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Disposable aptasensor combining functional magnetic nanoparticles with rolling circle amplification for the detection of prostate-specific antigen

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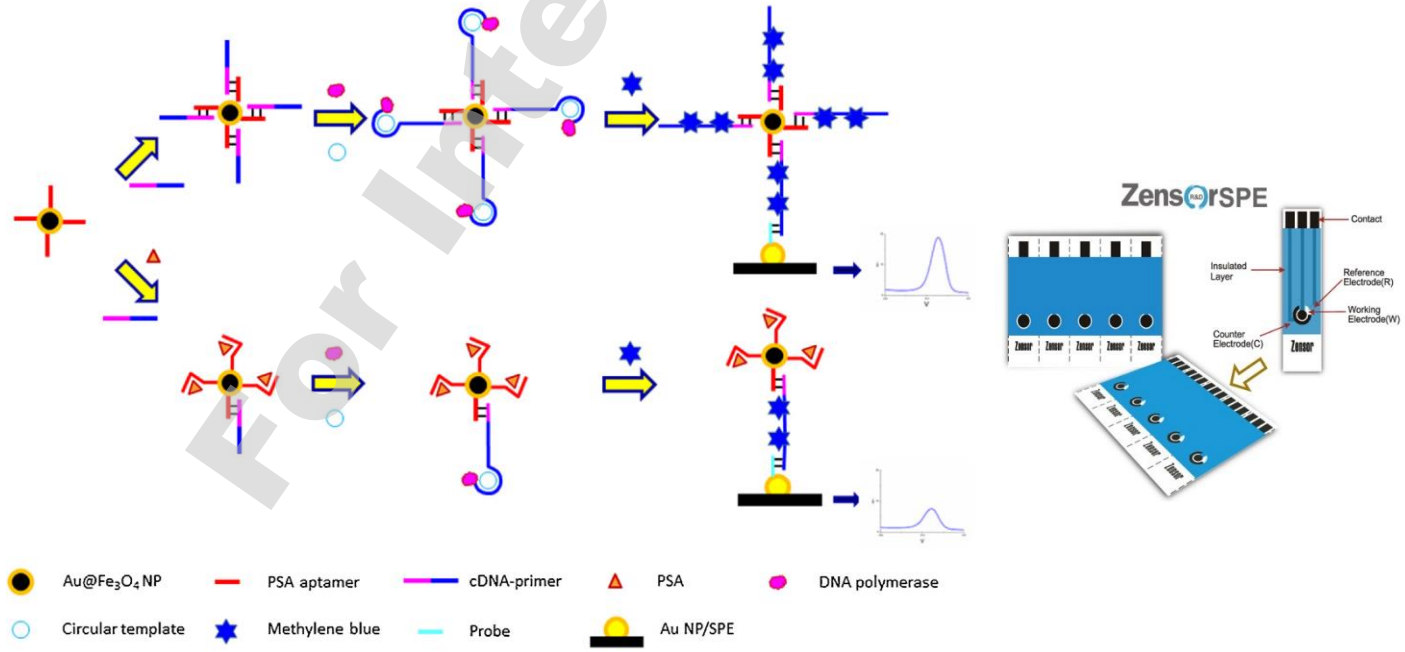
ABSTRACT

This paper describes a disposable and accurate aptasensor—that functions with signal amplification—for prostate-specific antigen (PSA) analysis in neutral (pH 7.4) condition. Combining aptamer-immobilized magnetic nanoparticles with rolling circle amplification (RCA) has provided a PSA detector with adequate sensitivity. In the absence of PSA, a portion of the complementary DNA-primer (cDNA-primer) bound with the aptamer and became the primer for the RCA reaction. The product of RCA contained G-rich bases that bound specifically with methylene blue (MB), thereby providing a measurable signal. In the presence of PSA, the aptamer would bind to it and fold, leading to fewer bound cDNA-primer units. Because the number of RCA primer elements decreased, the signal of MB weakened. The difference in the currents of MB measured in the presence and absence of PSA reflected the concentration of PSA. The intensity of the signal had a linear relationship with the logarithm of the PSA concentration over the range from 100 fM to 10 nM. The correlation of determination (R^2) of this calibration curve was 0.993, with a limit of detection of 22.3 fM.



Scheme 1. Representation of the RCA-assisted aptasensor for the detection of PSA.

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Research Paper

Functional magnetic nanoparticles–assisted electrochemical biosensor for eosinophil cationic protein in cell culture

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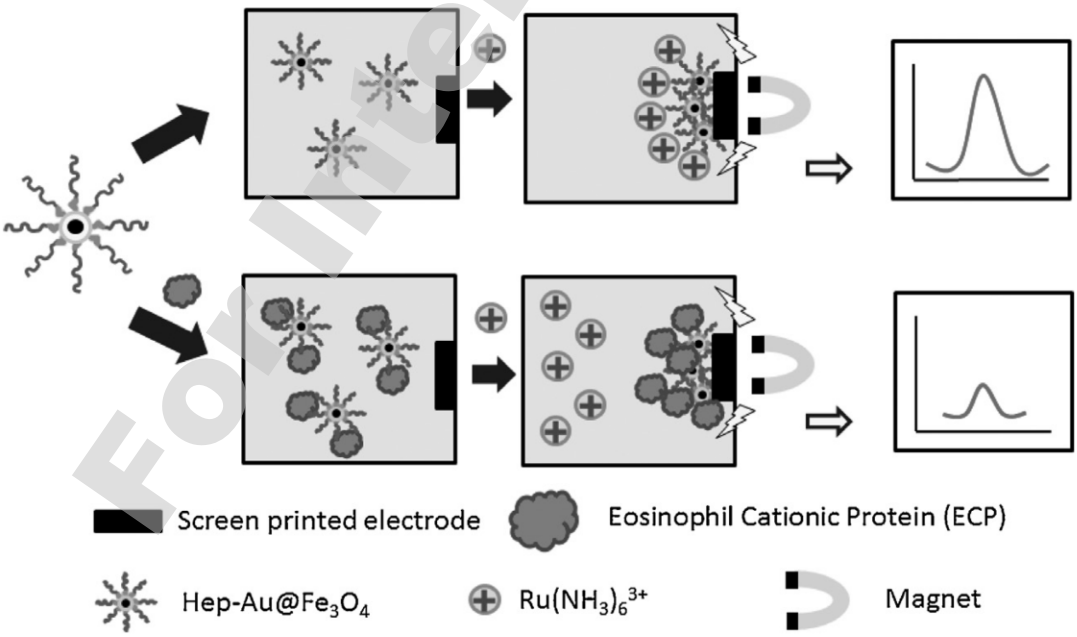
ABSTRACT

A low-cost electrochemical biosensor, assisted by a new type of functional magnetic nanoparticles (NPs), has been developed to detect eosinophil cationic protein (ECP), a known biomarker of asthma, in cell culture. The heparin-modified magnetic NPs were mixed with a sample solution containing ECP. After ECP had been captured by the NPs, a magnetic field was applied behind a graphite-based screen-printed electrode. The functional magnetic NPs were attracted to the electrode, raising the ECP concentration near its surface. Because of the use of the functional magnetic NPs, the difference in the signal was amplified when applying larger sample volumes for detection, thereby enhancing the sensitivity of the biosensor. This approach provided a linear range for the analysis of the logarithm of the ECP concentration from 1 to 1000 nM, with a coefficient of determination 0.992; the limit of detection was 0.30 nM. The fabricated biosensor displayed good recovery in a cell culture medium incubated with the Beas–2 B cell line. The ability to detect the concentration of ECP in a cell culture at any time point should be useful for explaining contradictory findings regarding the relationship between the initial ECP concentration and the cell line.



Scheme 1. Cartoon representation of the electrochemical ECP biosensor.