNETIC TRANSDUCERS

Magnetic transducer makes use of the phenomenon of emf induction by change in the magnetic flux. The electrical signal hence produced provides the detection of the targeted element.

Magnetic transducers have their application in nanobiotechnology in detecting a specific cell. Nanoparticles containing magnetic material are engineered biotechnically and aptamers or antibodies which bind to the target cells are attached to the surface. The nanoparticles areintroduced inside the system where they bind to the specific cells. Then, they are magnetized by passing an electric field. The magnetization leads to the flux change through the transducer which identifies the targeted cells through an electric signal. After that even the separation or the removal of such cells is possible through the application of a strong magnetic field.

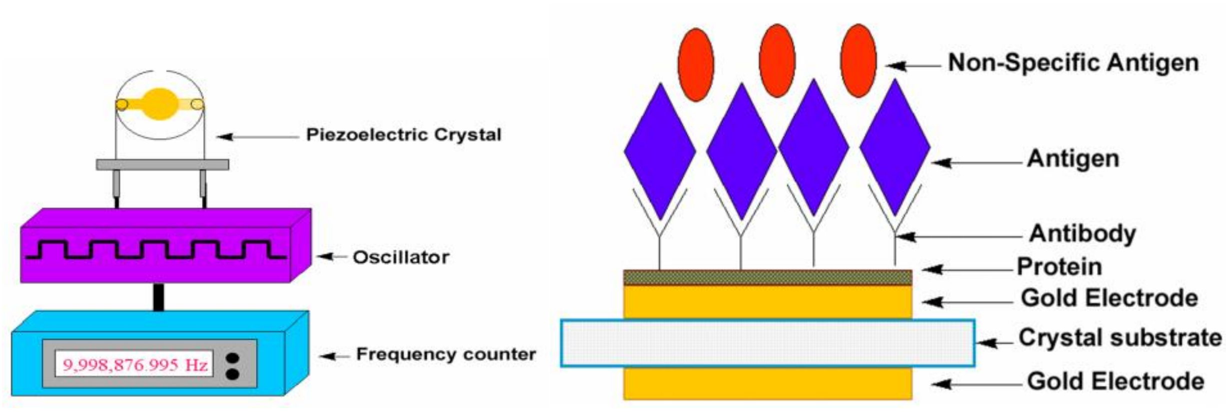
GMR- giant magnetoresistance is a phenomenon seen in structures in alternating ferromagnetic and non magnetic material. It leads to a change in resistance if the magnetization in the alternating ferromagnetic films is parallel in one and anti parallel in the other. It is a highly sensitive method of detecting magnetic changes and is also used in the fabrication of transducers.

Telomeres are unique DNA–protein structures that contain noncoding long, repetitive sequences of TTAGGG and telomere-associated proteins. A novel nanosensor based on magnetic nanoparticles has been developed for rapid screens of telomerase activity in biological samples. The technique utilizes nanoparticles, which upon annealing with telomerase-associatedTTAGGG repeats, switch their magnetic state, a phenomenon readily detectable by magnetic readers. High-throughput adaptation of the technique by magnetic resonance imaging allowed processing of hundreds of samples within tens of minutes at ultrahigh sensitivities. Together, these studies establish and validate a novel and powerful tool for rapidly sensing telomerase activity and provide the rationale for developing analogous magnetic nanoparticles for in vivo sensing. Since elevated telomerase levels are found in many malignancies, this technique offers provides access to an attractive target for therapeutic intervention and for diagnostic or prognostic purposes.

PIEZOELECTRIC TRANSDUCER

Piezoelectric transducer is the one that converts change in pressure or mass to an electrical field, thereby, behaving like a sensor. It is made up of a piezoelectric material. Example of a piezoelectric material is quartz. Quartz is a sheet structure of silica with the molecular formulaSiO_2. It is polar in nature. Any mechanical stress leads to a change in structure and hence the separation between positive and negative centres changes, causing a net electric field. If such a material is connected to a circuit, the mechanical stress will lead to an electrical signal, which in turn can be detected.

Piezoelectric transducers can be used as biosensors in a way that a molecular recognition element, say, an antibody can be made attached to a piezoelectric electrode. If the analyte binds to the antibody or any bulky molecule has an affinity towards the analyte which is already bonded to the antibody, the change in mass causes the electrode to experience sufficient pressure so as to produce an electrical field which in turn changes the resonating frequency of the crystal which can be noted and hence works as a beacon to show the binding of the analyte with the provided antibody.



[Source: Biosensors Based on Piezoelectric Crystal Detectors, Ashok Kumar]

Source:
http://nptel.ac.in/courses/118107015/14