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Current trends in the development of conducting polymers-based biosensors

Faezeh Ghorbani Zamani [a, 1], Hichem Moulahoum [a, 1], Metin Ak [b], Dilek Odaci Demirkol [a], Suna Timur [a, *]

[a] Biochemistry Department, Faculty of Sciences, Ege University, Izmir, Turkey
[b] Chemistry Department, Faculty of Science, Pamukkale University, Denizli, Turkey

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ABSTRACT

Bioelectronics devices are seeing great improvement. After the earliest generations of sensors and biosensors, the current generation is attracting great interest due to the advantages that it showed. Despite the positive advantages, some drawbacks linked to the technologies used in the construction process are still seen. Therefore, the scientific community is giving its best to further develop the current biosensor knowledge and bypass the disadvantages seen before. In this review, we will be examining the current approaches taken by research in order to avoid the already seen drawbacks in sensors development. Many tools and methodologies are being used ranging from conducting polymers, conducting polymer nanowires, embedded metal nanoparticles in polymeric films, to conducting polymers synthesis in ionic liquids and polymeric ionic liquids. These approaches permitted the fabrication of highly simplistic and low-cost biosensors stressing on their potential in biological samples detection. The dynamic seen between polymers and protein opens the door to many possibilities to use novel materials or devising new techniques for the next generation biosensor systems. Despite all the efforts been made, the subject of modification of electrodes by chemical reactions is still a remarkable area of research activity. Hence, in this review, the considerable emphasis has been placed on the recent approaches of electrical active polymer modified electrodes specialized for application in biosensing devices and in particular amperometric biosensors.

1. Introduction

Biosensors providing a positive impact in diagnosing, monitoring, and biomolecules maintenance have seen increasing importance in healthcare, medical science, agriculture, environment monitoring, food, and biosecurity. Simple and fast electron transferring processes between the analyte and electrode surface are highly demanded for improving the biosensor performance. In other words, a biosensor has to simplify the formation of specific probe-target complex triggers into a useable reading signal. In biosensors, converting the bio-recognition event into a proper signal is ensured by a transducer [1]. The difficulties of transmitting electrical signals between biological recognition elements and signal transducers are the main barriers in electrochemical systems. Some unwanted phenomena such as deep suppressed electroactive prosthetic groups in the protein structures, protein denaturation and/or disapproving protein direction on the electrodes obstruct the simple electron transfer between large redox proteins and transducers.

Depending on the utilized transducers, biosensors could be divided into three main generations (Fig. 1) [1]. The first-generation biosensors revolve around the electrical responses occurring through the diffusion of reaction products to the transducers. These biosensors have seen many drawbacks such as high-applied potential, which causes some changes and brings possible interference, fluctuant concentrations of the product, which brings systematic complexity and decrease in electrical currents, and finally causes detection limitations [2]. The use of mediators between the reaction products and transducers had improved the system response and caused the introduction of the second generation [3]. Applied mediators in conjunction with redox proteins are not selective, which causes various interfering interactions. In

* Corresponding author. Biochemistry Department, Faculty of Sciences, Ege University, Izmir, 35100, Turkey.
E-mail address: suna.timur@ege.edu.tr (S. Timur).
[1] Authors contributed equally.

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