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Development of a Multiwalled Carbon Nanotubes/Platinum Nanoparticles Modified Glassy Carbon Electrode Sensor

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Abstract: *The electrochemical behaviour of amoxicillin trihydrate (AMX) at Platinum nanoparticles (PtNP) and Multiwalled carbon nanotubes (MWNT) - PtNP modified glassy carbon electrodes (GCE) have been investigated using Differential Pulse Voltammetry (DPV). AMX is one of the new types of important penicillin antibiotics with a wide spectrum, which is usually used for treating hemolytic streptococcus, pneumococcus, and diphtheria bacteria. Compared with the bare electrode, the peak current of AMX on (MWNT) - PtNP modified GCE showed marked increase and the peak potential showed a negative deviation. Under the optimized conditions the concentration of AMX showed excellent linear relationships with a detection limit of* 4.642×10^{-8} *M.*

Introduction

AMX is used to treat infections caused by bacteria, such as pneumonia, bronchitis, gonorrhea and infection of the ears, nose, throat, urinary tract, and skin [1] by inhibiting bacterial cell wall synthesis. As the clinical use of AMX became common, methods for its quantification have attracted the attention of investigators. Several methods were used for the determination of AMX. Most of the reported methods suffer from disadvantages such as complicated procedure, time consuming, requirement of expensive instruments and low detection sensitivity. The integration of nanotechnology with electrochemistry is expected to produce major advances in the field of electrochemical sensors. By combining, the two classes of nano materials carbon nanotube (CNT) and metal nanoparticles (NPs) novel hybrid materials can be synthesized that successfully incorporate the properties of the two counter components. CNT-NP hybrids materials have been reported to exhibit many promising applications [2-4]. The present work reports voltammetric determination of AMX on MWNT/PtNP modified Glassy carbon electrodes (GCE).

Experimental

Fabrication of MWNT/PtNP modified GCE

The electrochemical deposition of PtNP on a cleaned GCE was performed in 0.1 M H… solution containing 2mM H_2PtCl_6. Then 4 µL of MWNT dispersion was cast on the surface of a PtNP modified GCE and dried in the air to form a MWNT/PtNP modified electrode.

Preparation of analyte sample

Standard solutions of the analyte (1×10^{-3}- 1×10^{-6} M) were prepared by serial dilution … stock solution using phosphate buffer solution (PBS), pH 7.

Determination of AMX

Sample solution was taken in the electrochemical cell. The solution was then de-aera… with nitrogen for 5 min. The voltammetric behavior of AMX in PBS was studied … sweeping the potential from 0.3 V to 1 V at a scan rate of 100 mV/s.

Results and discussion

AMX gave an oxidation peak on bare GCE at 788 mV with a peak current of 1.829 µA … order to reduce the oxidation potential of AMX, At MWNT- PtNP modified GCE A… gave a well defined oxidation peak at 650 mV with a peak current of 18.5 µA. The res… indicate that the incorporation of MWNT could significantly improve the electron tran… behaviour of NP films due to its excellent electronic conductivity.

The effect of the electrodeposition conditions, such as deposition time and number of s… cycles on the response of the electrode were studied. The amount and particle size of … PtNP depend on the electrodeposition time. The oxidation peak current increa… gradually as deposition time increased. However, when increasing deposition t… continuously, the oxidation current decreased slightly, which might be associated with … decrease of the surface area resulting from the aggregation of PtNPs on the electr… surface. So, electrodeposition time was optimized to 9 minutes.

Effects of various experimental parameters, such as supporting electrolyte, pH, f… thickness and scan rate on the response were optimized. On the basis of higher p… current and better peak shape, it is inferred that the oxidation response of AMX at b… modified electrodes are much better in phosphate buffer solution (PBS) than that in o… medium. Thus PBS was used as the experimental medium for the further studies of A… Linear behavior of anodic peak current with the square root of scan rate ($\upsilon^{1/2}$), indic… that the electrode reaction of AMX on the modified GCEs is controlled by diffusion rather than adsorption.

Concentration studies of AMX were performed under the optimal DPV conditions at modified GCE. The results show that the oxidative peak current has a linear relationship with the concentration in the range 1×10^{-6}-1×10^{-5}M.

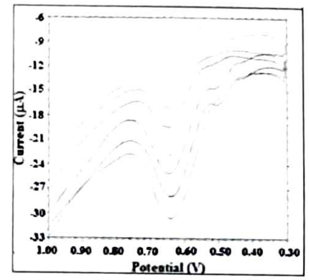

Figure 1 Differential pulse voltammograms of AMX at different concentrations on MWNT/PtNP/GCE

The analytical utility of the developed sensors in the determination of AMX in pharmaceutical preparations and in urine samples were determined.

Conclusions

MWNT/PtNP/GCE displays a strong electrocatalytic activity towards the oxidation of AMX. The prepared electrodes were successfully applied for the determination of AMX in pharmaceutical and in urine samples.

References

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St. Joseph's College (Autonomous), Irinjalakuda

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CERTIFICATE

This is to certify that ~~Mr./Ms./~~Dr. Laina A.L, S.H. College, Chalakudy participated/~~was a resource person~~/presented a paper in the Seminar on 15th & 16th February 2018.

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