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Rapid Detection of Prostate Specific Antigen Biomarker Using Magnetic-Nanoparticles

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Abstract

Prostate carcinoma is the most common leading cause of cancer-related deaths in men, aside from lung cancer. To date, proteolytically-active prostate specific antigen (PSA) serine protease is a useful diagnostic serological marker for the early diagnosis and monitoring of prostate cancer. In the past years, researchers executed a lot of research to increase the utility and applicability of PSA detection methods. However, these methods were usually frustrated by limitation in sensitivity, specificity, times constrains and ease of on-site application. Thus, there is a need for novel direct and highly sensitive PSA detection methods. This work showed the ability of the developed electrochemical and optical (Surface Plasmin Resonance (SPR) and colorimetric) biosensors to detect PSA with high sensitivity and specificity and within a short timing. Moreover, these novel approaches can be implemented in other miniaturized configurations such as screen printed electrode and paper-based low-cost point-of-care biosensor due to the elimination of washing and blocking steps as well as the amplification and labelling procedure.

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Keywords: Prostate Specific Antigen**;** Electrochemical Impedance Spectroscopy; Surface Plasmin Resonance; Colorimetric; Magnetic nano-particles; Biosensor; Self-assembled monolayer.

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1. Introduction

Due to the clinical outcome of prostate specific antigen (PSA) serine protease in prostate cancer diagnosis, their was a need for a sensitive and specific PSA detection method to capture prostate cancer at the earliest stage.[1,2] To date, a number of conventional techniques such as enzyme-linked immunosorbent assay (ELISA), radioimmunoassay and fluorescent immunoassay were reported to be so far sensitive with the possibility of a high through-put system application.[3,4] However, these methods were inconvenient, sophisticated, require trained personnel and labour being based on the use of expensive labelling approaches.[5,6] All of which delays clinical results processing and reporting time. In view of that, there is a distinct need for the development of novel label-free, fruitful and portable real time PSA diagnostic devices such as biosensors for several reasons: minimization of the therapeutic turnaround time (TAT), reduction of the clinical costs, improvement of patients compliance and clinical outcomes. In this report, two group of optical (Surface Plasmin Resonance (SPR) and colorimetric) [7,8] and electrochemical impedimetric biosensors[9] were developed.

2. Methodology

The biosensor analyte was constructed by covalently binding PSA specific peptide substrate through its N-terminus with a carboxyle-terminated magnetic –nano particles (MNPs) and to a gold sensing platform via thiol moiety at the C-terminal. The biosensor recognition element is the serine PSA protease. Upon proteolysis of the probe MNPs-peptide moiety by PSA, the physical link between the MNPs-peptide moiety and the gold sensor platform will be abolished. An external magnetic field would attract the cleaved MNPs-peptide moieties away from the gold sensing platform changing its properties which could be interpreted by the electrochemical impedimetric spectroscopy and SPR physical transducer or by visible colour change as shown in figure 1

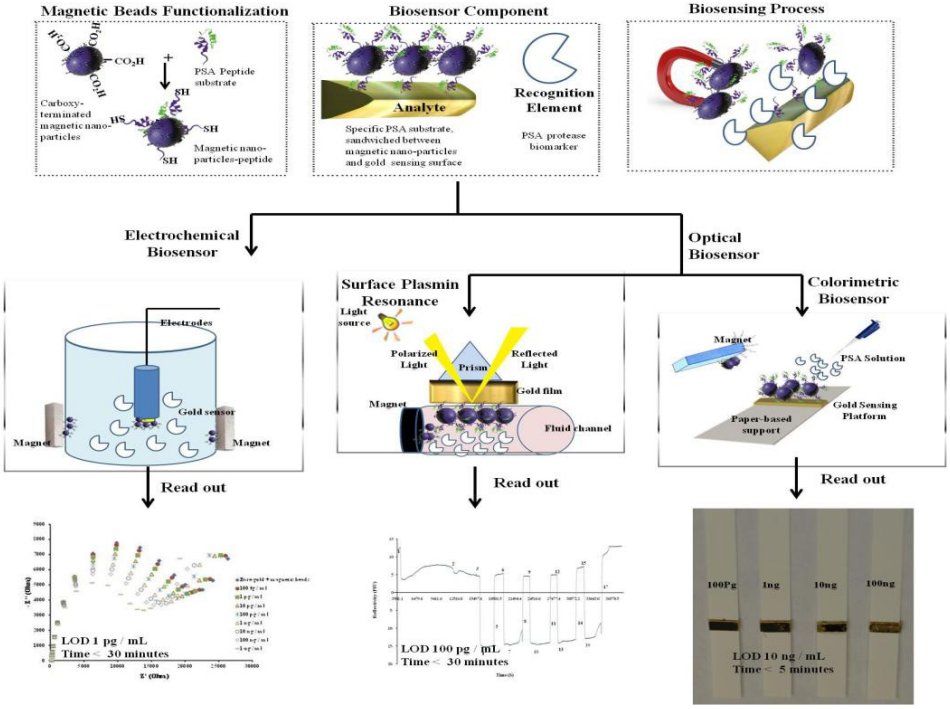

Fig. 1. Mechanism of the PSA biosensning using magnetic recognition SAM monolayer