Frequency Response of Grown Nanowires

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Abstract: *The Cu (copper) nanowires are grown by electrochemical deposition. Three electrodes are used for the synthesis of nanowires in anodic alumina membrane(AAM). Impedance spectroscopy is done to draw the response of the impedance on the grown wires with change in frequency.*

Introduction

There is of great interest in the fabrication of nanoscale components e.g nanowires, and nanorods. Materials used for this fabrication is to be deal with the nanoscale dimensions and the sometimes the properties of the materials like resistance, conductance and impedance behave differently as they response when we use materials in bulk. Sometimes these properties can be used for various applications. As the term GMR (Giant Magneto Resistance) is very popular and it has the use in memory storage. There are different methods for the growth of nanowire like CVD(Chemical Vapour Deposition) in the nanopores of membrane, Etching of the large

wires to nanoscale or Electrochemical deposition. Template used can be ion -track etched polycarbonate membrane or anodic alumina membrane.

Method

The electrochemical deposition is used for the fabrication of nanowires. Template used for the growth of nanowies is anodic alumina membrane with pore diameter of 100nm and a average sepration of 700nm in between pores. The Pores are the place where the wires are grown. A thin conducting coating of silver paste is required on the back of membrane to make the membrane conducting for the deposition of ions in the pores.

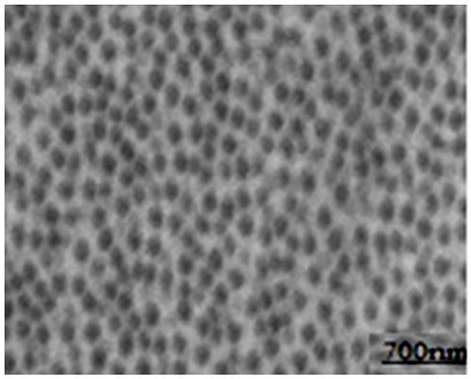

Fig-1 : Sem View of AAM membrane

The system used for the deposition of the nanowires is three electrode electrochemical cell consisting of working electrode, reference electrode and counter electrode.

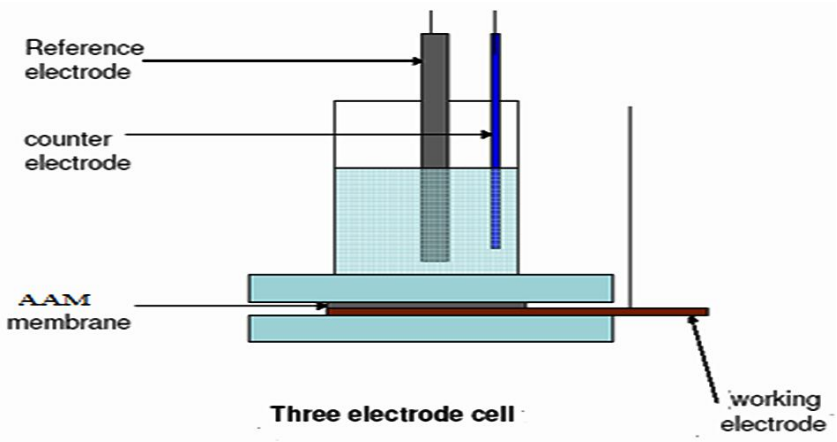

Fig-2

Platinum wire is used as counter electrode, Ag/AgCl as reference electrode and Copper beneath membrane as working electrode. Three electrode system is very useful in maintaining the potential constant between working electrode and reference electrode. Electroposition to obtain Cu wires is performed at pHH"4. Where the pH value is controlled by mixing a fixed amount of sodium hydroxide (NaOH) or sulphuric acid (H_2So_4) solution. Cu nanowire deposition takes place at room temperature that is same as deposition time and at a constant deposition potential ,when using Ag/AgCl as refrence electrode,which performs as the

$$AgCl(s)+e^{-}= Ag(s)+Cl^{-}(aq)$$

The potential of Ag/AgCl depends upon the activity of Cl^{-}.thus

$$E=E^{0}_{AgCl/Ag}-0.05916\ loga_{Cl^{-}} =+0.2223\ V -0.05916\ loga_{Cl^{-}}$$

Chlorides can contaminate the setup so we modified our setup with three electrode electrochemical cell by introducing an ion conducting membrane in order to prevent the chlorides in the refrence electrode from diffusing to the working electrodes.

Observations:

The impedance spectroscopy done to know the response of grown nanowires to the varying frequency, shown in fig 3.

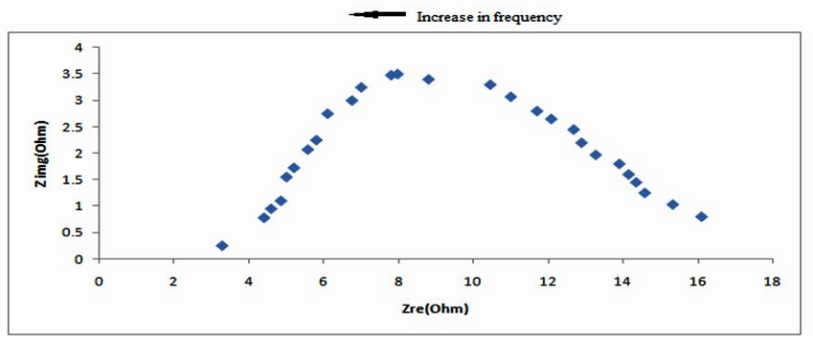

Fig - 3

It actually depicts the Nyquist plot in which real part of the impedance is drawn on x-axis and imaginary part of impedance on Y-axis with varying frequency from 100 Hz to 100Khz as shown in fig 3.

Discussion

As it is clear from the fig 3 the impedance of the nanowires is not constant for all frequency showing that theset having some reactance also. This reactance may be due to parallel growth of nanowires. As current flows through them, there may occur some capacitive reactance and inductive reactance with pure resistance of grown nanowires. Due this there is creation of semicircle in Nyquist plot.

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