ND*nano* Undergraduate Research Fellowship (NURF)
2012 Project Summary

1) Student name: Truong Pham
2) Faculty mentor name: Professor Hsueh-Chia Chang
3) Project title: Optically Addressed Nanoarray for Biosensing
4) Briefly describe any new skills you acquired during your summer research:
I received training on the electron-beam evaporator and the sputtering system in the clean room. I also studied the literature to produce titanium dioxide through anodization and set up an I-V scanning experiment to study opto-electronic properties of titania.
Finally, through weekly meetings with my advisor, I acquired experience in model developing.
5) Please briefly share a practical application/end use of your research:
Multi-target DNA detection device

Project Summary:

Titanium dioxide (TiO2) is a n-type photoconductive semiconductor that has a band gap in the UV spectrum. This property allows the material to have potential uses in multi-target DNA detection. This summer project has two main goals. The first goal is to find out different ways of depositing TiO2, a photoconductive material on ITO-coated glass. The second goal is to study optoelectronic properties of TiO2 substrate when it interacts with PBS buffer solution using I-V scanning.

To fabricate TiO2 on ITO substrate, I had to first receive training on depositing titanium on ITO glass using both the FC-1800 electron beam evaporator and the Perkin-Elmer sputtering system in the clean room. After being deposited on ITO glass, titanium was converted to titanium dioxide through either anodization or thermal oxidation. For the anodization process, a two-electrode design was used. The positive electrode was connected to the titanium film and the negative electrode was connected to a platinum wire. Both electrodes were immersed in either a water-based solution or a dimethyl sulfoxide solution with fluoride ions. Different voltages were applied to find an optimal voltage for the anodization process. Thermal oxidation of titanium was conducted by heating titanium-coated ITO glass slides in ambient atmosphere at 400 degrees Celsius for six hours. It was found that anodization, even though producing TiO2 films with a higher photocurrent, was harder to control due to many parameters involved with the process. Thermally oxidized titanium films, even though yielding a lower photocurrent, were easier to be mass produced, thus were more appropriate for optoelectronic testing.

I-V scanning was conducted to study optoelectronic properties of TIO2 substrate when it interacts with PBS buffer solution. The greatest shift in photocurrent was observed when the substrate was back-illuminated with 302-nm wavelength light. Additionally, an interesting hysteresis phenomenon was observed in the reverse-bias direction. A model is being developed to explain this result.

Ultimately, it is expected that multi-arrays of different probe DNAs can be functionalized on the TiO2 surface. When that is achieved, UV light can be used to activate certain probes to detect only relevant target DNAs. As a result, a fast, specific multi-target DNA detection technology is possible.