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Vapor Liquid Solid Growths of Germanium and Gallium Antimonide Nanowires

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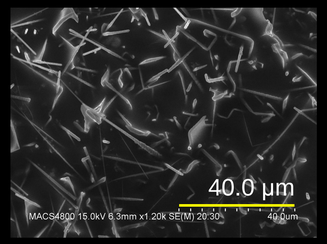
Abstract

Determining the optimal growth parameters for germanium (Ge) and gallium antimonide (GaSb) nanowires is the focus of this research. Given that nano materials behave differently from their bulk counterparts we are researching several variables that influence nanowire diameter and length such as temperature, ramp rate, gas flow rate, and catalyst particle size.

Background

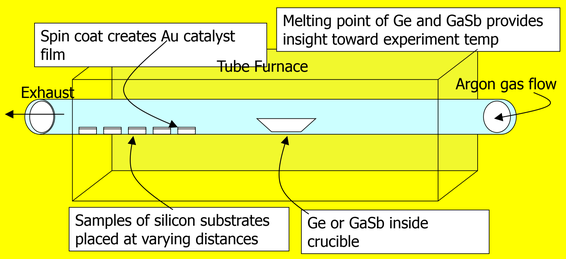
- Nano materials can be engineered to make use of their optical properties.
- The infrared response (IR) of Ge and GaSb nanowires are directly controllable based on their geometry.
- Fine tuning the IR response can lead to device integration for night vision and free space communications.



Experimental

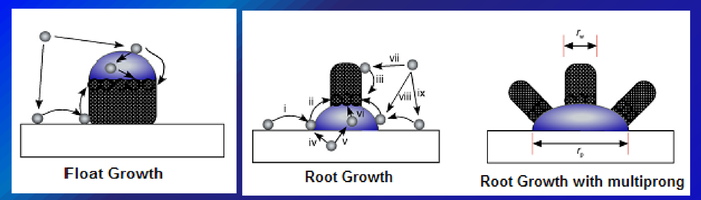
- A Vapor Liquid Solid (VLS) method was used along with adjustments to the following variables in order to observe their effect on nano growth:
- Gold (Au) colloidal catalyst. Batch sizes ranged from 2, 5, 10 and 50 nm.
- Catalyst spin coated at different rpm.
- Growth temperatures ranged from 820 - 900 ^{o}C.
- Growth time varied from 15 min to 1 hr.
- Argon gas flow varied from 50 to 100 sccm.

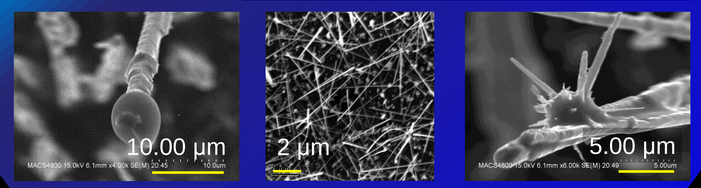
VLS Procedure



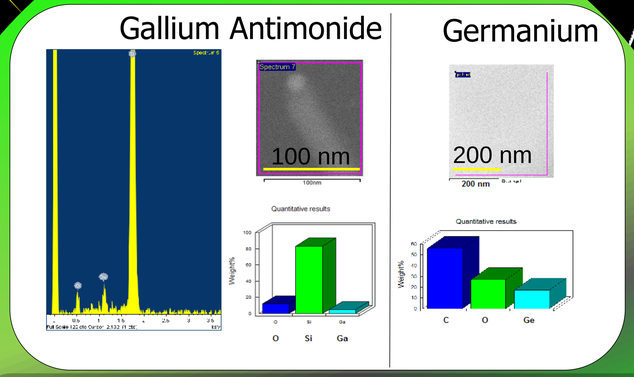
Growth Examples

- Float and/or Root growth can occur during VLS.
- In both cases, the catalyst is active at the growth site.



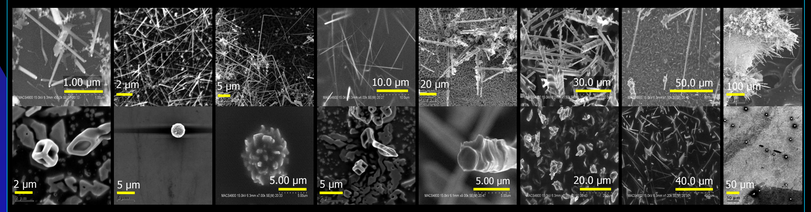


Analysis – SEM/EDS



- Scanning Electron Microscope/Energy Dispersive Spectrometer Elemental analysis.
- Analysis indicates presence of gallium oxide and germanium oxide, respectively.

Results - Scanning Electron Microscope



- Top row: comparison of nanowire size differences.
- Bottom row: some oddities of nano growth.

Conclusion

- The goal of this research involves synthesizing Ge and GaSb nanowires via the VLS method.
- Our initial attempts proved successful in growing germanium oxide and gallium oxide nanowires of varying lengths. Some nanowires are approximately 200 µm in length.
- Current uses for germanium oxide and gallium oxide nanowires include IR sensor technology.
- Further research to eliminate the source of oxygen so that pure Ge and GaSb nanowires can be grown is underway – this includes determining if the above-referenced experimental variables are the source.

References and Acknowledgments

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