RESEARCH
O&G Forum 2024; 34 – 2s: 618 - 622

FABRICATION OF NICKEL SELENIDE NANOSTRUCTURE MODIFIED ELECTRODE FOR THE DETECTION OF DRUG MOLECULE.

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Abstract

INTRODUCTION: The detection and analysis of drug molecule plays an important role in various fields including pharmaceutical research, clinical diagnostics and forensic analysis. The field of nanotechnology for drug detection is newly developing due its unique properties. The nickel selenide nanoparticle is a binary compound that has remarkable physicochemical properties and potential applications in various fields.

AIM: The aim of the study was to fabricate the nickel selenide nanoparticle and sensing of the drug using the nanoparticle.

MATERIALS AND METHODS: To 0.09M of Selenium 0.1M of Sodium borohydride was added in double distilled water.This solution was stirred for 3 hours and a black color solution was obtained . To this 0.07M of Nickel Nitrate was added and stirred for 1 hour .This mixture was left in the centrifuge for 24 hours at 180℃ .It was then cooled at room temperature and dried ethanol was added to it and the nanoparticle powder was obtained .With this nanoparticle powder further drug sensing was carried out.

RESULTS: Basic analysis for the confirmation of material was done and it was found that the nickel selenide is pure crystalline in nature.FE SEM analysis showed that selenium particle were found like a layer on a sphere .The drug sensed was Paracetamol which was done using a modified electrode ,it was found to be active at pH-7.

DISCUSSION: Paracetamol is the most commonly used drug .The detection of Paracetamol using nickel selenide was highly stable.Nickel Selenide proved to be efficient in drug detection due to its morphological features .It had good catalytic activity ,good electrical conductivity and stability .

CONCLUSION: This study proves that the Nickel Selenide nanoparticles were highly efficient in the detection of paracetamol ,due to their sensing ability and stability.

KEYWORDS: Nickel selenide ,electrochemical sensing,Paracetamol,fabrication,drug detection.

INTRODUCTION

Paracetamol(acetaminophen) is a widely used drug as an analgesic and antipyretic to treat mild to moderate level of pain .It is a derivative of Acetanilide .It is a non opioid analgesic.

This drug was not approved for commercial use until the 1950s as toxicity was a concern ,but clinical trials proved that paracetamol had a consistent safety profile.It does not have any anti inflammatory activity and does not produce any gastrointestinal damage like other non steroidal anti inflammatory drugs.It is in effective in intense pain and does not cause any depressant effect on respiration.The mode of action of Paracetamol is due to indirect inactivation of cannabinoid CB1 receptors .Earlier studies also suggest that Paracetamol shares mode of action similar to that of certain NSAIDs by inhibiting COX-1 and COX-2 .(1)

Paracetamol is used to treat mild to moderate pain such as headache ,cold,flu,sprains and backache ,minor arthritis pain and toothaches. Paracetamol used in combination or alone may be used as adjunct in pain during menstruation .The adult oral dose of paracetamol is 650-1000 mg for every 4 hours .The maximum daily dose is 4g.Pediatric oral dose is 10-15 mg per day for every4 to 6 hours with a maximum dose of 5g per day.Thus Paracetamol is drug of choice in several patients ,children,pregnant women and the elderly .But the Paracetamol has certain adverse effects on the human body.The overdose of Paracetamol cause renal impairment, hepatotoxicity ,hyperventilation ,acidosis ,hypoglycemia .It is also reported to cause myocardial damage ,multisystem organ failure and in extreme cases pancreatic toxicity.Early recognition of Paracetamol poisoning in patients will help in minimizing mortality and morbidity .There are different stages of paracetamol toxicity (2). In Stage 1(24 hours after ingestion) there are clinical signs like anorexia ,nausea and vomiting ,stage 2 (72 hours after ingestion) which leads to liver dysfunctioning ,hypoglycemia.In stage 3 (96 hours after ingestion) there is maximal liver toxicity,multi organ failure ultimately leading to death of a person . In some cases it might cause sudden death of a person who might look healthy .In such cases when different reasons of death are being analyzed drug toxicity due to overdosage can be considered and detected using a nanomaterial by forensic analyses .

This is one such study that involves the use of nickel selenide nanoparticle for the detection of Paracetamol through laboratory procedures .The morphology , concentration ,pH and stability nickel selenide nanoparticle is an advantage with its various application.The electronic and magnetic properties of nickel selenide lead to its use in optical recording of materials ,solar cells, sensors and laser material .The electronic configuration of nickel and lesser electronegativity difference with selenium lead to the formation of various complexes .(3)

The nickel selenide nanoparticle is a p type semiconductor with a bulk energy band gap of 2.0eV .Higher concentrations were found to have better efficacy in the application. The nanoparticle was found to have many unsaturated atoms and stable phases at room temperature ,which showed the presence of electrochemical active sites and high speed charge transfer channels(4).The nickel selenide is a binary compound that has remarkable physicochemical properties .The nanoparticle was found to have good catalytic activity ,good electrical conductivity and stability.It was found to have higher d-band states that indicated good electrocatalytic activity towards oxygen reduction and hydrogen evolution . The low dimensional stability of the nanoparticle leads to superior physio chemical properties.The resistance of the nanoparticle is temperature dependent(5).The fabrication of nickel selenide nanoparticle can be achieved through various synthesis methods such as chemical precipitation ,hydrothermal synthesis or sol-gel technique .In sensing of paracetamol the nanoparticle can be used as a sensing element in electrochemical or optical

sensors, further the surface of nanoparticle can be modified by using certain specific ligands or molecule that have affinity towards the drug.The drug was sensed using the electrochemical method .This method was chosen due to its rapidity,

Cost effectiveness and it was a better alternative to conventional methods(6) . Thus this study aims in fabricating the nickel selenide nanoparticle and sensing the drug.

MATERIALS AND METHODS

Duration of study

The study was conducted in Maroon seven lab in Saveetha dental college for a period of 3 months .

Materials Required

0.09M of selenium,0.1M of Sodium borohydride ,0.07M of Nickel Nitrate, double distilled water.

Synthesis of Nickel Selenide Nanoclusters

The nickel selenide nanoparticles were synthesized using one step hydrothermal technique .To 0.09M of Selenium 0.1M of Sodium borohydride was added in double distilled water.This solution was stirred for 3 hours and a black color solution was obtained . To this 0.07M of Nickel Nitrate was added and stirred for 1 hour .This mixture was left in the centrifuge for 24 hours at 180℃ .It was then cooled at room temperature and dried ethanol was added to it and the nanoparticle powder was obtained .With this nanoparticle powder further drug sensing was carried out.

Fabrication of Flexible Nickel Selenide /Polyimide Device

The synthesized nanoparticles were dispersed uniformly in the DMF solution and was deposited in the polyimide substrate using the spin coating technique.0.2% of Nickel selenide was dispersed in DMF and was coated at 500 rotations per minute for the polyimide substrate to be coated.The nickel selenide was further deposited at 2,000rpm and calcined for 3 hours at 70 degree.The coated Nickel selenide were placed in the centre of the source and was further processed and the fabricated device was obtained which was used in the CBZ sensing.

Sample Preparation for CBZ Sensing

The phosphate buffered solution which was used for sensing was prepared by mixing 68.44mM of NaCl 0.134 mM of KCl,5.07mM of Na2HPO4, and 88.1 mM of KH2PO4 in 2 mL of DI water.(7)

RESULTS

The study was conducted for sensing the Nickel selenide nanoparticle and to detect the Paracetamol drug.The results were as follows

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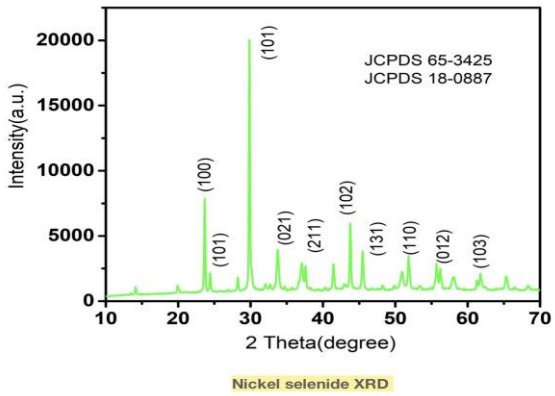


Graph 1:Represents XRD (X-Ray Diffraction Analysis).This is the basic analysis for the confirmation of the material formation ,sharp peaks indicate the crystallinity of the material .No noise was found in the peaks. 100,101 ., represent the Miller indices number .Highest crystallinity was found at 20,000 intensity

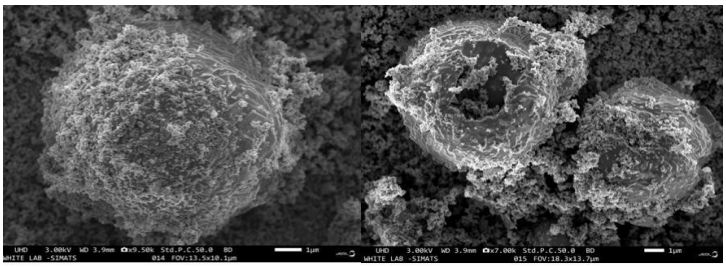
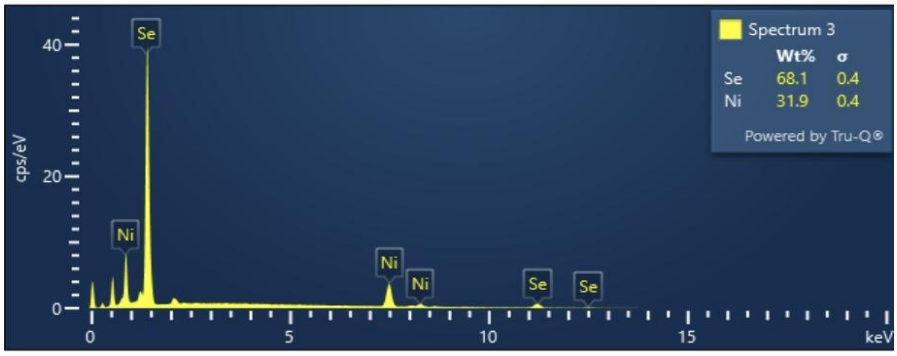
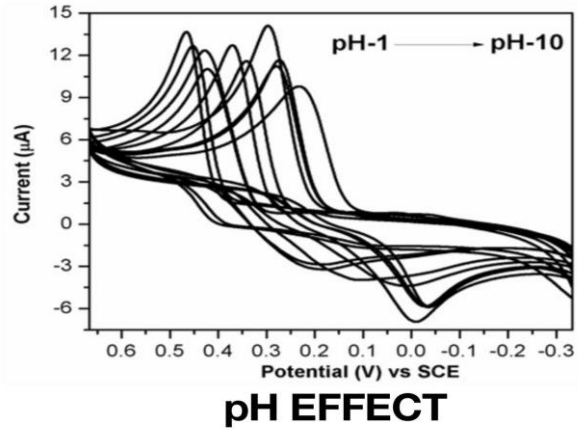


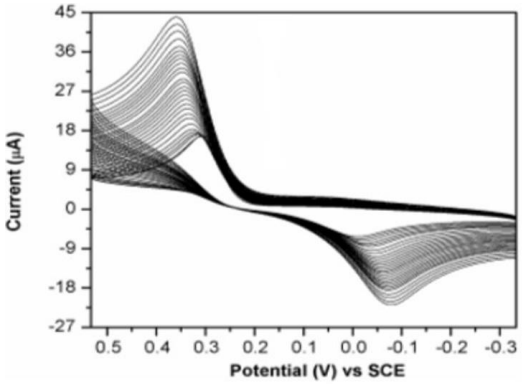
Figure 1:Represents the SEM EDX image of the nanoparticle .The SEM EDX was done to check the morphology of the material.It was found to be a sphere on which Selenium particles were embedded.



Graph 2: Represents the EDX (Energy Diffraction X-ray) of the material .The purity of the material was checked .It was found that only Nickel and Selenium were present.



Graph3: The pH effect was done to observe at what level the nanomaterial senses the electrochemical solution . On a pH scale of 1-10 ,the nanomaterial was able to sense the electrochemical solution at pH 7.



Graph4: Represents the Scan Rate of the Nanomaterial.The increasing peaks shows that the Nickel Selenide is able to sense the drug with high stability.

DISCUSSION

From the graphs obtained it is seen that the Nickel selenide is a highly pure element ,with sharp crystalline features and sphere-like morphology. It was able to sense the drug with high stability at a pH 7 .XRD pattern of the Nickel selenide particles show that they are highly crystalline and have smaller particle size with JCPDS 65-3425 and JCPDS 18-0887.

FE SEM analysis shows that the nanoparticle has spherical morphology .EDX justifies the purity of the nanomaterial .In the pH effect the peaks of the graph increase ascendingly on a scale of 1-10 and the results showed that the paracetamol can be detected at pH 7 .The scan rate was done to check the sensitivity and the stability in the detection of Paracetamol .

Paracetamol being one of the most commonly used drugs it is more prone to overdosage that ultimately leads to poisoning .The paracetamol poisoning can be treated with N-acetylcysteine in certain cases.It is known to cause fatal hepatic failure ,fatal hepatic necrosis .It also alters the antioxidant enzyme system ,leading to renal damage .(8)

People with existing renal failure ,hepatic disease are more prone to the toxicity of drug if it is been over used .It also presents some increased risk factors for development of asthma early age ,which shows that increased exposure to paracetamol in the intrauterine life,infancy or early childhood may be cause. (9)

Studies revealed that oxidative stress plays an important role in the Paracetamol toxicity .

The Paracetmol toxicity also leads to the damage of mitochondria thereby increasing the risk of liver injury . The role of antioxidants and oxidative stress is critical in the overdose toxicity.

Therapy for the overdose poisoning resulted in decreased oxidative stress and antioxidants,thereby normalizing the serum level.Previous studies have reported that oxidative damage can also cause damage to DNA ,proteins .This oxidative stress reaction caused due to Paracetamol overdose can be prevented by formulating different extraction reagents of antagonist Some studies suggest that certain chemicals can be used to prevent the damage caused to liver and kidney due to the overdose .Prazosin which is commonly used to treat hypertension has also been used to control the hepatotoxicity caused by Paracetamol. Age may also be a factor that may lead to increasing damage in the body due the overuse of the drug.(10)

Studies have shown women at delivery and postpartum have high levels of the paracetamol in the body which may lead to oxidative stress.Factors like drinking ,smoking and use of tobacco may also aggravate hepatotoxicity. In recent days Paracetomol poisoning has been one major cause for hospitalization causing damage to overall systemic health and in certain cases leading to death of the individual ,in some cases the reason for death may remain unknown and the autopsy reports may suggest presence of high concentration of the certain drugs .These drugs can be detected by various methods ,using nanoparticle to detect has been recently developing .

The Nickel selenide nanoparticle is a highly stable material and the morphology of the particle is an added advantage The nickel selenide nanoparticle were found to have pre catalytic properties and they undergo structural changes on reaction that indicates better adaptability .In a previous study the chronoamperometry was done and it was found that the selenium rich core was able to retain the nickel particles .The nickel selenide nanoparticles can undergo surface reconstruction by exchanging anions with the electrolyte .The structure has a good monodispersity property.(11)

The nanoparticle has excellent conductivity which provides an improved charge transfer capability in the pH effect experiment performed in the current study .(In the ph effect experiment a three electrode setup was done in which the first electrode was working electrode(glossy carbon electrode) ,the second electrode was reference electrode (silver/silver chloride electrode)the third electrode was platinum wire, these electrodes were placed in a electrochemical cell with an electrolyte .)It is also found that depending on the concentration of nickel and selenium taken the conductivity varies .(12)

The nickel selenide is non stoichiometric and has various selenide forms with optimum anion size .The flexibility of the nanoparticle is more thereby helping in better reactivity .In this study the nickel selenide was synthesized using electrochemical sensors .The electrochemical sensing is a rapidly growing field of interest and it provides simple,fast and sensitive usage.The nickel nanoparticle is less expensive and less toxic .The nanomaterial has narrow band gap and low resistance which leads to its catalytic properties.The bandgap and size is an important characteristic of any nanomaterial.The Nickel selenide exhibits an orthorhombic structure and was found to be stable at high temperatures.(13)

Some other uses of Nickel selenide are electrochemical water splitting ,oxygen evolution reaction and hydrogen evolution reaction and it is also used as supercapacitors and it is also used as a photodetector.(14)Due to the sharp peaks obtained they emit light on excitation

The nickel selenide is used to detect paracetamol by using various electrochemical techniques in which various electrolytic solutions like phosphate buffer ,sodium hydroxide are used .As mentioned earlier several electrodes were used to detect the pH range .(15)

Studies suggest that the amount of concentration of nanomaterial taken will also affect the resultant properties .Different ratios of nanoparticles show different wavelengths.(16)

CONCLUSION

The various parameters like concentration,pH had affected the nanoparticle property.The study concluded that the nickel selenide had highly crystalline nature ,

and was highly stable in detecting the paracetamol drug .The use of Paracetamol should be controlled and it should be cautiously as it has several harming effects on the body .This study proved that nickel selenide was effective in detecting paracetamol.

CONFLICT OF INTEREST

There is no conflict of interest.

ACKNOWLEDGEMENT

We extend our gratitude to Saveetha dental college and hospital for their constant support and encouragement and hereby helping in successful completion of this research work.

FUNDING

1.Saveetha institute of medical and technical sciences
2.Saveetha dental college and hospital
3.Saveetha university
4.Kamala dental speciality hospital

ETHICAL CLEARANCE

Since it is an invitro study ,ethical clearance is not required.

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