NDnano Undergraduate Research Fellowship (NURF)
2012 Project Summary

1) Student name: Anthony Erdman
2) Faculty mentor name: Dr. Mark Wistey
3) Project title: On-chip Lasers

4) Briefly describe any new skills you acquired during your summer research:

The majority of my summer research took place inside the new semiconductor processing and device fabrication clean room in Stinson-Remick. In order to enter it, I had to be trained on proper gowning techniques and etiquette inside the clean room. Inside the clean room, I was trained on plasma-enhanced chemical vapor deposition (PECVD), reactive-ion etching (RIE), and rapid thermal processing (RTP). Additionally, in the basement of Stinson-Remick, I was trained on photoluminescence (PL).

5) Please briefly share a practical application/end use of your research:

Molecular Beam Epitaxy (MBE) is used for a variety of devices. These devices range from optoelectronics (e.g. lasers and solar cells) to microelectronics (e.g. high electron mobility transistors). Passivation of Germanium is vital for optoelectronics and microelectronics in order to avoid nonradiative recombination centers at the interface due to dangling bonds and other defects at the interface.

Project summary:

My summer with Dr. Wistey and his group was split into two main areas of focus. The first area of focus was to get the Molecular Beam Epitaxy (MBE) machines running consistently. The MBE's require their insides to be an "ultraclean" environment at an "ultrahigh vacuum" ($1x10^{-10}$ Torr). Unfortunately, the filter for the ultra high purity (UHP) nitrogen line went bad in my first week and contaminated the MBE's, many costly pumps attached to them, and a wide assortment of other machines in the clean room. To remedy this, we first had to pinpoint what the contaminating compound(s) was, identify what was contaminated, figure out a proper cleaning method, perform it, and finally, reinstall everything back together. For the components that we could clean, we boiled them in a powerful degreaser and soaked them in nitric acid, acetone, methanol, and isopropanol. This process proved difficult for the larger components like the load chamber for the MBE. Also, we installed new stainless steel UHP N_2 lines in the clean room floor and new nitrogen manifolds and regulators. Despite not being able to use the MBE's to grow anything, I gained a greater understanding working on them and cleaning parts of them than I would have otherwise.

After all the cleaning we could do was done, we began to work with the graduate students on germanium oxides. The goal of this project was to see if we could optimize the oxide layer that we were growing. The first step was to remove the native oxide layer, which involved using a very dangerous, and even deadly, concentrated form of hydrofluoric acid. We then grew the oxide layer using the rapid thermal processing (RTP) machine. In order to characterize our oxide quality, we used photoluminescence (PL). This step proved to be the most difficult because here is where we especially needed consistency, not only from sample to sample, but from day to day. Each day we had to recalibrate the machine using a control and we took three measurements per sample. This entire process went through multiple iterations as we changed parameters during the oxidation and learned what created a better oxide layer.

Publications (papers/posters/presentations):