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Biosensing Technology: A Brief History

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Abstract: Biosensors are currently ubiquitous in the biomedical field as well as in a variety of other fields such as point-of-care intensive care for therapy and illness, ecological assessment, nutrition monitoring, the discovery of drugs, and other medical and forensics research. Biosensors were first reported during 1906 when M. Cremer determined that an acid concentration in a liquid is proportionate to the electric potential. Until then, a number of advancements have been made in this field. Biosensors can be described as analytical tools which consist of a grouping of natural sensing components such as a receptor and a transducer. In comparison with any further currently accessible analytical device, these sensors are sophisticated in the environments because of selectivity, sensitivity and specificity. This Paper aims to give an brief idea about biosensor technology.

I. BRIEF HISTORY OF BIOSENSORS

Biosensor is an analytical device consisting of a biocatalyst (enzyme, cell or tissue) and a transducer which can convert a biological or biochemical signal or response into quantifiable electrical signal. Several researchers with different background are involved in this field of research, from chemistry to physics, to microbiologists and of course to electrical engineering, all are deeply involved in several facets of the assembly of the object “Biosensor”.

Looking at the past we realize also that the concept of Biosensor has evolved about 50 years ago, Biosensor is a self contained analytical device that responds to the concentration of chemical species in *biological samples*. This is clearly wrong, but it has been very difficult to clarify this point. No mention of a biological active material involved in the device. Thus any physical (thermometer) or chemical sensor (microelectrode implanted in animal tissue) operating in biological samples could be considered a *Biosensor*. We agree that a biosensor canbe defined as a device that couples a biological sensing material (we can call it a molecular biological recognition element) associated with a transducer. Recently the concept evolved again in the tentative to replace or mimic the biological material with synthetic chemical compounds.

In 1956 Professor Leland C. Clark publishes his paper on the development of an oxygen probe and based on this research activity he expanded the range of analytes that could be measured in 1962 in a Conference at a Symposium in the New York Academy of Sciences where he described how “to make electrochemical sensors (pH, polarographic, potentiometric or conductometric) more intelligent” by adding “enzyme transducers as membrane enclosed sandwiches” [1]. The first example was illustrated by entrapping the enzyme Glucose Oxidase in a dialysis membrane over an oxygen probe. The addition of glucose determined the decrease of oxygen concentration in proportional relation. The first biosensor was described in the published paper coining the term “enzyme electrode”

[2]. Then subsequently in 1967 Updike and Hicks use the same term “enzyme electrode” to describe a similar device where again the enzyme glucose oxidase was immobilized in a polyacrylamide gel onto a surface of an oxygen electrode for the rapid and quantitative determination of glucose [3].

Besides amperometry Guilbault and Montalvo in 1969 use glass electrodes coupled with urease to measure urea concentration by potentiometric measurement [4].

Starting from 1970, several others authors start to prove the concept of Biosensors, the coupling of an enzyme and electrochemical sensors. This was at the beginning a Biosensor, a strange research where biological elements were combined with electrochemical sensors.

In the electrochemical community at that period the research on Ion selective electrodes (ISE) was very active and the idea to extend the range of sensors to non electrochemical active compounds, and even to non ionic compounds, like glucose, has been very well accepted. We saw at that time the possibility to extend much more the research activity. The groups active in ISE development have been definitively the first to shift to the development of electroanalytical biosensors. Professor G. Rechnitz developed of an “amygdaline” sensor based on the coupling of an Ion Selective Electrode (cyanide ISE) with betaglucosidase to give benzaldeyde and cyanide [5].

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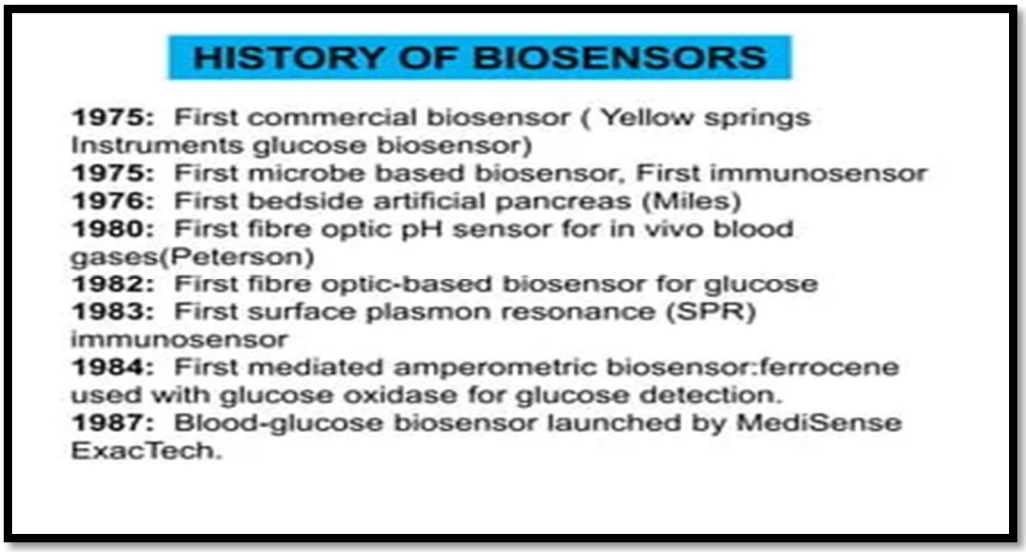

But this was just the beginning of a large activity where obtained couplings have been multiplied by changing the "biological element" and the kind of transducer Various types of biosensors being used are enzyme-based, tissue-based, immunosensors, DNA biosensors, and thermal and piezoelectric biosensors. We continue also today to Biosensors are classified into two groups i.e. either based on the Biological Element used in the analysis or the method of transduction implemented. As mentioned already, some of the commonly used biological elements or bio-recognition elements are DNA, enzymes, antibodies, microorganisms, tissues, cell receptors etc.

The next and most commonly used classification of Biosensors is based on the type of transduction used in the sensor i.e. type of physiochemical resulting from the sensing event. Further, the biosensors based on method of transduction are again divided into three types. They are:

- Mass based Biosensors
- Optical based Biosensors
- Electrochemical Biosensors

There are again few subclasses in each of these types. Resulting from the interaction of the analyte with the biological elements to easily measure and quantify.

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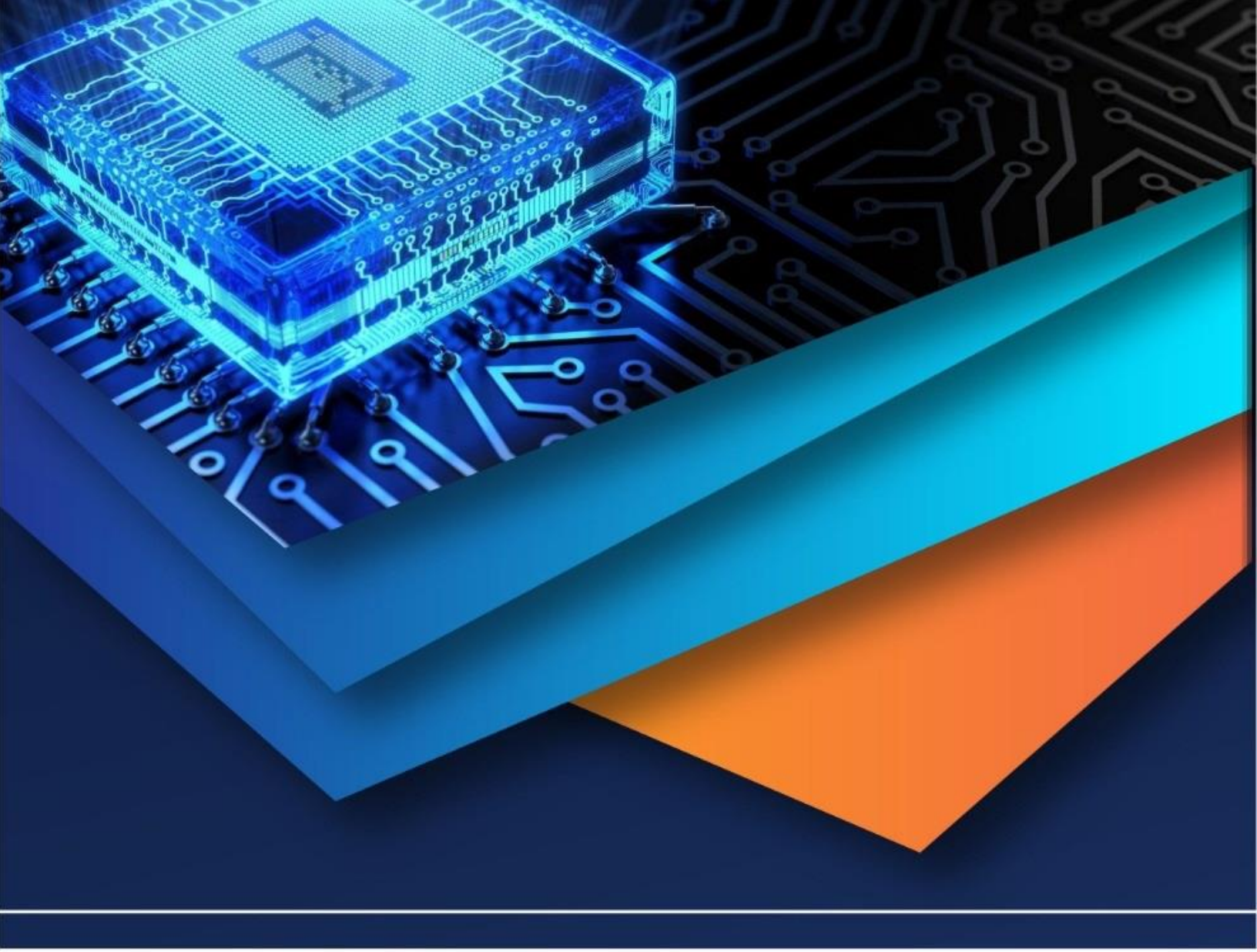

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