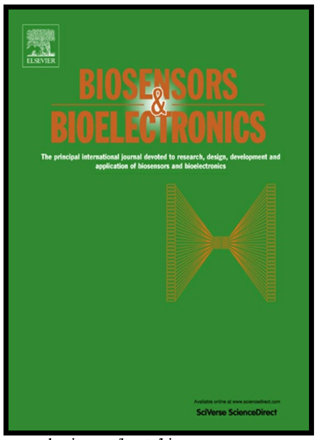

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Molecular architecture for DNA wiring

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Abstract

Detection of the hybridisation events is of great importance in many different biotechnology applications such as diagnosis, computing, molecular bioelectronics, and among others. However, one important drawback is the low current of some redox reporters that limits their application. This paper demonstrates the powerful features of molecular wires, in particular the case of S-[4-[2-[4-(2-Phenylethynyl)phenyl]ethynyl]phenyl] thiol molecule and the key role that play the nanometric design of the capture probe linkers to achieve an efficient couple of the DNA complementary ferrocene label with the molecular wire for an effective electron transfer in co-immobilised self-assembled monolayers (SAMs) for DNA hybridisation detection. In this article, the length of the linker capture probe was studied for electron transfer enhancement from the ferrocene-motifs of immobilised molecules towards the electrode surface to obtain higher kinetics in the presence of thiolated molecular wires. The use of the right couple of capture probe linker and molecular wire has found to be beneficial as it helps to amplify eightfold the signal obtained.

Keywords: DNA hybridisation, bioelectronics, electron transfer rate constant, molecular wires, electrochemistry, ferrocene, biosensor.

1. INTRODUCTION

The simple structure of two couples of nucleotides; A-T and C-G in the DNA double helix arrangement, which write our complex genetic information, has been used for disparate functionalities in different biotechnology areas. The best-known application is in the biomedical field, where DNA hybridisation can diagnose many different diseases, it can tell our genetic predisposition to many illnesses or determine the paternity with a lock of hair. Other area less widespread, where the unique electronic, molecular recognition and self-assembly advantages of DNA structure has been exploited, is the field of molecular electronics. In the area of bio-microelectromechanical systems, DNA has been used as a promising molecular switch, letting the current to pass through the DNA duplex in a nanogap device (Zaffino 2014). Also the DNA-based electrical circuits has been proposed by Dr. Porath, claiming the ability of DNA for conducting electrical charge over considerable distance (Livshits 2014). Moreover, in the computing area, the Weizmann Institute of Science fabricated the first programmable computer silicon microchips-free, which was composed of enzymes and DNA molecules (Lovgren 2003) and eleven years after it was possible to store a JPEG picture, an audio or a movie in a DNA digital data storage (Ezziane 2005; Dong 2015; Shipman 2017).
In most cases, it is required the immobilisation of a capture sequence of DNA onto the transducer surface and the detection of the hybridisation event with the complementary strand. The hybridisation can be detected through direct transduction, inducing changes in electrochemical parameters such as conductivity or capacitance (Paleček 1988; Porath 2000), but at low sensitivity due to the high background signal. This drawback is overcome with redox indicator attached to the duplex. The redox enzyme labels are the ones most used in electrochemical detection since they provide higher signal amplification. Nevertheless, it requires the use of additional reagents and steps in the

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