Nanoelectronics Undergraduate Research Fellowship (NURF)
2010 Project Summary

Student name: Brian Rockwell
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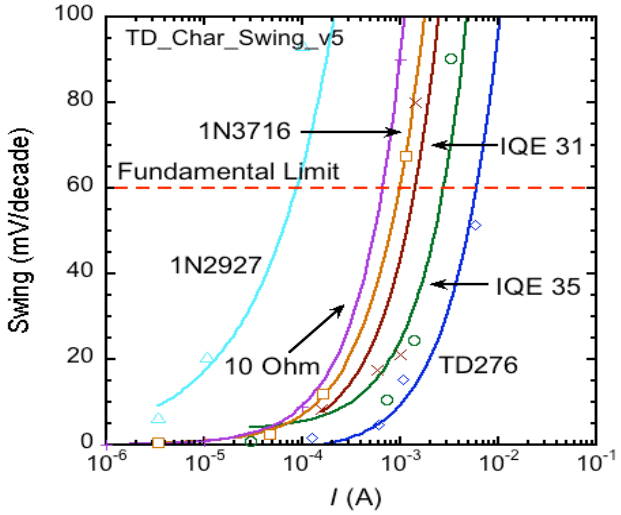
Project title: Measurements of Voltage-Controlled Current-Swing in Semiconductor Tunnel Junctions

My project primariliy involved the characterization and analyzation of the reverse-polarity characteristic of tunnel diodes, a heavily doped p+n+ semiconductor junction. The goal was to find a more efficient method for switching circuits and rectifiers than present diodes and transistors, which have a fundamental limit to their subthreshold swing of 60 mV/decade. Subthreshold swing is the change in voltage required to increase the current in a device by an order of magnitude, which for diodes and transistors is an invariant constant at room temperature.

I spent time working in device fabrication and the clean labs researching TFETs (Tunnel Field-Effect Transistors), which are related to tunnel diodes in the same way that transistors are related to diodes. The majority of my time was spent at a probe station and a semiconductor parameter analyzer to characterize the reverse-polarity I-V graph of several different types of tunnel diodes. With this data, it became clear that to decrease the subthreshold swing of tunnel diodes, one needed to increase the electric field in their semiconductor p+n+ junctions, accomplished by increasing the n-type doping by several orders of magnitude. The most promising materials were Ge and InGaAs/InAs/GaAs, achieving subthreshold swings below 3mV/decade at their smallest.

Poster: Measurement of Voltage-Controlled Current-Swing in Semiconductor Tunnel Junctions

(see images next page)



Swing vs Current – visual representation of tunnel diodes breaking the fundamental limit

Energy vs Position – Energy band diagrams with corresponding electric fields at several different bias voltages