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Review

Electrochemical and piezoelectric DNA biosensors for hybridisation detection

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ABSTRACT

DNA biosensors (or genosensors) are analytical devices that result from the integration of a sequence-specific probe and a signal transducer. Among other techniques, electrochemical and piezoelectric methods have recently emerged as the most attractive due to their simplicity, low instrumentation costs, possibility for real-time and label-free detection and generally high sensitivity.

Focusing on the most recent activity of worldwide researchers, the aim of the present review is to give the readers a critical overview of some important aspects that contribute in creating successful genosensing devices. Advantages and disadvantages of different sensing materials, probe immobilisation chemistries, hybridisation conditions, transducing principles and amplification strategies will be discussed in detail. Dedicated sections will also address the issues of probe design and real samples pre-treatment. Special emphasis will be finally given to those protocols that, being implemented into an array format, are already penetrating the molecular diagnostics market.

Contents

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1. Introduction

DNA biosensors (or genosensors) are analytical devices that result from the integration of a sequence-specific probe (usually a short synthetic oligonucleotide) and a signal transducer. The probe, immobilised onto the transducer surface, acts as the biorecognition molecule and recognises the target DNA, while the transducer is the component that converts the biorecognition event into a measurable signal. Assembly of numerous (up to a few thousand) DNA biosensors onto the same detection platform results in DNA microarrays (or DNA chips), devices which are increasingly used for large-scale transcriptional profiling and single-nucleotide polymorphisms (SNPs) discovery.

As clinical diagnostics and other applications (e.g., environmental screening) do not generally need the massive data accumulation typical of gene chips, alternative technologies are in development whose promise is to provide flexible and economical alternatives for applications that require relatively fewer measurements. Among other techniques, electrochemical and piezoelectric transductions are the most attractive due to their simplicity, low instrumentation costs, possibility for real-time and label-free detection and generally high sensitivity.

In the past few years, several excellent reviews have been published on both electrochemical and piezoelectric DNA sensing [1–7]. Focusing on the most recent activity of worldwide researchers, the aim of the present review is to give the readers a critical overview of those important aspects that contribute in creating successful genosensing devices. For the sake of clarity, this review will specifically focus on devices in which the biological recognition elements are surface-immobilised, and therefore in intimate contact with the transducer. Hence, the whole branch of literature recently