CALIFORNIA STATE SCIENCE FAIR
2004 PROJECT SUMMARY

Name(s)
Aditya Rajagopal

Project Number
S0524

Project Title
Synthesis of Gallium Oxide Nanowires by Chemical Vapor Deposition

Abstract

Objectives/Goals
The goal of this project was to synthesize gallium oxide nanowires.

Methods/Materials
The fabrication of the nanowires was done by a process known as chemical vapor deposition. In this method, the gallium metal is vaporized in a vacuum tube, while an mixture argon-oxygen gas is flowed in. The oxygen reacts with the vaporized gallium to form a gallium(3+) oxide molecule. This gallium oxide molecule then deposits on a silicon substrate laced with a gold catalyst. The wires then grow radially outward from the single gold catalyst molecule. The stucture, composition, and presence of wires is then checked using a Scanning Electron Microscope.

Results
In my project, I tested the effect of temperature fluctuation on the synthesis of gallium oxide, Ga2O3, nanowires. I attempted to synthesize wires at the following temperatures: 850 centigrade (C), 860 C, 870 C, 880 C, 920 C, 940 C, 950 C, and 980 C. During all the synthesis the pressure was kept approximately constant at 10^-4 torr; furthermore, the a constant flow-rate, constant reaction time, and similar silicon wafers assured that the differences in the synthesis processes would be due to differences in temperature alone.

To that end, I observed a distinct difference between the synthesis of nanowires in the different temperature ranges. In the first synthesis at 920 C, I observed a plethora of nanowires of different sizes and lengths. Most wires appeared to be well over tens of microns in length. The diameter of the wires, which is controlled by the size of the gold catalyst molecules, ranged from 16.2nm to 34nm, with an average of 22.4nm.

Furthermore, a large number of nanowires were also found on the samples fabricated at 940 C, 950 C, 880 C, and 870 C. The synthesis reactions at 980 C, 860 C, and 850 C yielded no wires.

Conclusions/Discussion
I found empirically that the best heating temperature was 920 degrees; this temperature resulted in the largest number of actual wires (approximated), as well as the best quality of wires. The goal of this project was to discover if it was possible to grow gallium oxide nanowires, and if so, to find the best synthesis conditions for these wires. To this end, I was successful. The data I collected in this experiment serves as a foundation for my continuing research concerning the electrical properties of gallium oxide nanowires.

Summary Statement
My project is about the synthesis of Gallium Oxide nanowires, possible semiconductors, for future use in nanodevices such as MEMs.

Help Received
Used lab equipment at UCI; Mr. Zhiyong Fan's help in the electron microscope imaging of the wires.