

Abstract

Nanostructures of Zinc Oxide (ZnO) were synthesized on silicon substrates coated gold as catalyst. Using a thermal furnace and a continuous flow of oxygen, ZnO nanostructures were grown in the temperature range 850 – 1000° C on silicon substrates. The morphology of the nanostructures were determined using scanning electron microscopy and the structural characteristics were determined by X-ray diffraction analysis. Details of my work is described in the poster.

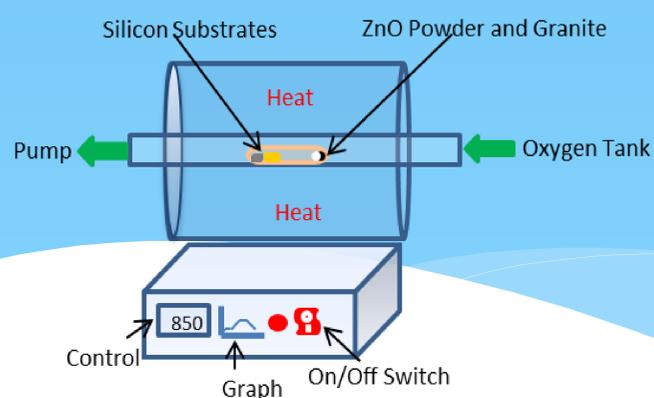
Introduction

ZnO is a widely studied material that has attracted a lot of attention in the science world since the 1960s, It has since been active in different applications because of its properties:

- ZnO can be characterized as a white powdery substance with a melting point of 1975oC, boiling point of 2360oC, density of 5.61g/cm², and molar mass of 81.408g/mol. It has very diverse structures and could induce anisotropic growth. Their configuration is much richer than any known materials including carbon nanotubes
- ZnO columns were grown from Zn vapor and O atoms generated in air plasma.
- ZnO is a semiconductor with a exciton binding energy of 60meV and a band gap of 3.37eV at room temperature.
- Numerous techniques have been developed for the synthesis of one-dimensional ZnO nanostructures in other to harvest its numerous potential applications. The growth techniques include but not limited to:
 - Physical Vapor Deposition (PVD)
 - Chemical Vapor Deposition (CVD)
 - Metal-Organic Chemical Vapor Deposition (MOCVD)
 - Pulsed Laser Deposition (PLD)
 - Atomic Layer Deposition (ALD)
 - Sputtering
 - Sol-gel
 - Etc.
- The vast morphological advantage ZnO has over other semiconducting materials makes ZnO a very essential material with applications in
 - Electronics – for transistor fabrication
 - Medicine – as bio cavities
 - Optoelectronics – lasers, photoconductivity
 - Sensors

In this work we used a combination of techniques; the vaporization and condensation combines with a chemical reaction for the formation of ZnO nanostructures

Experimental Procedures



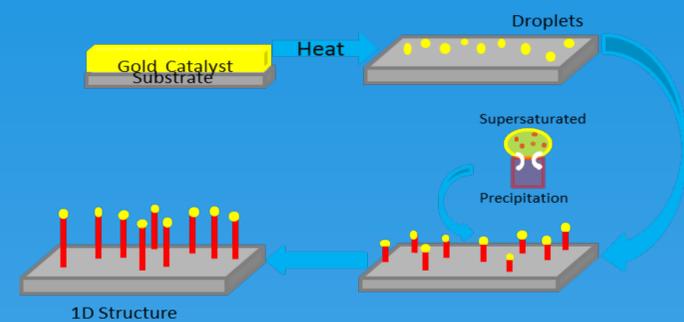
ZnO thin films were prepared by using chemical evaporation deposition. The substrates were first cleaned in deionized water, and then coated with gold catalyst. This Si- coated substrate and a plain Si substrate was placed in a thermal furnace with Zinc Oxide powder and carbon mixed together. Oxygen was admitted into the furnace on one end and pumped out of the other end.

Growth Parameters

- | | |
|---|----------------------------|
| ❖ Mixture of ZnO powder and Carbon powder | Ratio of 1:6 |
| ❖ Growth temperature | 850 – 1000° C |
| ❖ Chamber Pressure | ~ 0.4 |
| ❖ Gas flow | Oxygen, throughout process |
| ❖ Growth Time | 30 minutes |

Growth Process

Vapor-Liquid-Solid (VLS)



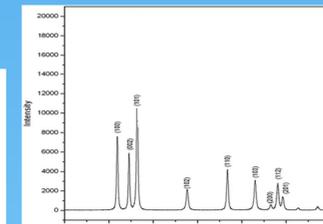
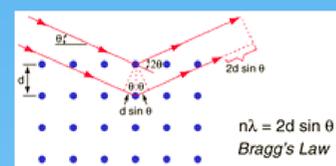
- In VLS method the gold catalyst forms liquid droplets when it is heated to temperatures and then by absorbing vapor components at a high temperature initiate the growth process.
- Then it drives the precipitation of the components to the liquid-solid interface to master an exceptional amount of free energy for the droplets system.
- Finally the 1D crystal starts to grow and will continue to grow as long as vapor components are supplied.

Chemical Reaction

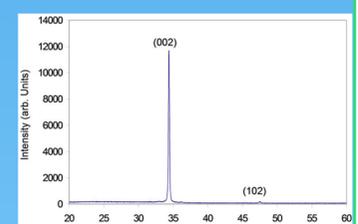


Results And Discussion

X-Ray Diffraction

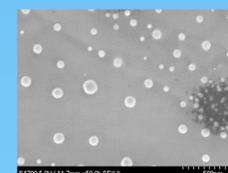
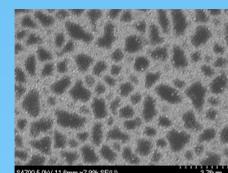


X-ray diffraction of ZnO Nano powder

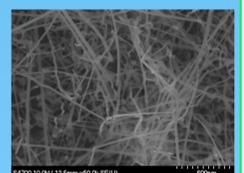
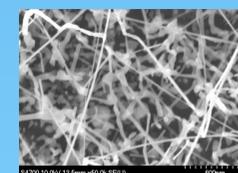


X-ray diffraction of ZnO Nanowires

Scanning Electron Micrographs



SEM images of ZnO nano-particles



SEM images of ZnO nanowires

Growth without the flow of oxygen resulted in the synthesis of nano-particles which we believe is made of Zn-Au alloys. However once oxygen is introduced ZnO nanowires were formed due to the abundance of oxygen to combine with the Zn to for ZnO

Conclusion

ZnO thin films are synthesized in deionized water and coated with gold catalyst. It was placed in a thermal furnace with carbon and zinc oxide where it was heated at a high temperature in order for the nanostructure to grow. However the substrate must be introduced to oxygen or else it will not grow. Then it is placed in a SEM machine to see the dimension and shape and XRD machine to graph it's growth structure.

References

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