ISSN: 0975-766X
CODEN: IJPTFI
Available Online through
www.ijptonline.com
Research Article

SYNTHESIS, CHARACTERIZATION AND SIGNIFICANCE OF NANOWIRES IN PHARMACEUTICALS

V.Viswanath*, P. Bhavani Manoja
Associate professor, Department of Pharmaceutics, PRRM College of Pharmacy, Kadapa 516 003.
Email: viswanath.prrm@gmail.com

Received on: 20-02-2019 *Accepted on: 30-03-2020*

Abstract

Because of their potentiality in many electronic systems silver nanowires can attract very much attention in both academia and industry. Many research articles relating to silver nanowires in the past. But relatively few review articles focusing on these unique materials present review introduce. The definition and characterization of silver nanowires the synthetic methods applied to prepare silver nanowires; the factors which affect their final morphology also discussed in detail and also discuss the typical synthetic technologies and representative studies which are summarized. Further the applications of silver nanowires as conductive materials and components of electronic systems are reviewed. The challenges which remains with silver nanowires are proposed finally.[1]

Keywords: Nanowires, Template, Laser ablation

1. Introduction

Nanoscale sized structures are attracted particular interest due to its unique mechanical, electronic, optical and magnetic properties in the past. Huge surface to volume ratio of nanowires opened up a broad range of their applications. One of the most important one-dimensional (1-D) nanostructures, metallic nanowires such as nickel nanowires, copper nanowires and gold nanowires are expected to play a particular role in future. Now a days considerable attention is focused on nanowires and 1-D nanostructures systems such as nanorods, nanobelts, nanoribbons, nano troughs and nano fibres because of their high potential in many kinds of applications as molecular electronics, diagnostic biosensors, novel scanning microscopy probes, sensors and resonators in nano-electro-mechanical systems, reinforcing phases in advanced nano composites, bio medical science, energy storage, electrochemistry opt electronic device and building blocks the ability of metallic nanowires to create future technologies and various applications in science, technology and engineering can cause the scientists and researchers to investigate and enhance the present state of knowledge about metallic nanowires from how the metallic nanowires produced, characterization of metallic nanowires including the physical characterization, mechanical characterization, chemical characterization an so on. The experimental procedure and techniques to characterise metallic nanowires can results always to find out most accurate and most straightforward ways the present software and analysis used for modelling and simulation of nano structures are use full to overcome the difficulties in the investigation and minimise the costs and time used for understanding its unique properties through complex experimental procedures. The main contents of this review are organised into five sub topics. The next subtopic will discuss the synthesis process of metallic nanowires. The discussion will focus on a relatively straightforward method which is template-assisted electro deposition, and the summary of other relevant methods used to synthesize metallic nanowire is presented at the end of Subtopic two. The third subtopic will review the mechanical characterization process involved to extract the mechanical behaviours of metallic nanowires which includes tensile characterization and nanoscale testing methods, bending characterization and loading tests, mechanical resonance tests, and compression loading characterization. Each of these mechanical characterization methods is introduced in this section complete with an example from prior work in the literature. The fourth section presents the modeling method as an alternative way to extract mechanical behavior of metallic nanowire and at the end of this section will come out with a summary of parameters used as well as the finding of each previous study regarding modeling. The last subtopic will summarize the fields of application achieve by a different type of metallic nanowires.[2]

2. Advantages of Nanowires:

- NW devices can be joined in a rational and expected because:
- NW can be precisely controlled during synthesis,
- Chemical composition,
- Diameter,
- Length,
- Doping \electronic properties
- Reliable methods exist for their parallel assembly.

- It is possible to merge distinct NW building blocks in ways not possible in conventional electronics.
- NWs thus characterize the best definite class of nanoscale building blocks and this precise control over key variables has respectively enabled a wide range of devices and integration strategise ton be pursued.[3]

3. Disadvantages:

- Complications in manipulating individual NWs.
- Complications to control whether building blocks are semiconducting or metallic.
- Up to date, device fabrication by NW chiefly is a random event, posing a considerable barrier to achieve highly incorporated nanocircuits.
- Stretching a nanowire can either increase or decrease its conductivity--depending on the type of nanowire.

4. Synthesis of silver nanowires (AgNWs)

4.1 Hard templet method

Using a nano porous membrane as a template the AgNWs can be developed within the pores of the membrane. The diameter of the AgNWs can be varied by choosing membranes with pores of different sizes. When they exploited porous membranes to prepare conductive polymers, metals, semiconductors and nanostructures with extraordinarily small diameters. Porous alumina, nanochannel glasses, mesoporous silica and porous polycarbonate were extensively used to prepare metal nanostructures. By use of these hard templates, the nanostructures can be generated within the pores by either the electrochemical or chemical reduction of metal ions. The advantage of hard templates is that the resultant AgNWs can be highly ordered and they can possess well defined morphologies. though, complex trials are required for the subsequent removal of these templates and this purification process may damage the nanowires, especially those with high aspect ratios.

4.2 Soft template method

AgNWs were synthesized *via* the polyol method, using silver nitrate ($AgNO_3$) as the Ag source [20]. PVP (3 g) was completely dissolved in glycerol (95 ml) by heating to 80 °C. The solution was cooled down and $AgNO_3$ (0.79 g) was added under vigorous stirring (800 rpm) until the powder was completely dissolved. NaCl was mixed in 10 ml of glycerol and added to the PVP/glycerol solution. The effective temperature of the mixture was slowly increased to 210 °C. Once the temperature was reached, it was maintained for further 10 minutes. Samples were taken at different temperatures, diluted (1:1) with water and analysed by UV Spectrophotometer to follow the formation of the AgNWs. Finally, the reaction was cooled down to room temperature, diluted 1:1 with deionized water and centrifuged (4000 rpm, 1 h), the pellet was washed twice with isopropanol (4000 rpm, 30 min) and twice with deionized water (4000 rpm, 10 min). The product was stored in deoxygenated purified water at room temperature, protected from light or freeze dried.[4]

4.3 Spontaneous Growth

The different steps involved as follows:

1. Diffusion of the development species from the bulk to the emergent surface. This is considered to occur rapidly adequate so frequently it is not a limiting factor.

2. Adsorption and desorption of the development species on to and from the emergent surface. This is a method that can be rate limited in the concentration of the development species is low.

3. Surface diffusion of the adsorbed development species. All through this diffusion stage the development species can be integrated into a growth site and contribute to the crystal growth or flee from the surface.

4. Surface development by irreversible absorption the absorbed growth species in the crystal.

5. If a derivative of a chemical reaction is produced, desorbs from the surface. Then the development species can adsorb again and the development process continues.

4.4Template based synthesis

This is a general method that can be used to develop nanorods and nanowires. Different templates with nanometres size channels have been explored for the template development. The most commonly used are anodized alumina membranes, radiation track engraved polymer membranes, nanochannel array glass, radiation track engraved mica and mesoporous substances.

Alumina membranes with normal parallel porous preparation are made by anodic oxidation of Al in solutions of dissimilar acids. The pores are typically arranged in a hexagonal array and can attain densities as high as 1011 pores per square centimetre. Polycarbonate membranes are prepared by bombardment a non-porous polycarbonate sheet with a thickness 6 to 20 microns with nuclear fission fragments to produce damage tracks that are consequently chemical etched. The pore delivery in this case is indiscriminate with a typical density up to 109 pores per square centimeter. Various materials have different combination or fabrication methods. In all cases the templates are anticipated to provide a standard array of sites with nanometer dimensions to show the development of nanowires or nanorods in a controlled fashion

4.5 Electrochemical deposition

It is also known as electrodeposition, this procedure involves an electrolysis process that results in the deposition of solid material in an electrode. The procedure involves: a oriented diffusion of charged growth class through a solution with an external electric field. Reduction of the charged growth species at the developed surface that also is one of the electrodes of the electrolysis method. When electrodeposition (also known as electroplating) is limited inside the pores of template membranes, nanocomposites are produced. If the template is separated, nanorods or nanowires are prepared. When a solid is placed in a polar solvent or an electrolyte solution, surface charge will be developed. At an interface between an electrode and an electrolyte solution, an oxidation or reduction reaction takes place by a charge transfer through the interface until the equilibrium is attained.[5]

5. Characterization

The methods to fabricate Si nanowires are given as follows:

Vapor-Liquid-Solid (VLS) mechanism

Chemical Vapor Deposition (CVD) mechanism

Molecular Beam Epitaxy mechanism

Laser Ablation mechanism

Aqueous mechanism (Electroless chemical etching)

5.1 Vapor-Liquid-Solid Mechanism

The VLS system is a 1D crystal growth method that is assisted by a metal catalyst. It results in the creation of whiskers, rods, and wires. For some reason, e.g., temperature or vapor pressure difference, the alloy is more supersaturated; i.e. it becomes a solution in which the specific concentration of the components is elevated than the equilibrium concentration. It then drives the precipitation of the component at the liquid–solid interface to complete minimum free energy of the alloy system. Accordingly. Because vapour, liquid and solid phases are concerned, it is known as the VLS method. At a glance, one can recognize that the size and arrangement of the catalyst are connected to the diameter and site of the1D structures, as the liquid phase is limited to the area of the precipitated solid phase.

5.2 Chemical Vapor Deposition

This technique is a cost efficient technique. Here for the expansion of Si nanowires SiO granules are used as resource components. In crucible of a tube heating system SiO granules are taken. To the tube heating system inert gas supply is provided. Near about 1350^{0}C temperature is supplied to the furnace. By it Si gets evaporated and moves from hotter end to the cooler part to the substrate and Si nanowires are produced.

5.3 Laser Ablation

This is the method by which ultra-thin Si nanowires can be prepared. A pulsed laser is used in this method. A objective matter is placed in a oven and to it heat is supplied. The target substance is ablated by using the pulsed laser resource. Ablated Si material on it way collide with the inert gas molecules and cools down. when the Si vapour cools it condenses to Si nano droplets. These Si nano droplets fell on the substrate to form Si nanowires.

5.4 Aqueous Method (Elrctroless Chemical Etching)

Production of nanowires take place after several continues reaction in the aqueous solution so it is called as aqueous technique. Most frequently for the etching mechanism the elements that are used for deposition are Ag, Au, and Cu on Si substrate. These metals moves the electron from the Si substrate. Oxidation of Si takes place .In one way to produce Si nanowires by this technique AgNO3/HF solution is taken. Si wafer is placed in the solution for the deposition. In the solution there are lots of Ag+ to oxidize Si by take electron from it and also produces SiO2. In the existence of HF, SiO2 gets easily etched away. Si under Ag particles are protected. Then by using HNO3, Ag particles are isolated by leaving Si nanowires.

6. Applications

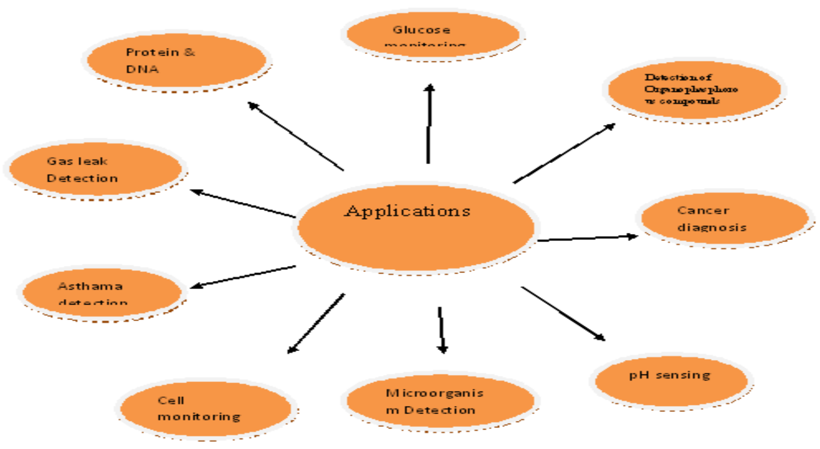

Fig -A: Applications of Nanowires.

6.1 Glucose Monitoring

One of the chief reasons for developing *in vivo* glucose sensors is the discovery of hypoglycaemia in people with insulin dependent (type 1) diabetes. It modulates emission in response to the adsorption of specific biomolecules.

6.2 Asthma Detection

A nano-biosensor that can be used to identify asthma attacks up to three weeks before they happen just by using a handheld device to test the nitric oxide level in the patients breath. Testing frequently, as a diabetic patient would test their blood sugar level, could save lives.

6.3 Astronaut's Diagnosis

Astronauts works in a space vehicle or eventually living in an extraplanetary surroundings. Another biosensor can pass through membranes and into the white blood cells known as lymphocytes, in order to identify early radiation damage or illness in astronauts by sensing signs of biochemical changes.

6.4 Detection of Organophosphorus Compounds

AChE-based biosensors have a major drawback: since organophosphorus and carbamic pesticides, heavy metals, and detergents exert strong definite inhibition of AChE. AChE inhibition test is limited to only a limited number of analytes.

6.5 pH Sensing

Surface receptor plays a key role in defining the response of the nanowire sensors which was additionally tested by probing the pH response without changing the silicon oxide surface layer.

6.6 Protein and DNA Detection

Biological macromolecules, such as proteins and nucleic acids, are usually charged in aqueous solution and, as such, can be identified readily by nano sensors when suitable receptors are linked

6.7 Gas Leak Detection

The use of minute and sensitive nano sensors can allow for the distributed position of devices over a large area, thus allowing for a more accurate and timely determination of a gas leak. Nanosensors are being developed for the discovery of various hazardous gases, including but not limited to: H2, NH3, N2O4, hydrazine, and others.

6.8 Microorganism Detection

Detection of bacteria

Various nanotechnology-based methods have previously been described including ferrofluid magnetic nanoparticles and ceramic nanospheres. A bio conjugated nanoparticle-based bioassay for *in situ* pathogen quantification can identify a single bacterium within 20 min.

Cancer Diagnosis

Current advances have led to QD bioconjugates that are highly luminescent and stable. These bioconjugates elevate new possibilities to study genes, proteins and drug targets in single cells, tissue samples and even in living animals and facilitate visualization of cancer cells in living animals.

Cell Monitoring

The most frequently used optical method is to monitor intracellular species with fluorescent labels. In a new method, fibreoptic as well as cell-implantable nano sensors have been developed and tested for pH, calcium, sodium, potassium, nitric oxide, oxygen and glucose recognition for their use in early rat embryos and single mammalian cells.

Conclusion

Nanowire sensors have the prospective to modify conventional medicine to precision medicine in clinical oncology. Though, several obstacles currently obstruct their development into clinically significant portable point of care diagnostic devices. Clinical laboratories regularly use commercial in vitro diagnostic procedure that are manufactured within defined specifications at targeted costs and exhibit very little variability. In addition, these devices must meet regulatory requirements to certify their approved for use by the significant regulatory body before launch. Hence integrating nanowires into micro fluidic systems that facilitate automated multiplex functionalization and recognition should be positive because they represent a path towards clinical applications.

Acknowledgement

The author is thankful to P. Rami reddy Memorial college of Pharmacy, Jawaharlal Nehru technological university Anantapur, for their help in compiling the outline of article and linguistic support**.**

Reference

1. Pei Zhang, Ian Wyman, Jiwen Hu , Shudong Lin, Zhiwei Zhong , Yuanyuan Tu, Zhengzhu Huang, Yanlong Wei, Silver nanowires: Synthesis technologies, growth mechanism and multifunctional applications.
2. A.G.N. Sofiah, M. Samykano , K. Kadirgama, R.V. Mohan, N.A.C. Lah, Metallic nanowires: Mechanical properties – Theory and experiment.
3. http://www.slideshare.net/mobile/tamvantranz/nanowires-presentation
4. Nanowires and nanorods.
5. Dr. Jyothi kar, sigma sai, Fabrication &characterization of silicon nanowires. National institute of technology.

Corresponding Author:

V.Viswanath

Associate professor, Department of Pharmaceutics, PRRM College of Pharmacy, Kadapa 516 003.

Email: *viswanath.prrm@gmail.com*