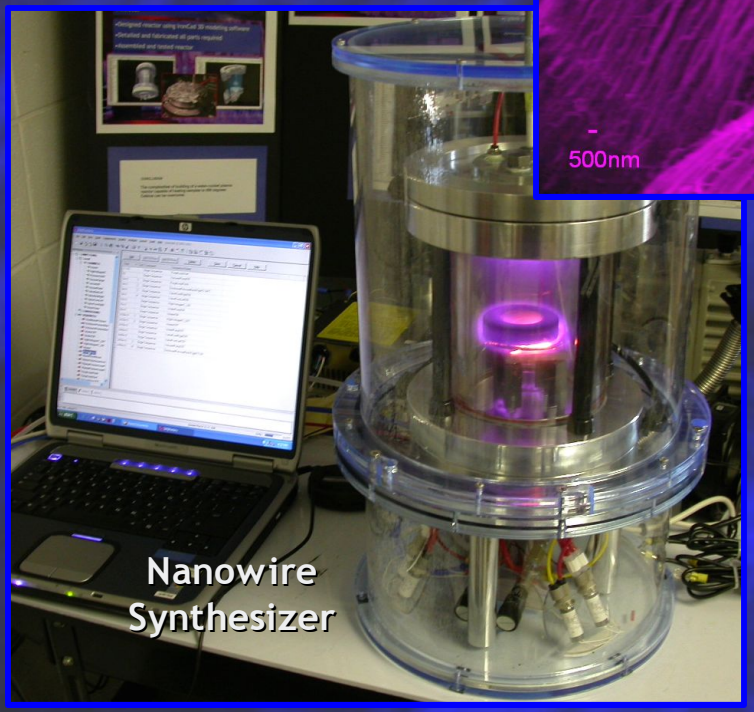
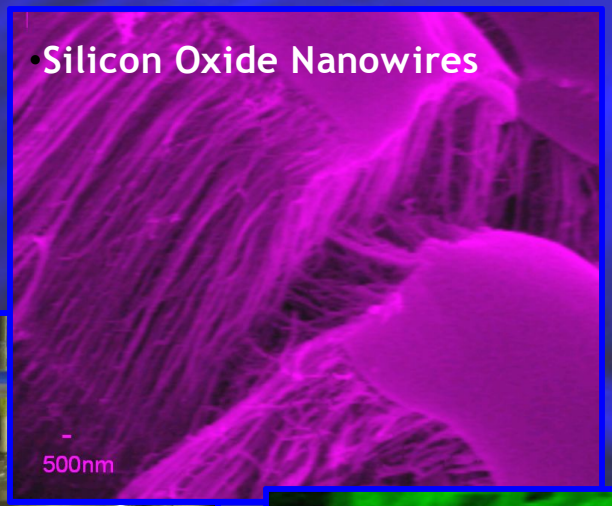
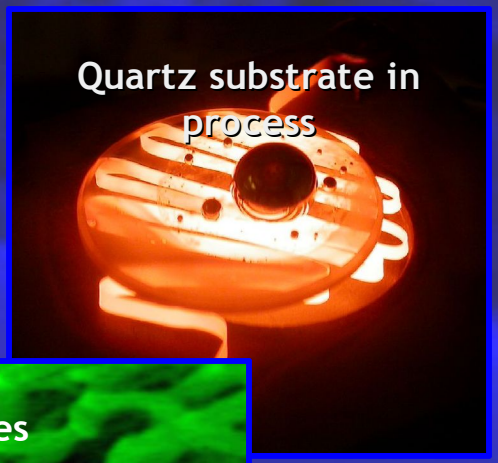
Nanowire Synthesizer







Practical Applications

- Nanomaterials produced in vacuum reactors can be used in a wide range of applications Including:
- Electronics
- Fuel cells
- Rechargeable batteries
- Drug delivery
- Sensors
- High performance coatings
- UV light-emitting diodes
- Lasers

Project Overview

- Started research at the University, in the Chemical Engineering department in August 2003
- Worked on the properties of Gallium and the production of Gallium films for Gallium nitride experiments
- November to February 2003 – Developed and built low cost, flexible plasma reactor for Nanowire research
- February 2004 - Conducted first experiments in home built reactor
- March 2004 - Produced first Silicon Oxide and Nickel Oxide Nanowires in home built reactor
- Research is ongoing

Hardware development

- Designed and produced new reactor
- Assembled and tested vacuum system
- Designed and produced high voltage power supply (improvement to prior design)
- Assembled PC control package using LabJack data acquisition and control system
- Learned Azeotech PC control and data acquisition software
- Designed and produced high temperature heater for 800 degree C requirement
- Total material cost <1000*

*Does not include PC and process gas cylinders

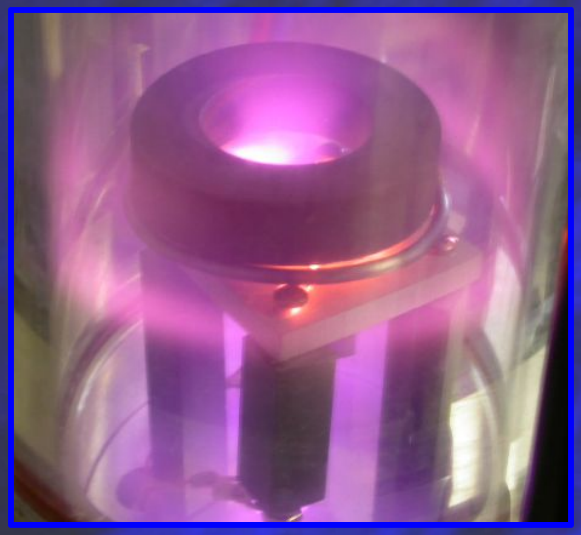
Versatility

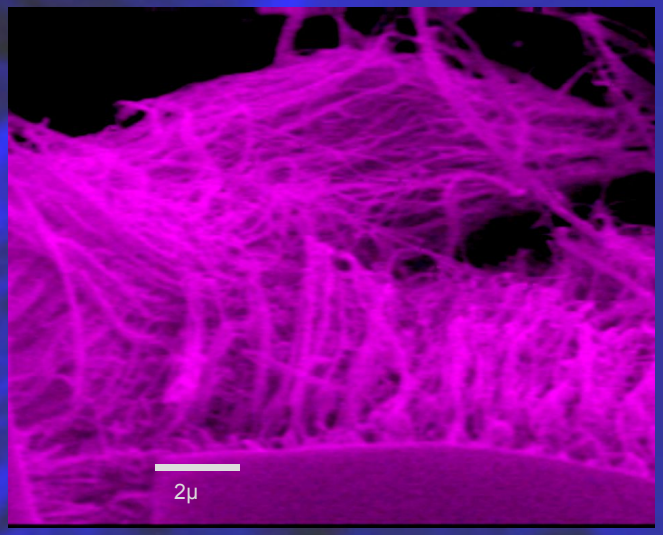
- The reactor was designed to allow quick sample access and easy reconfiguration of electrodes, heaters, and substrate stages

Silicon Oxide Nanowire experiments

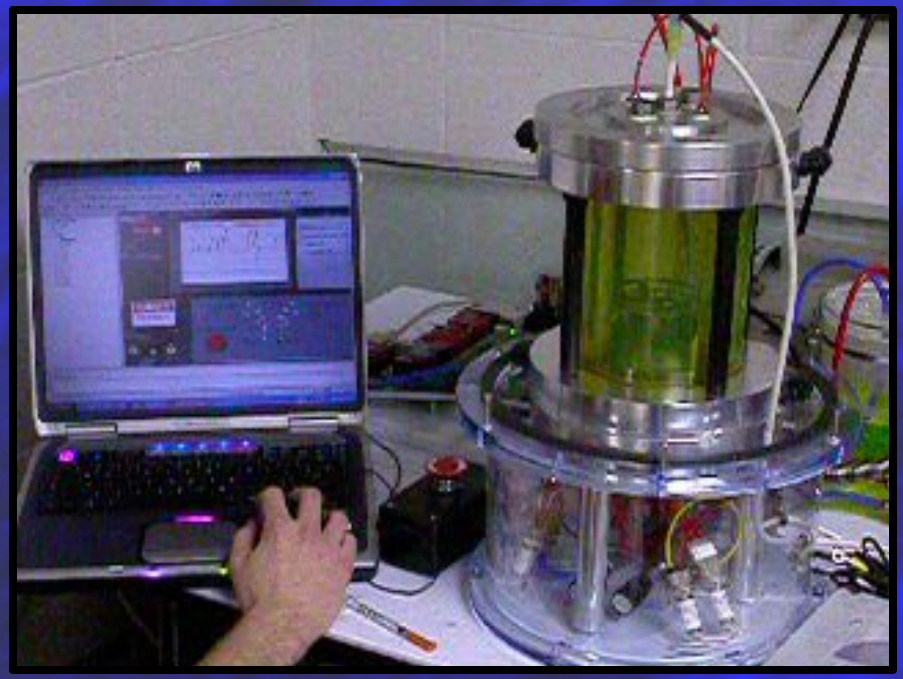
- Silicon oxide Nanowires were grown on a silicon wafers at +/- 800°C. The silicon wafer was coated with a gallium film prior to processing

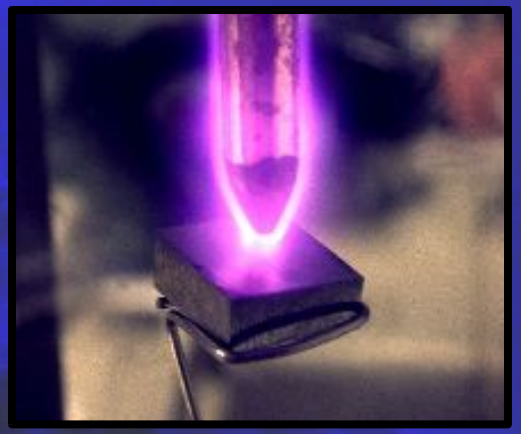
- In the first experiments, the process gasses were 80 sccm hydrogen, 20 sccm nitrogen, and argon in the inert gas envelope. The nichrome filament was the source of the nickel.



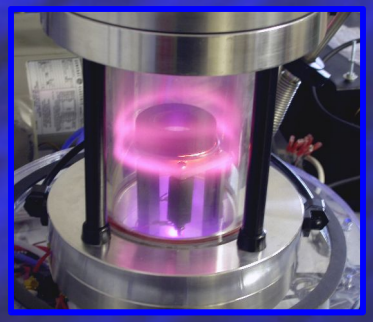


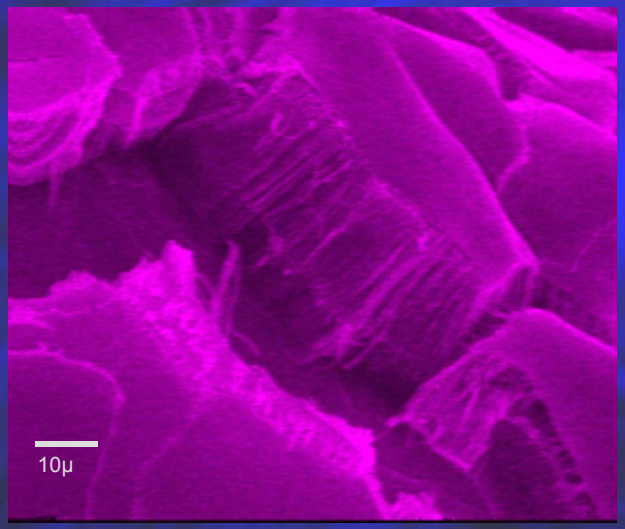
Reactor in Action

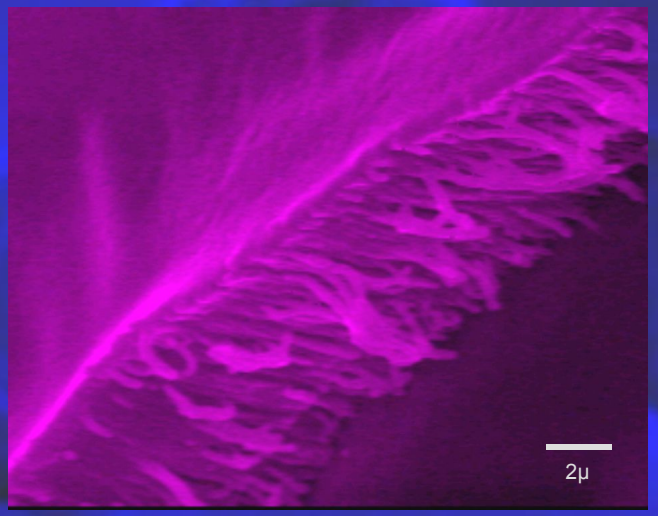


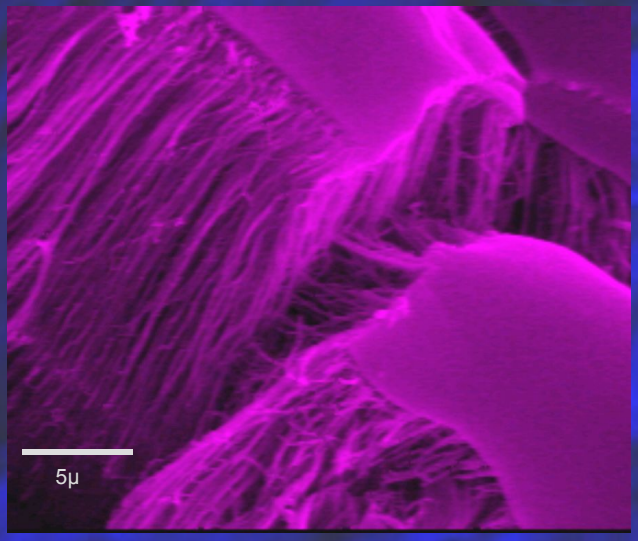


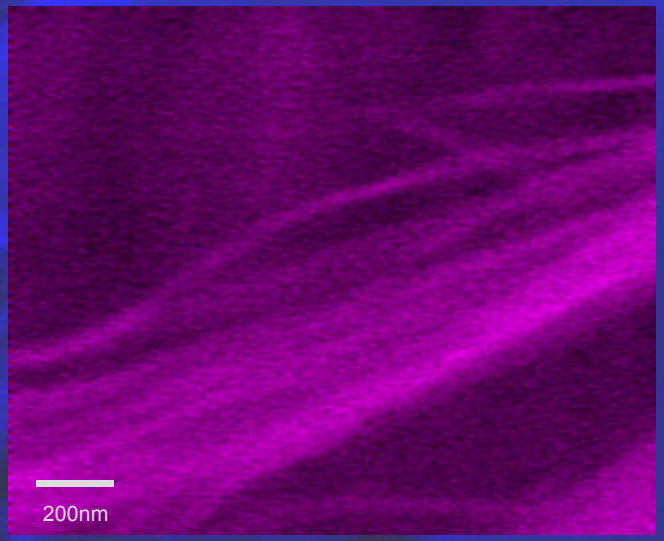
Silicon Oxide Nanowire experiments



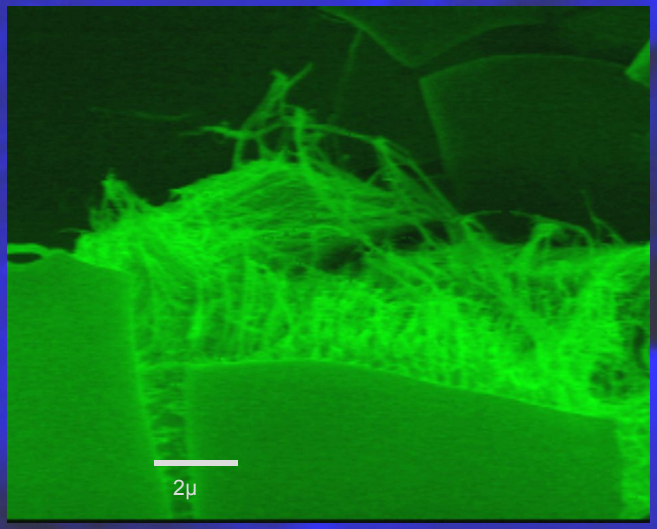


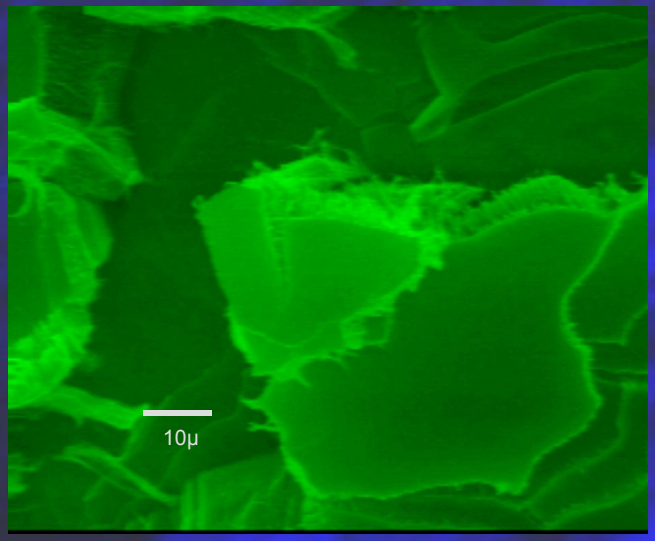


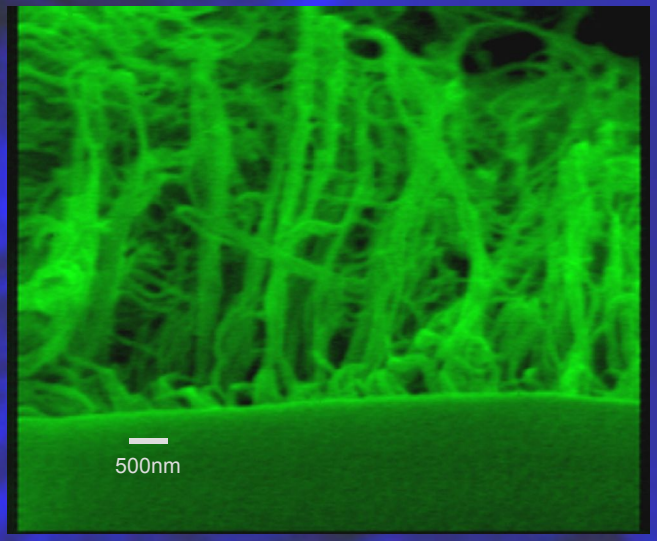




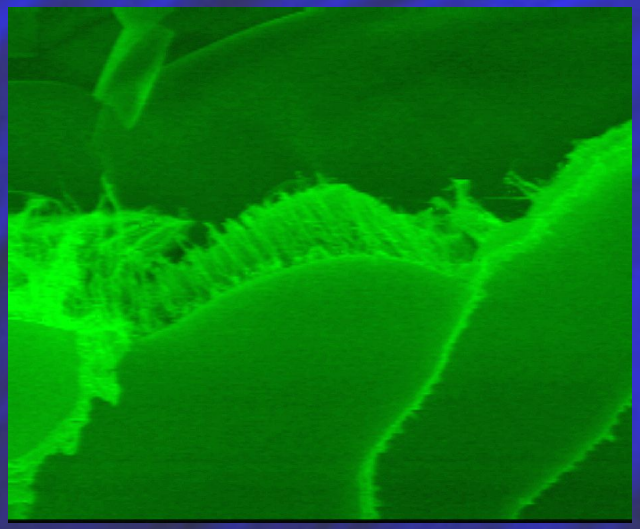
Silicon Oxide Nanowire experiments

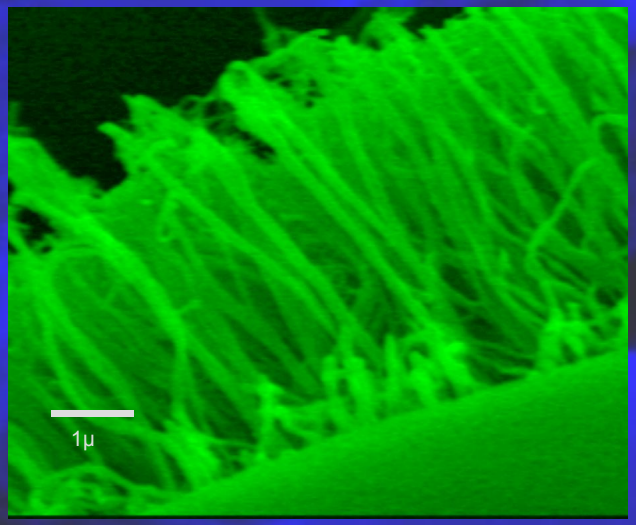


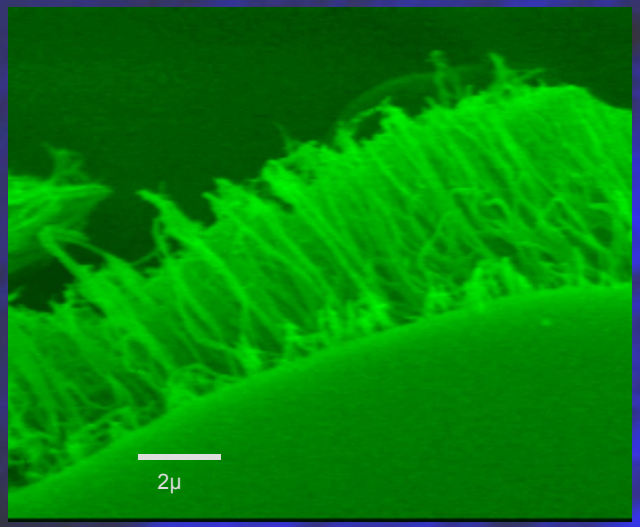


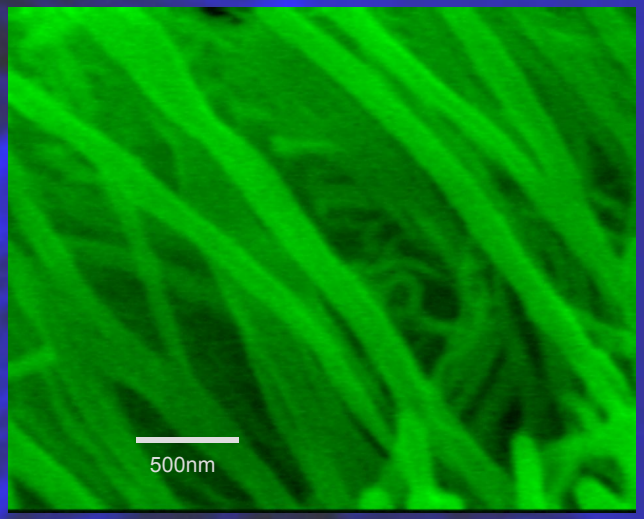


Silicon Oxide Nanowire experiments

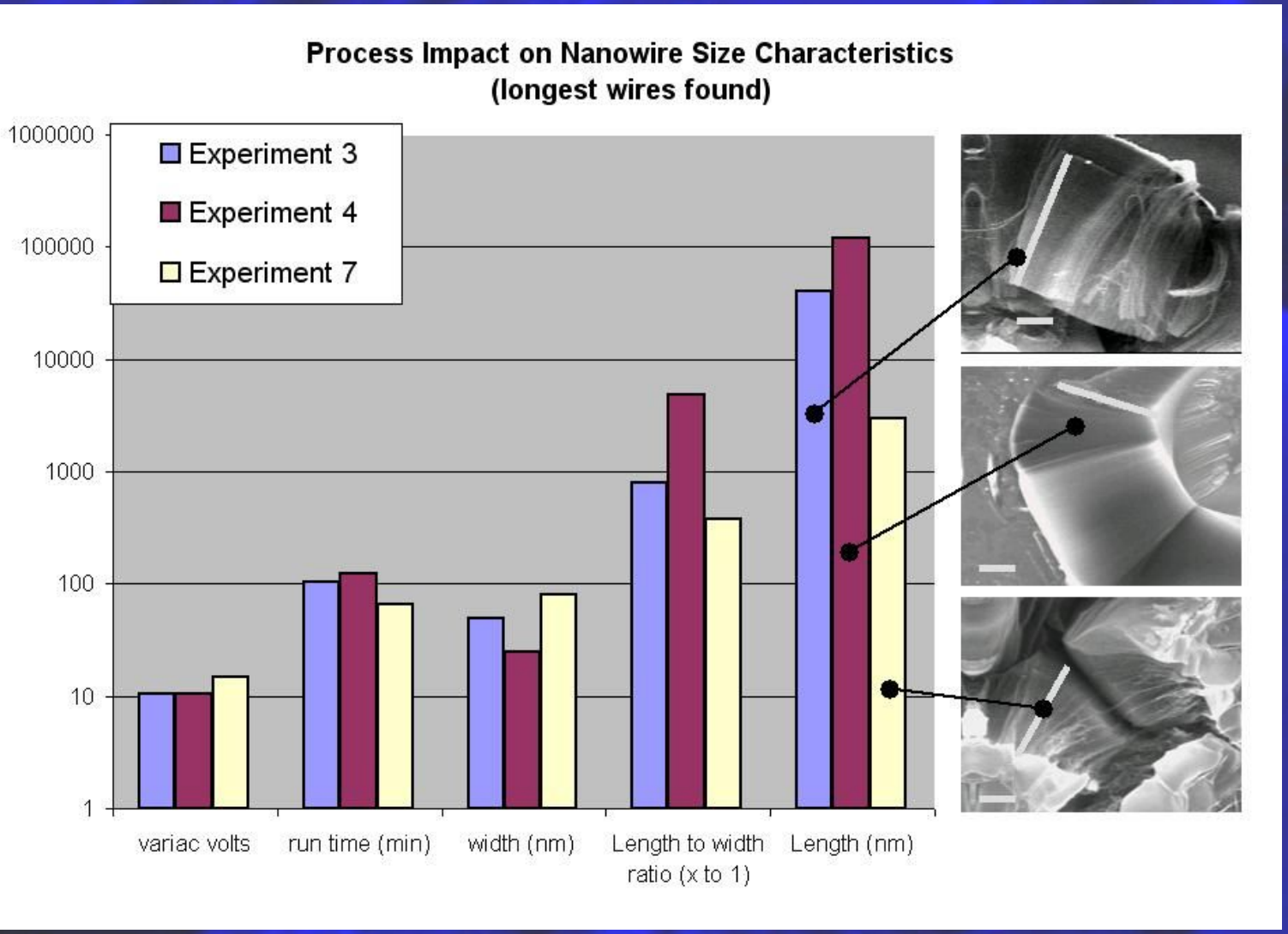








Process Impact on Nanowire Size



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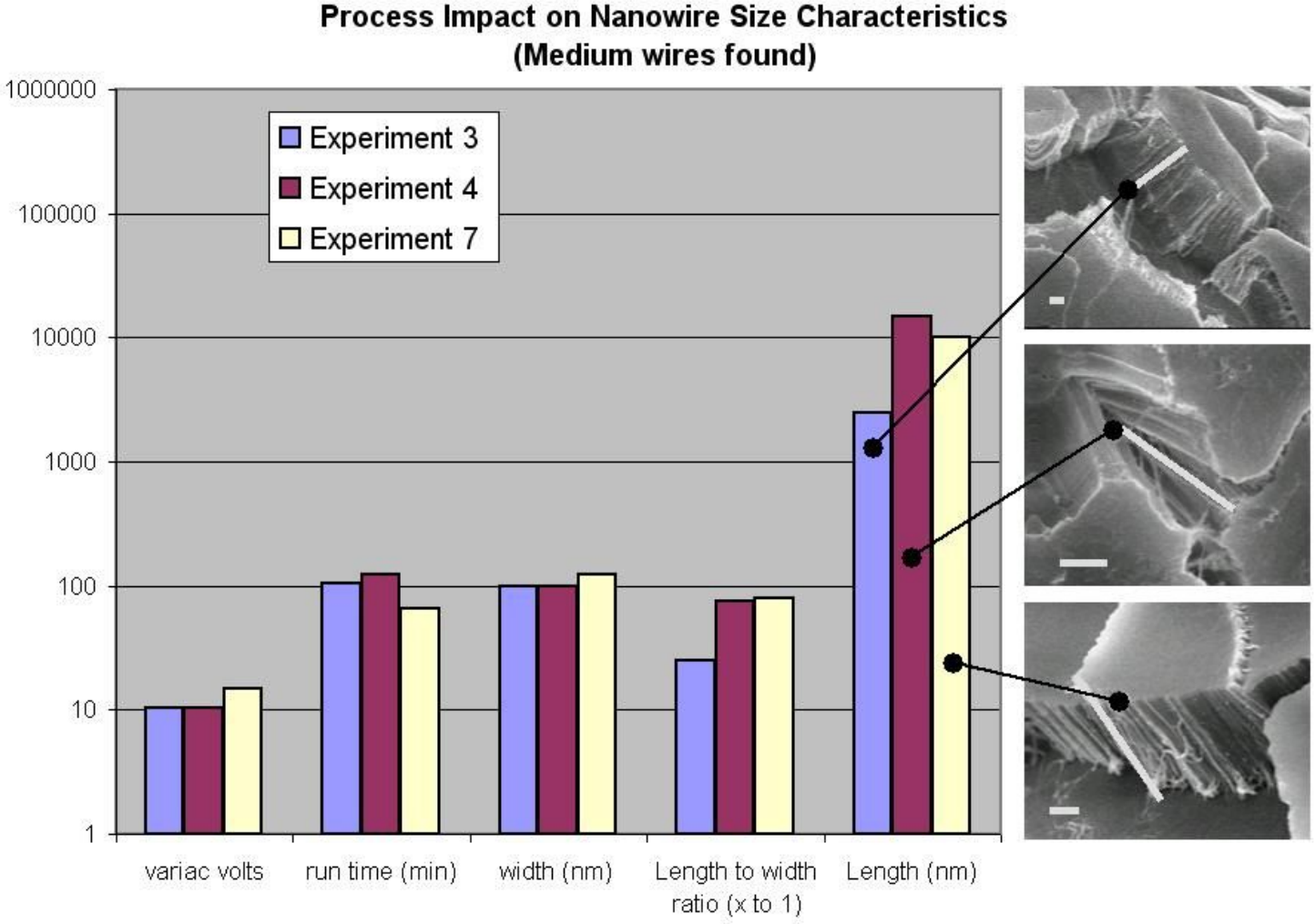
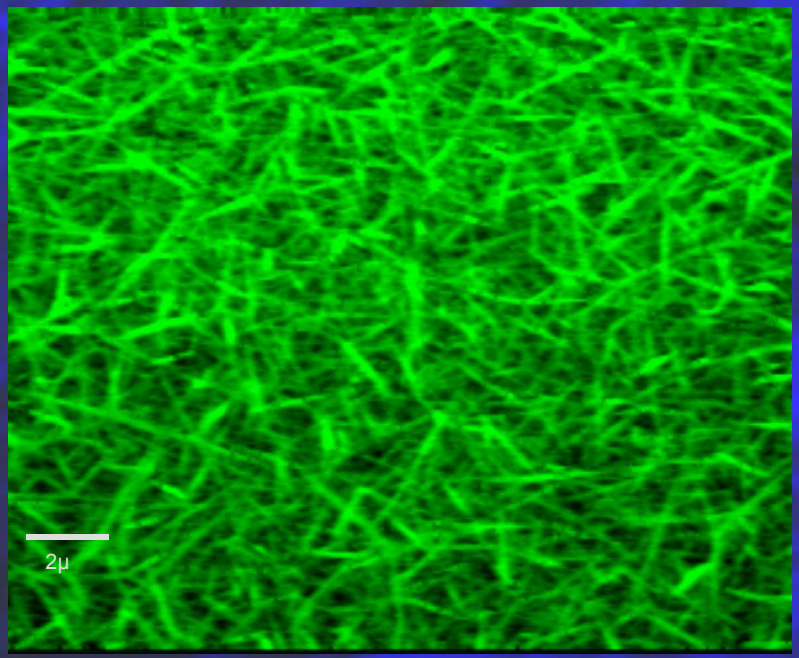
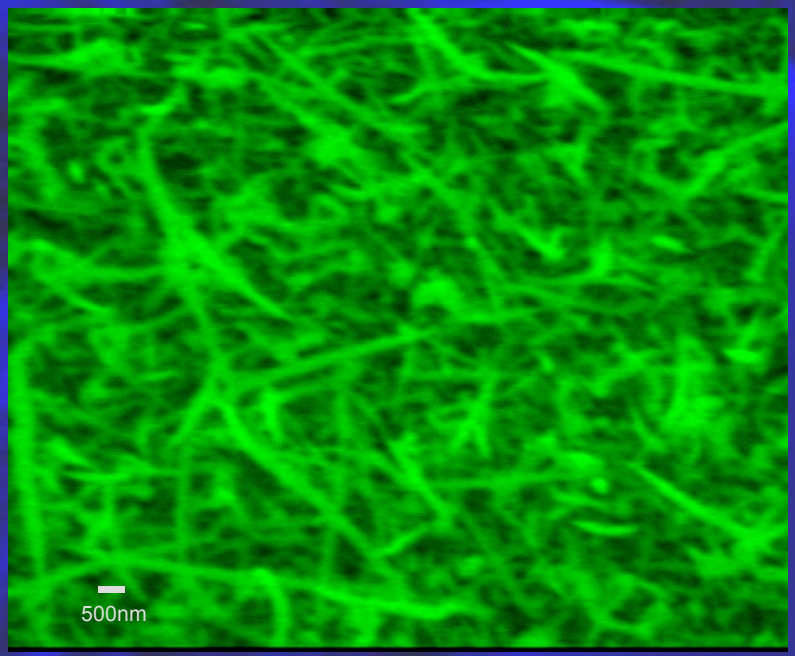


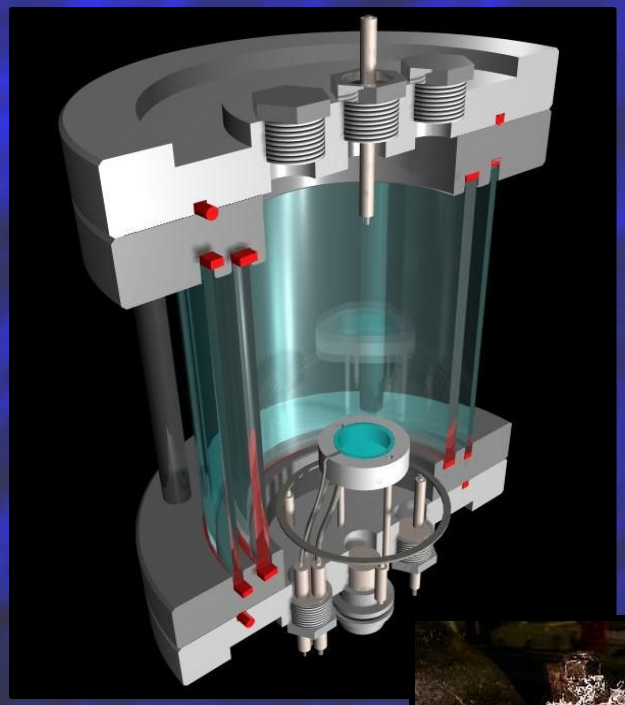
Nickel Oxide Nanowires

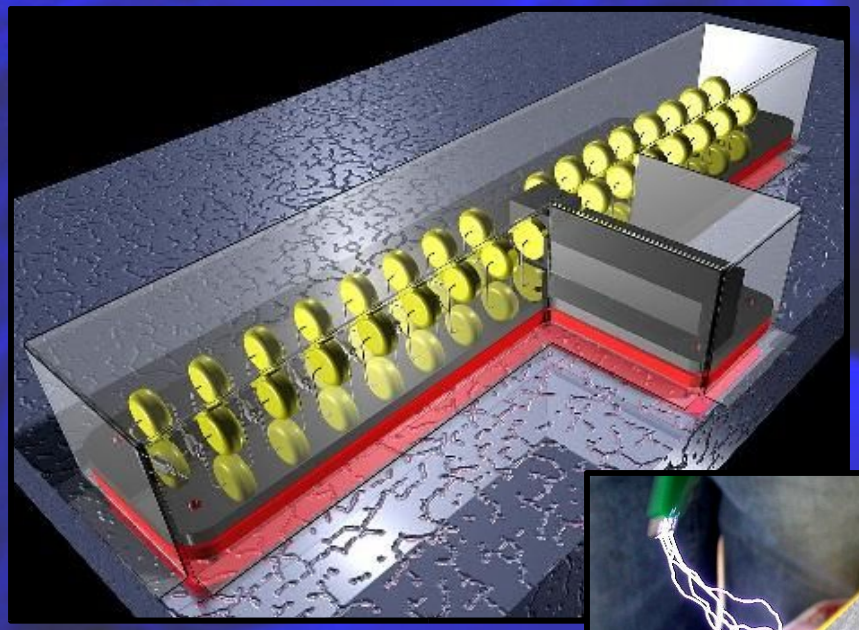
- Nickel oxide Nanowires were grown on a quartz disk at +/- 800°C with 80 sccm hydrogen, 20 sccm nitrogen and argon and air in the inert gas envelope. The nichrome filament was the source of the nickel





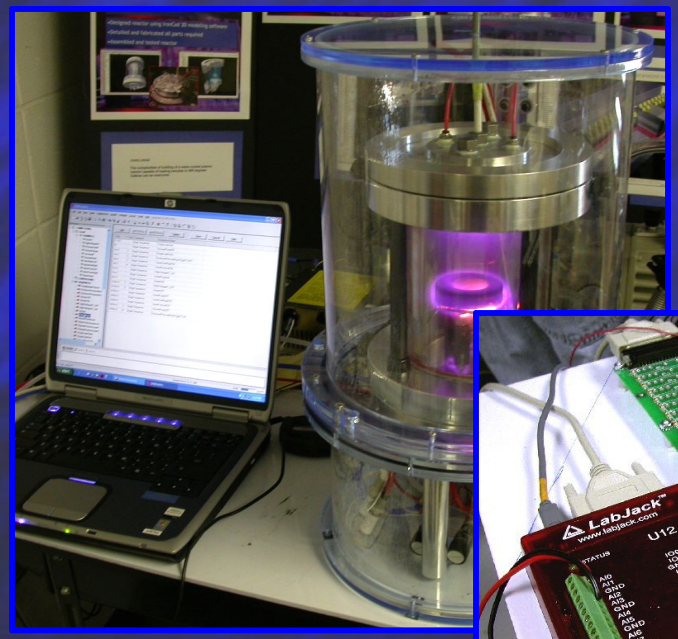
3D Solid Models and Fabrication

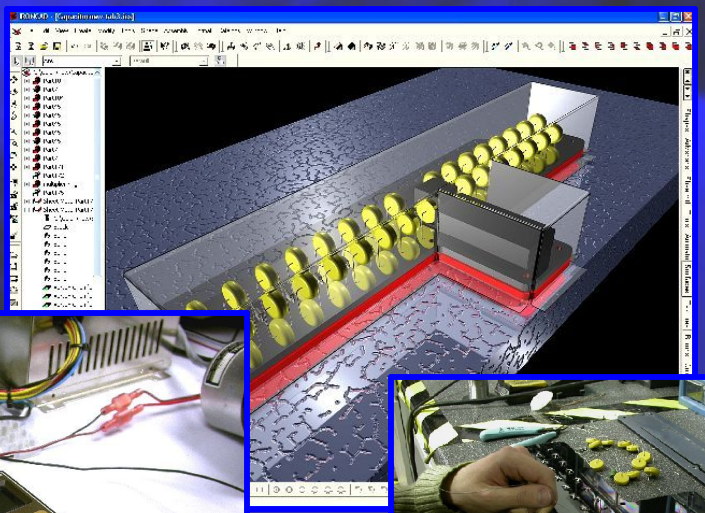


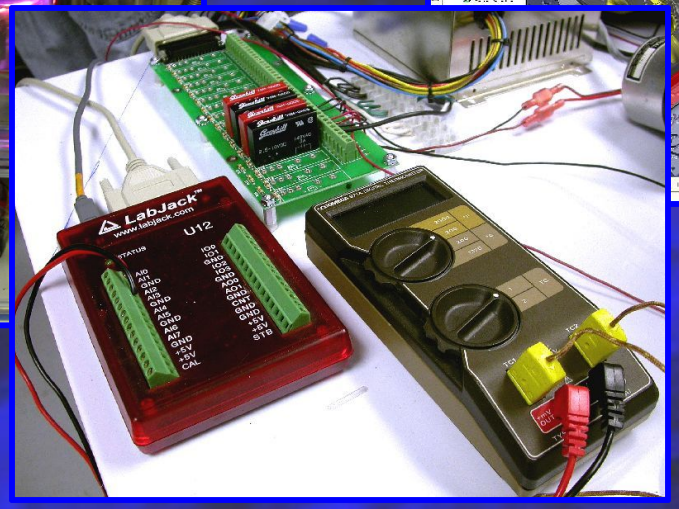


Controls and Plasma Sources

- Developed control system using Azeotech Automation & Control Package and LabJack PC control hardware
- Designed and built 60KV low current power supply

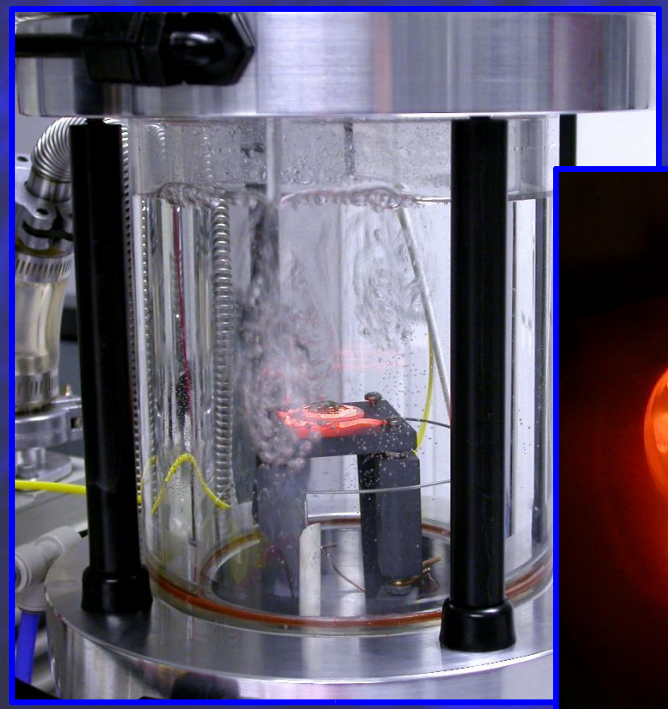


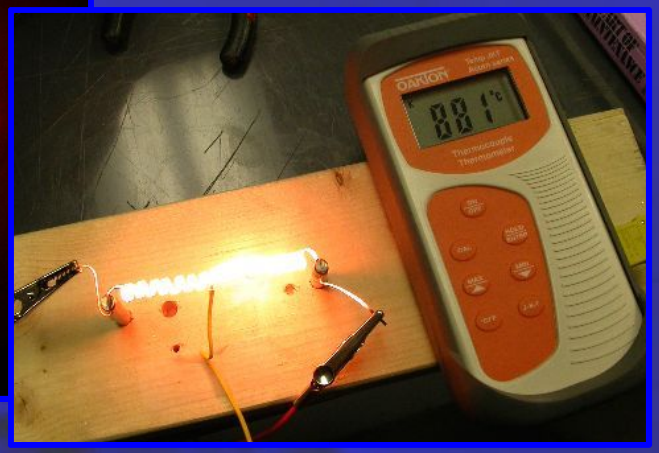


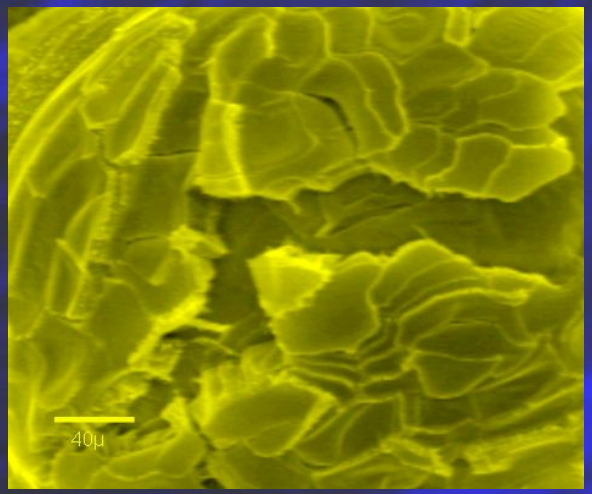
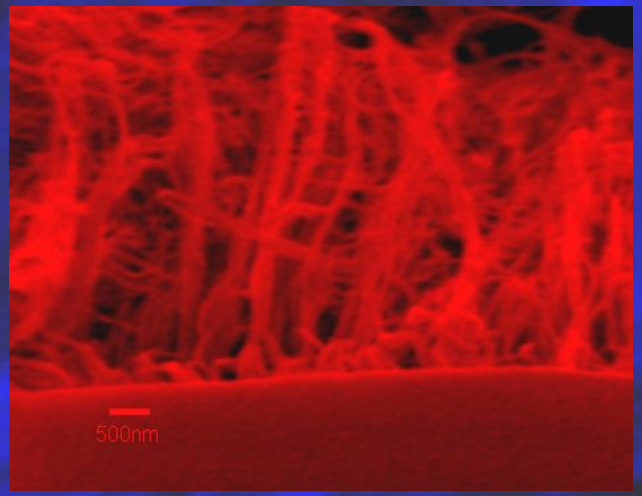
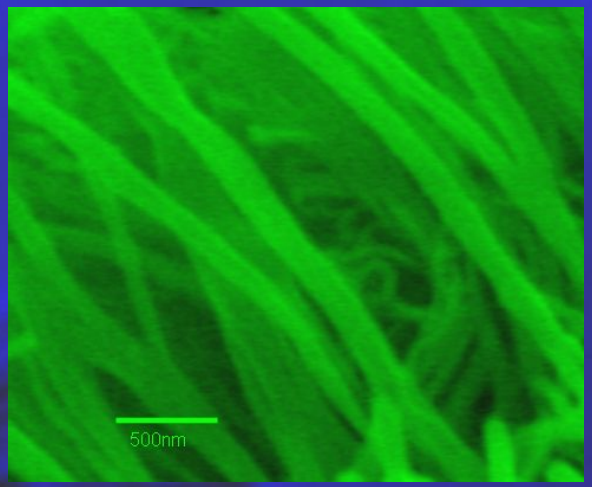


High temperature substrate heater

- Made and tested nichrome ribbon heaters to heat gallium to 800 degrees C for Gallium Nitride and Silicon Oxide Nanowire experiments





Conclusion

- The Engineering Goals for the Nanowire Synthesizer were met. The system was successfully employed to produce Silicon Oxide Nanowires and Nickel Oxide Nanowires.
- Additional research is planned to pursue improved forms of these materials and to better understand the variables that affect the growth of Silicon Oxide and Nickel Oxide Nanowires.