Formation of Nanowires Through a CVD System

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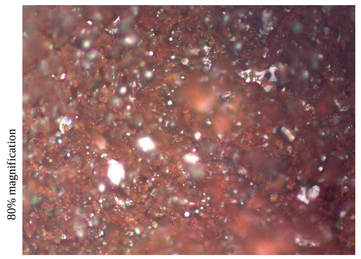
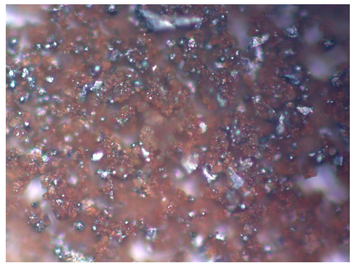
SiGe Samples



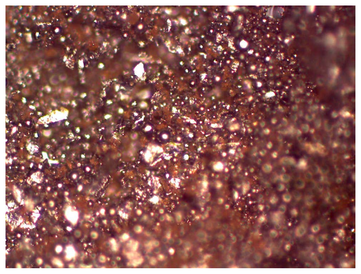
A silicon-germanium alloy placed on a silicon plate heated at 900 C and 1000 C for 1 and 3 hours. Exposed to hydrogen and argon at a 1 to 1 ratio. The melting point is 1380.2 C

SiGe 900 C 1 Hour



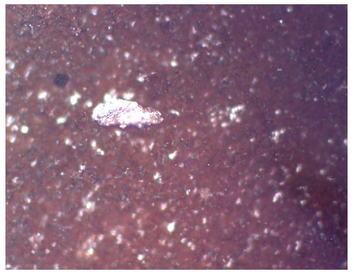
No visible change when viewed with light microscope

SiGe 900 C 3 Hours



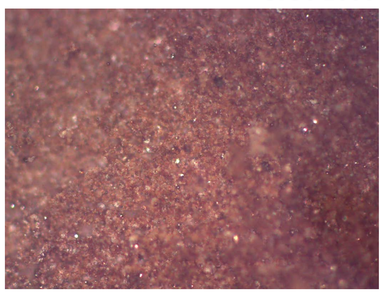
The spherical globules are observed here. This may suggest a connection between the wires and the globs.

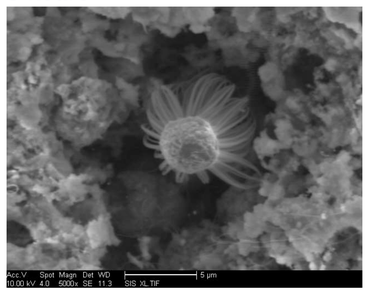
SiGe 1000 C 1 Hour



Also, no visible change when viewed with light microscope. The most valid reason was that the temperature was too low compared to the melting temperature

SiGe 1000 C 3 hours



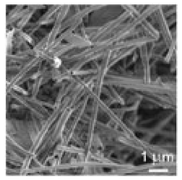


Globular formations occurred at a very small amount. Only under an electron microscope can the nanowires can be observed.

Prior to my experiment, wires were found in SiGe, but with a different hydrogen to argon ratio. The change in ratio may be the reason for impaired growth of wires

As technology grows faster and more efficient, new transistors (a device that conducts electronic signals) have to be formed. Then comes the nanowire, a cord of metal that is between 1 to 100 nanometers (a nanometer is 1 billionth of a meter). With this device, more transistors can be placed on a processor, allowing the processor to act faster and computers can have a higher storage space. This experiment is the search to find the best way to create nanowires with a CVD system.

How to Create Nanowires.



There are two ways to form a nanowire. It can created from "top-down" or "bottom –up."

Top-down is when a normal fiber-optic cable is heated and stretched to the point where it is as thin as a nanowire.

Bottom-up , the method used in the experiment, is the use of a CVD (Chemical Vapor Deposition). This is when a catalyst layer is placed on a base and the heated and exposed to a gas. The catalyst is used to attract the gas to the plate and the nanowires form themselves.

Possible Errors

- Residual particles on the sample when adding the catalyst to the plate.
- The heating tube had to be replaced in the middle of the experiment. Particles may have been left behind. Also, the replacement may have been installed incorrectly, allowing air to seep in.
- Uneven distribution of the powder on the base between samples.

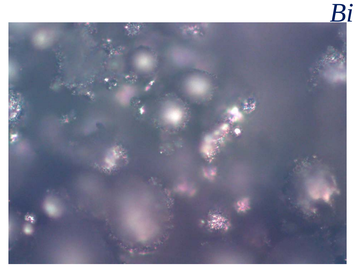
Conclusion

- With SiGe samples, no nanowires were immediately observed. However, under the electron microscope, some were found.
- With Bi samples, large amounts of nanowires were discovered around 250 C.
- The starting temperature for nanowire growth for Bi is around 245 C.
- The samples must slightly melt into individual spheres for the wires to grow.

Further Experimentation

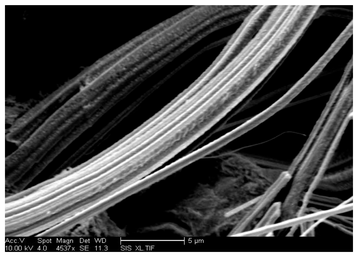
- What is the reason behind the color change for bismuth?
- Why are the spheres needed for nanowire growth?
- Under what conditions affecting SiGe will create similar results with Bi?

Bi Samples



A bismuth powder on a silicon plate heated between 240-270 C at intervals of 10. Heated for 1 -3 hours. Exposed to hydrogen and argon at a 1 to 1 ratio.. The melting point is 271.5 C

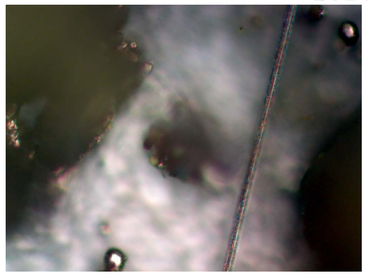
Bi 250 C 1 Hour

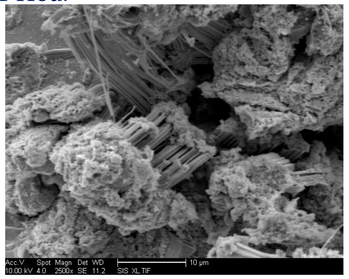


Heating bismuth at 250 c for 1 hour showed to be the most successful growth of nanowires. However, no nanowires appeared at 240 C. As a follow-up, tests were performed to find the starting temperature for wire growth.

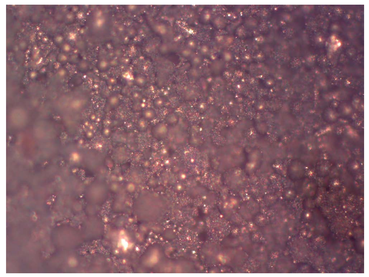
All bismuth samples turned various shades of green and melted into spheres at certain spots.

Bi 240 C 1 Hour



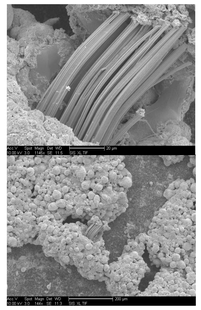


Bi 245 C 1 Hour

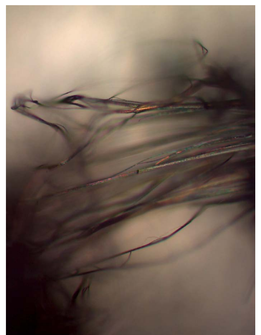


No nanowires were visible in this sample. A slightly higher temperature used in the following test.

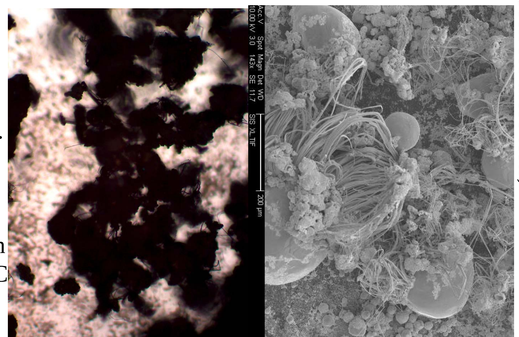
Under an electron microscope, very few nanowires were found.



Bi 248 C 1 Hour



Higher amounts of nanowires were found at this temperature. This suggests that the starting temperature for nanowire growth is between 245 C and 248 C



Samples did not turn green for these tests,