Doping Dependent I-V Characteristics of Single Silicon Nanowire

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Background

- Silicon (Si) is well understood material, it lies at heart of IC technology.
- Si is indirect band gap material so it can not be used for opto electronic application.
- Luminescence in the visible region has been observed from Si nanostructures (SiNs). This motivated the researchers to work in the area of SiNs.
- By quantum confinement effect, the bang gap can be tuned from 1.1 eV to ~ 2.9 eV in the SiNs.
- Metal induced etching is one of the best method to fabricate Si nanowires (SiNWs).

Material Preparation

1st Step : *Cleaning of wafer*

wafers were ultrasonicated in acetone and ethanol to remove impurities prior to the porosification process.

2nd Step : *Removing of oxide layer*

The thin oxide layer formed on the surface was then dissolved in a 5% HF

3rd Step : *Growing of Ag nano particle*

This treated wafer was transferred into an Ag deposition solution containing 4.8 M HF and 0.005 M AgNO3 for 1 min at room temperature

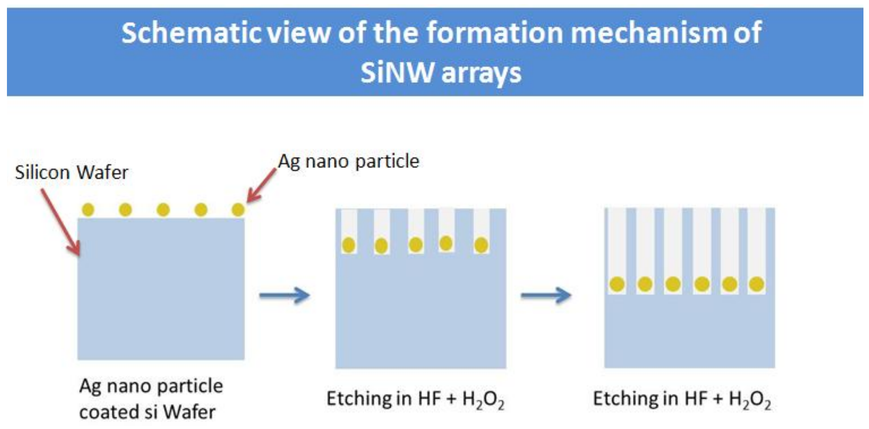
4th Step : *Etching process*

Then soaked into an etchant bath. The HF concentration of the etching solutions is 4.8 M, while the H2O2 concentrations is 0.5 M. The etching times are 60 & 75 minutes.

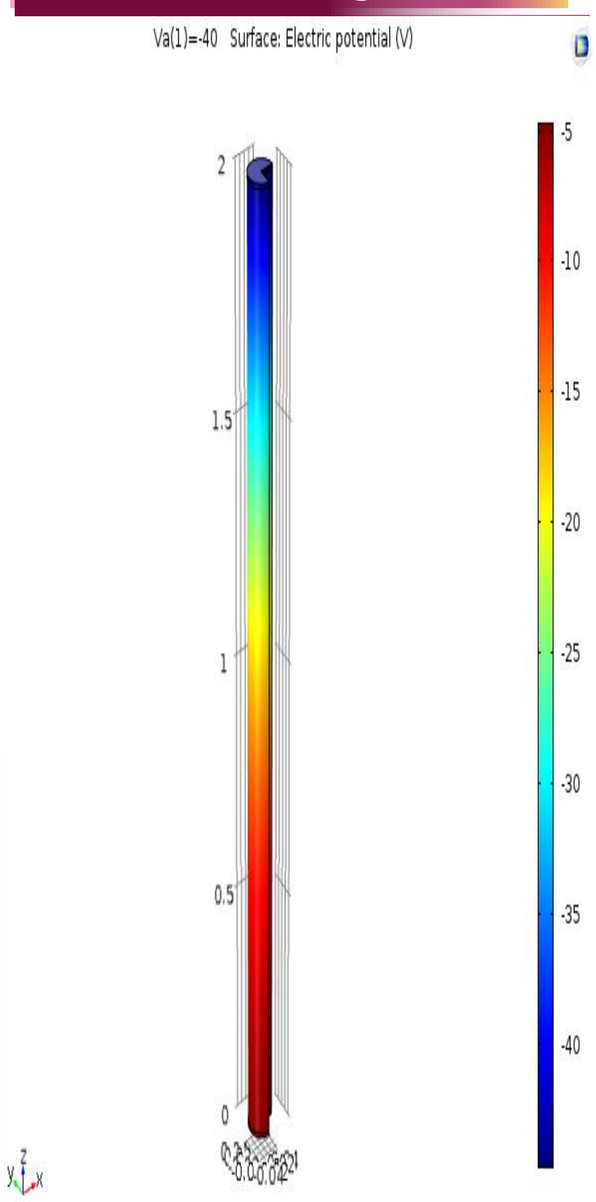
Abstract

- we have studied the electron transport properties of single silicon nanowire using semiconductor module of COMSOL® Simulator.
- We construct a MSM (metal-semiconductor-metal) model where metal is selected as copper and semiconductor is taken as silicon.
- Schottky diodes formed at both ends of silicon nanowire are biased by applying external potential so that one junction is in forward bias mode and another is in reverse bias mode.
- The effect of changing the doping concentration and effect of radius on electron transport behaviour of silicon nanowire.
- It is observed that by increasing the doping concentration the Schottky junctions disappear and silicon nanowire shows a linear trend in I-V characteristics.

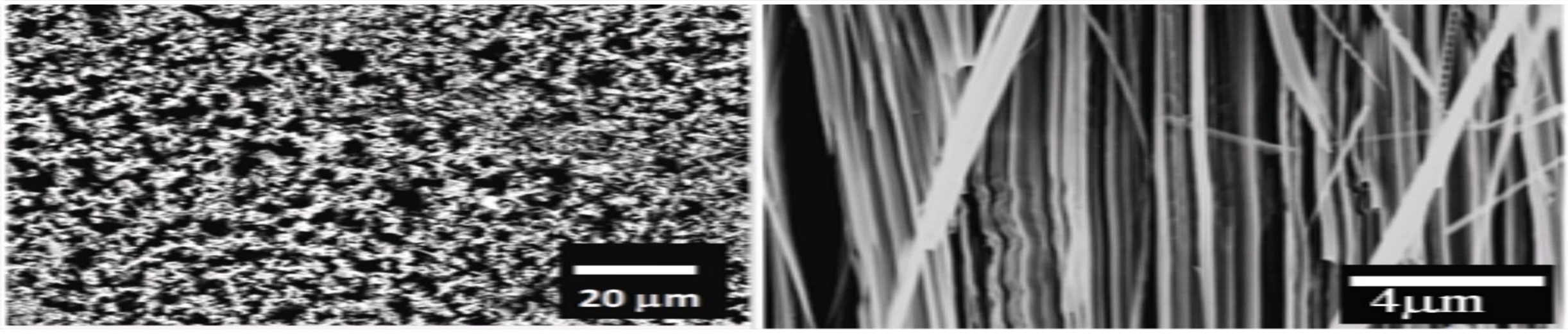
Metal Induced Etching (MIE)



Model Diagram

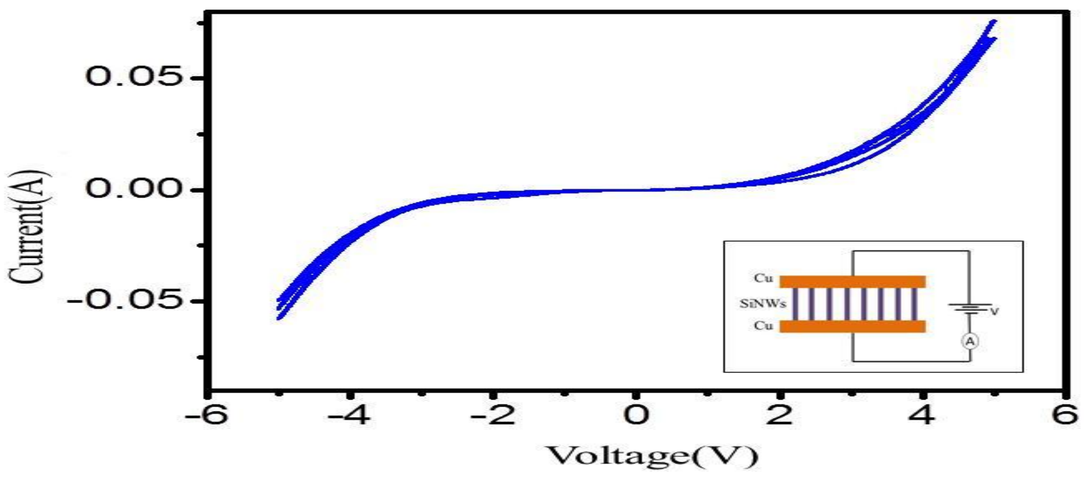


SEM Results

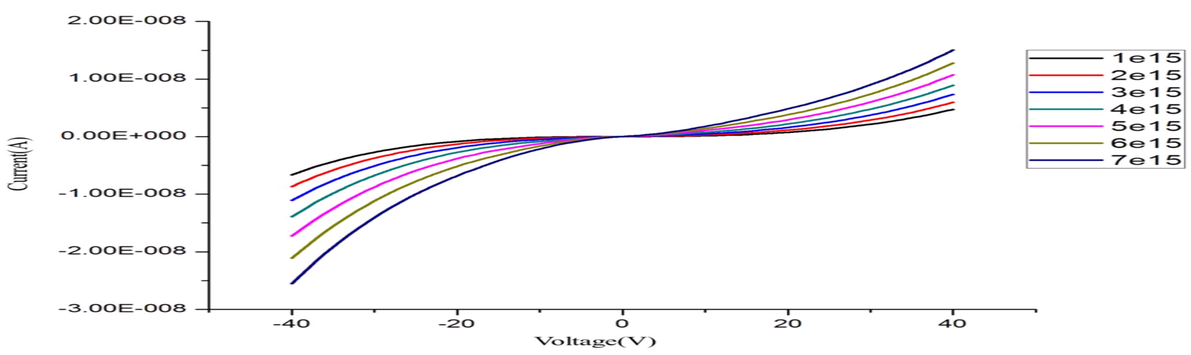


Top and cross-sectional SEM Image of well aligned SiNWs

I-V Characteristics (Practical)



I-V Characteristics(Simulation)



Conclusion

- Well aligned SiNWs fabricated in the higher resistivity (1-20 W-cm) while cheese like in lower resistivity (0.2 W-cm) .
- Band gap of SiNWs have been have been estimated and found to be ~ 2.5eV.
- Red emission from SiNWs has been seen under UV excitation at room temperature.
- Size of SiNWs are estimated by Raman spectra using phonon confinement (PC) model.
- Only PC effect is observed in lower doping sample n-,p- whereas combined effect of PC and Fano is observed in higher doping sample n+,p+.

References

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