ND*nano* Undergraduate Research Fellowship (NURF)
2011 Project Summary

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Project title: Progress toward direct gap group IV materials

My summer was split assisting both of the projects my group was working on. The primary project of our group was to get the Molecular Beam Epitaxy (MBE) machines up and running. As we are an MBE group this is where the group can truly excel. The second project focused around wafer fabrication, which we are hoping provides a more short term proof of principal.

Much goes into getting a machine as complex as an MBE ready for growth. Multiple chambers must be leak checked with helium and baked out (raised to a very high temperature [200 C] for an extended amount of time [over night or up to a week]) to ensure an "ultra clean" environment for the wafers inside. Additionally, thermocouple wires and power cables have to be built to withstand the high temperatures of the bake out using Teflon and high temperature solder.

On the fabrication side, we are attempting to stress germanium (Ge) through both lattice mismatch and mechanical means to create a direct bandgap from a material that is typically an indirect bandgap. This would make electrically driven germanium lasers possible making the material a major player in the field of optoelectronics. My job was to fabricate the germanium wafer for this. To do so, the big challenge was to make clean flat mesas in the germanium wafer providing surfaces in all three dimensions. The first step in this process was to coat the wafer in a layer of silicon dioxide (SiO2) to use as a hard mask, or a protective layer, while we remove the unwanted areas of germanium. After the SiO2 was deposited, the wafer had to be patterned to give us the shapes of the mesas. This was done by using photoresist (PR), followed by exposure, followed by development. Once the patterns for the mesas were applied, we could remove the SiO2 not being covered by the unexposed PR using a buffered oxide etch. When the oxide was removed, the remaining PR was removed leaving areas of bare germanium alongside mesas of germanium covered by SiO2. The bare germanium was then removed by (RIE) whereas the SiO2 would not due to the materials selectivity. Once RIE was completed, the remaining hard mask of SiO2 was removed by another buffered oxide etch and what remained were the pure germanium mesas.