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Nanobiosensor System for Aptamer Based Pathogen Detection in Environmental Waters

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Abstract : Environmental waters are monitored worldwide to protect people from infectious diseases primarily caused by enteric pathogens. All long, Escherichia coli (E. coli) is a good indicator for potential enteric pathogens in waters. Thus, a rapid and simple detection method for E. coli is very important to predict the pathogen contamination. In this study, to the best of our knowledge, as the first time we developed a rapid, direct and reusable SWCNTs (single walled carbon nanotubes) based biosensor system for sensitive and selective E. coli detection in water samples. We use a novel and newly developed flexible biosensor device which was fabricated by high-rate nanoscale offset printing process using directed assembly and transfer of SWCNTs. By simple directed assembly and non-covalent functionalization, aptamer (biorecognition element that specifically distinguish the E. coli O157:H7 strain from other pathogens) based SWCNTs biosensor system was designed and was further evaluated for environmental applications with simple and cost-effective steps. The two gold electrode terminals and SWCNTs-bridge between them allow continuous resistance response monitoring for the E. coli detection. The detection procedure is based on competitive mode detection. A known concentration of aptamer and E. coli cells were mixed and after a certain time filtered. The rest of free aptamers injected to the system. With hybridization of the free aptamers and their SWCNTs surface immobilized probe DNA (complementary-DNA for E. coli aptamer), we can monitor the resistance difference which is proportional to the amount of the E. coli. Thus, we can detect the E. coli without injecting it directly onto the sensing surface, and we could protect the electrode surface from the aggregation of target bacteria or other pollutants that may come from real wastewater samples. After optimization experiments, the linear detection range was determined from 2 cfu/ml to 10^5 cfu/ml with higher than 0.98 R^2 value. The system was regenerated successfully with 5 % SDS solution over 100 times without any significant deterioration of the sensor performance. The developed system had high specificity towards E. coli (less than 20 % signal with other pathogens), and it could be applied to real water samples with 86 to 101 % recovery and 3 to 18 % cv values (n=3).

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