Sequence-Specific Electrochemical Recognition of Multiple Species using Au/Ag Nanoparticle Labels

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Recently, various DNA-based assay protocols have been established to achieve a rapid and sensitive detection of specific DNA sequence. Of particular interest is the possibility to perform this analysis with micro-fabricated devices for on-site monitoring and rapid identification without complex machineries [1-3].

In this work, we report an electrochemical methodology that enables the rapid identification of different DNA sequences on the microfabricated electrodes. A schematic of the chip electrode is given in Fig. 1. Dimensions of this chip are 18 mm in both width and length consisting of four individually addressable ITO spots, a Pt counter electrode and an Ag pseudo reference electrode. Our approach starts with selective immobilization of different DNA probes on individually addressable spots of a patterned indium tin oxide (ITO) coated glass electrode. This selective probe immobilization is achieved via an electrochemical copolymerization of pyrrole and oligonucleotides (ODNs) bearing a pyrrole group [3]. Fluorescence images reveal a successful implementation of this technique.

An exemplary target mixture containing *E. coli* and *Stachybotrys Chartarum (SC)*, an airborne pathogen, is introduced for species identification. Recognition of the DNA hybridization event of the immobilized probes with the target pathogen PCR products or synthetic oligonucleotides is achieved by an electrochemistry-based method utilizing Au/Ag nanoparticle labels. This detection method relies on the preferential electrochemical deposition of Ag on the nanogold labels attached to the complementary DNA hybrids. Noncomplementary DNAs or background electrodes without the presence of nanogold will result in negligible Ag deposits. The significant difference of chronopotentiometric stripping responses of Ag between complementary and noncomplementary DNAs, as shown in Fig. 2, allow for a reliable recognition of a particular pathogen species interested.

Not like the hydroquinone-based electroless deposition process (i.e. the silver enhancement kit), the electrochemical deposition protocol developed in this study ensures a low background Ag deposition (noise) and greatly enhances the effectiveness of the Ag/Au approach.

It is envisaged that the detection platform developed in this study can be integrated with other analytical functionalities, such as sample preparation and micro-PCR, to realize a truly portable DNA analyzer.

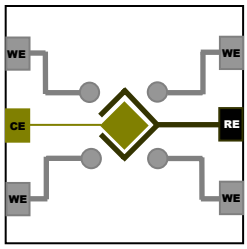

Fig. 1 Schematic presentation of our patterned electro-chemical chip. Note that WE, RE and CE denote the working, reference and counter electrodes, respectively

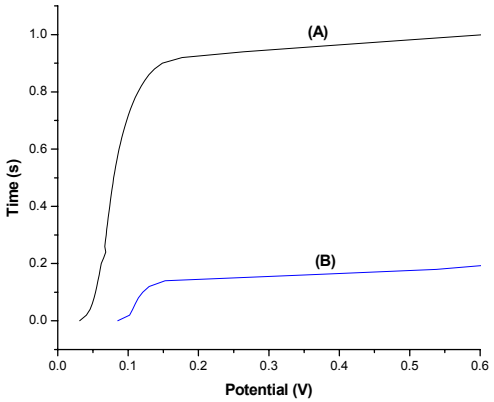

Fig. 2 Chronopotentiometric stripping responses of (A) *SC* probe incubated with complementary *SC* target tagged with gold nanoparticles, (B) *E. coli* probe incubated with the noncomplementary *SC* target tagged with gold nanoparticles.

References

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