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TECHNICAL PAPER

An electrochemical DNA biosensor based gold-thiolate conjugation utilizing ruthenium complex $[Ru(dppz)_2(qtpy)]Cl_2$

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Abstract Non toxicity and high isoelectric point of zinc oxide nanorods (ZnO NRs) are the promising materials widely used in biomolecule detection and biomedicine application. An electrochemical DNA biosensor was successfully fabricated by depositing (3-Aminopropyl)triethoxysilane and gold nanoparticles (GNPs) on the hydrothermal growth ZnO NRs. The modified surface with GNPs (35 ± 5 nm) was characterized by field emission scanning electron microscopy with energy dispersive X-ray and X-ray diffraction. The fabricated electrode was used for the label-free detection of DNA. Thiolated (–SH) single stranded DNA was immobilized onto the GNPs surface to form a gold-thiolate bond. Hybridization with complementary target DNA was performed with the presence of ruthenium complex. Immobilization and hybridization detection were performed using μAUTOLAB with cyclic voltammetric software. The measured sensitivity of the fabricated electrode for hybridization is up to 1.6 times larger than immobilization.

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1 Introduction

Currently, the detection of DNA is an area of great interest as it is the key feature in the research for specific nucleotide sequences of DNA detection. This technique plays an important role in biodiagnostics (Ali et al. 2012b), determination of genetic diversity (Hood and Galas 2003), criminal investigation in forensics and immigration (Heller 2002), food analysis (Ali et al. 2012a, c) and environmental monitoring (Ali et al. 2012b). At present, variety of high selectivity and sensitivity of DNA detection techniques such as polymerase chain reaction (PCR; Yoshioka et al. 1992), terminal-restriction fragment length polymorphism (T-RFLP; Osborn et al. 2000), chromatography in tandem with mass spectrometry (Farmer et al. 2005) and surface plasmon resonance (SPR; Byun et al. 2011) are widely studied. However, these techniques have their limitation including long assay time, complex laboratory procedures and high cost. Therefore, a variety of approaches for the detection of DNA which overcome those weakness have been actively studied, such as electrochemical sensing (Zhang et al. 2008), fluorescence (Selinger et al. 2000), bio-field effect transistor (Bio-FET; Ruslinda et al. 2013) and oligonucleotide microarray and DNA (Ali et al. 2012b). Among these techniques, electrochemical DNA biosensor with its simplicity, good sensitivity, low cost, and possible miniaturization has attracted significant research interest.

Nanostructured transparent metal-oxide-semiconducting has currently received considerable attention because of their convenient and useful electrical and optoelectronic properties, which are suitable for diversified applications (Fan and Freer 1993; Ghosh et al. 2006). Therefore, the choice of ZnO NRs, which is an inorganic metal-oxide-semiconductor, is particularly interesting because of their wide band-gap (~3.37 eV), high exciton binding energy