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Highly sensitive electrospun multiwalled carbon nanotubes embedded zinc oxide nanowire based interface for label free biosensing

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Abstract

We demonstrate synthesis of Multiwalled carbon nanotubes (MWCNTs) embedded highly oriented Zinc Oxide (ZnO) nanowires targeted towards development of ultrasensitive electrochemical nanobiosensors using electrospinning method. The synthesized composite nanowires combines advantages of ZnO such as biocompatibility, electrostatic affinity towards biomolecules with the excellent conductivity and surface functionalization capabilities of MWCNTs. Calcination temperature is optimized so as to ensure MWCNTs are present in their original form and at the same time highly crystalline ZnO is obtained. The key advantage of this process is that there is no separate functionalization process is required to create functional groups on MWCNTs. Furthermore, the electrochemical activity of MWCNTs embedded ZnO nanowires is much higher as compared to pure ZnO nanowires. We have demonstrated the performance of electrochemical nanobiosensor using Biotin-streptavidin interaction as model system. The sensor exhibits excellent sensitivity in the range 10 μgmL^{-1} - 0.5 $fgmL^{-1}$ of streptavidin with 0.5$fgmL^{-1}$ limit of detection.

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Keywords: Multiwalled carbon nanotubes;Zinc oxide;Ultrasensitive;biocompatibility;electrostatic;electrospinning;

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1. Introduction

Nano structured Zinc Oxide materials have garnered much attention towards immunosensing applications due to their higher electron–transfer kinetics and direct electrostatic immobilization of the low isoelectric point target proteins[1,2]. Recently, multiwalled carbon nanotube-metal oxide hybrid nanostructures attracted much interest towards development of highly sensitive immunosensors [3]. The conductivity and sensitivity of ZnO nanomaterial can be enhanced by doping with carbon nanotubes [4, 5]. In this work, we have demonstrated the electrospinning technique for fabricating wultiwalled carbon nanotube-zinc oxide electrochemical immunosensor platform. The performance of immonosensor was verified with standard Biotin-Streptavidin interaction as model system.

2. Results and Discussion

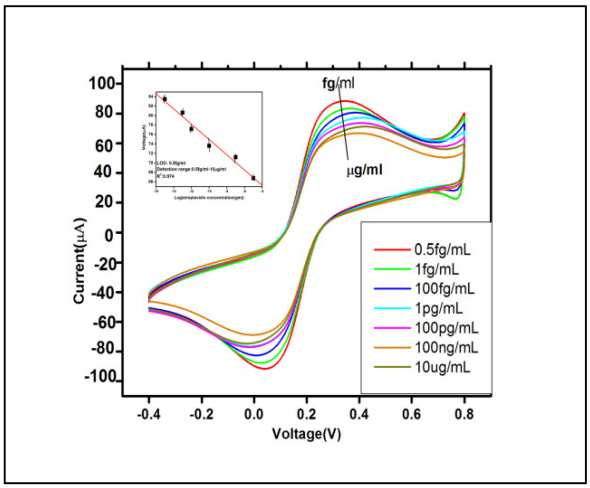

Fig. 1. Cyclic voltammetric (CV) response of the Biotin conjugated multiwalled carbon nanotube embedded zinc oxide nanowires as a function of streptavidin concentration. The fabricated immunosensor can detect 0.5 fg/mL streptavidin in the detection ranges of 10µg/mL-0.5fg/mL. Inset shows the calibration curve for the fabricated immunosensor.

3. Conclusion

In this work, we have demonstrated the multiwalled carbon nanotube embedded Zinc oxide nanowire immunosenor for Biotin-streptavidin interaction. The multiwalled carbon nanotube embedded Zinc oxide nanowire has been synthesized through electrospinning technique. The fabricated immunosensor shows excellent sensitivity with detection limit of 0.5 fg/mL in the wider detection range of 10µg/mL-0.5fg/mL streptavidin.

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