ND*nano* Undergraduate Research Fellowship (NURF)
2013 Project Summary

1) Student name: Santiago Esteban Martínez Prieto
2) Faculty mentor name: Prof. David Go
3) Project title: Experimental Studies on Field Emission-Driven Microdischarges

4) Briefly describe any new skills you acquired during your summer research:
I learned how to use several instruments including a vacuum chamber, a power supply, a picoammeter and a multimeter. Also, I learned how to see the connection of cables into circuits with resistors and capacitors. I learned that patience is a crucial factor for research and that it is important to not get frustrated when you get bad results. Finally, I learned how the cleanroom works and how to spin cast a solution onto a wafer.

5) Please briefly share a practical application/end use of your research:
Field emission would be a really good source of ionization for instruments like a mass spectrometer or a particle accelerator. It could also be used as a more efficient technique to measure Townsend's ionization coefficient under high electric fields.

Project summary:
The research was focused on field emission and its behavior under defined circumstances. Field emission is the discharge of electrons from the surface of a solid material at very high electric field. For this project, we needed first to create a high electric field by using devices with small gaps (less than 15 μm) and then experimentally demonstrate the relationship between pressure and current to prove the theory that states that field emission current scales by the factor $e^{\alpha d}$ due to ionization and multiplication in the discharge gap.

For the project, we used microdischarge devices that were made of metal (titanium or tungsten) on silicon with a photoresist polymer as a spacer, where the polymer height determines the electrode gap as seen in figure 1.

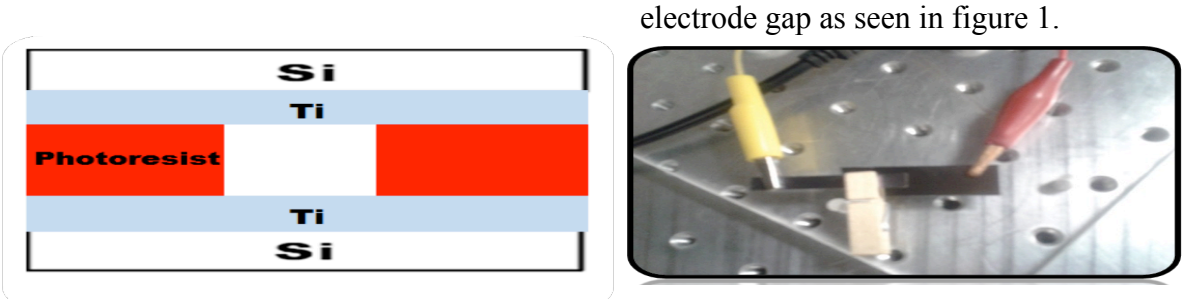

***Figure 1**: Microdischarges devices used in the project*

During the experiment current and voltage were recorded, and Fowler-Nordheim plots and current-voltage curves were used to confirm the presence of field emission. The relationship between the pressure and current was examined by measuring current versus pressure from ~0.01

to 700 Torr at a fixed voltage. These measurements show that current grows exponentially with pressure due to electron impact ionization of neutral gas molecules. This confirms theory stating that current scales as $i = exp(\alpha d) \times i_{FE}$, where α is the ionization coefficient, d is the gap size, and i_{FE} is the field emission current at ~0.01 torr.

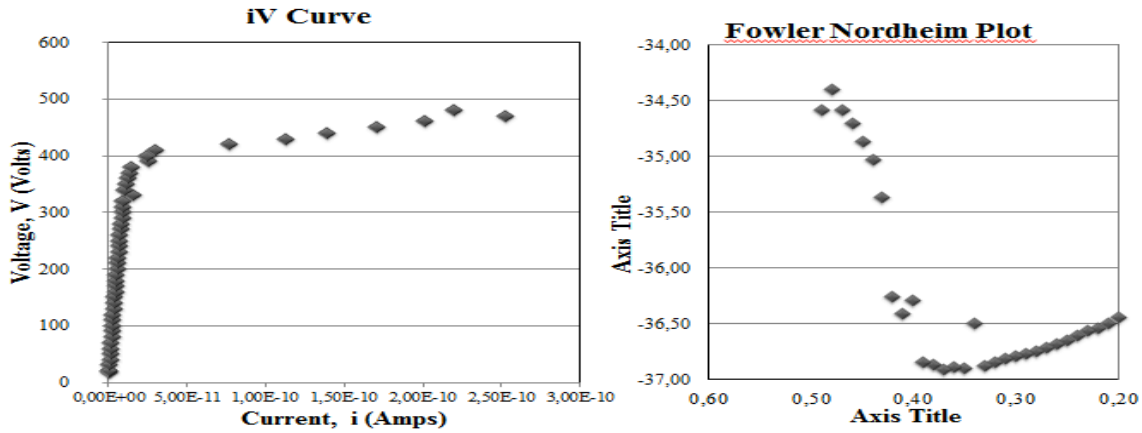

***Figure 2**: Examples of iV curve and Fowler-Nordheim plots for a device with a gap size of 9.5 um.*

Publications (papers/posters/presentations):

-Summer Undergraduate Research Symposium Poster.