Alyssa Mike

NASA Internship Report

Brief introduction/ background of intern

Alyssa Mike is a third year undergraduate student at Stanford University in California USA, pursuing a major in Biomedical Computation.

Alyssa comes from Vistabella, San Fernando. She graduated from St. Joseph's Convent San Fernando in June 2014 after completing CAPE Applied Mathematics, Pure Mathematics, Biology and Chemistry. As one of the top ten students in the Caribbean in Applied Mathematics, Pure Mathematics and Physics, Alyssa sought to apply her analytical and reasoning skills to her field of interest – health care and medicine. During Secondary School, Alyssa was President of the St.Joseph's Convent United Nations Educational, Scientific and Cultural Organization (UNESCO) club where she led the community outreach initiative in her area and studied UN statutes to educate teenagers about their human, civil and legal rights.

Currently at Stanford University, Alyssa is a Resident Assistant at an all-freshman dorm where she assumes a primary leadership role and serves as a role model for responsible behavior and personal integrity for seventy-eight first-year Stanford students. Alyssa also serves as a chair on the Conference committee for Stanford students in Biodesign and Biopharmaceuticals (SSB) where her main responsibility involves planning speaker series, student panels and an annual Spring conference which educate the Stanford community about cutting-edge research and innovation in healthcare. Alyssa is also an undergraduate researcher at the Stanford Medical School Center for Clinical Sciences and Research where she analyses ovarian cell lines using mass cytometry and bio computational tools.

Her passion for health care and technology fuels her continued work at the intersection of these fields. Alyssa hopes to use her acquired skills and knowledge to advance the way that we treat patients around the world.

Overview of the Experience

"If I have seen further than others, it is by standing upon the shoulders of giants." – Isaac Newton

Before I embark on any journey, I look to others who have been through similar experiences and learn from them. I am a firm believer that history is inundated with mentors. Who better to inspire my NASA internship journey than the first black woman in Space and Stanford graduate, Mae Jemison?

"You have the right to be involved. You have something important to contribute, and you have to take the risk to contribute it." – Mae Jemison

Imposter syndrome. There is something about the immense grandeur of being at a major research institution such as NASA Ames Research Center in California that initially begs the question, what contribution could I, a second year University student, possibly make to this organization in astrobiology, supercomputing, the search for life on other planets and robotic lunar exploration? But Mae Jemison's words ring in my ear and I know that I am where I am meant to be . As an afro-Caribbean woman in STEM, I have a unique perspective and set of skills to provide to this Institute. "Welcome to NASA, amid thousands of applications this year, you all have been selected to join us this Summer. Your safety is our main concern….No climbing on rocket ship structures..." Orientation begins and as I clap with the other interns, my sense of anxiety dissipates and a feeling of solidarity emerges. I truly

appreciate that we are all here to work on our individual projects that will culminate in the greater good for the scientific community.

"What we find is that if you have a goal that is very, very far out, and you approach it in little steps, you start to get there faster. Your mind opens up to the possibilities." - Mae Jemison

My project for the summer was to create a biosensor that detects bone loss in astronauts. It was very easy to be daunted by an undertaking with such major implications but I came to appreciate the mindset of taking things one-step at a time. I immersed myself in readings and videos on nanotechnology, carbon nanotubes, potentiometry and paper based electronics so as to get a holistic understanding of the goal of the broader Ames Nanotechnology group and my specific assignment. My next objective was to design a project proposal with the guidance of my mentor, Dr. Jessica Koehne. We decided that my project would comprise of a material analysis so as to find the best design and components for the biosensor. Over the course of my internship, I tested the conductivity, electrochemical and mechanical properties of carbon nanotube inks, calcium ionophores and polyimides inks. I worked on printing these conductive inkjet compatible inks and performing chronoamperometry using the ionophore on glassy carbon electrodes. By breaking down my initial project into its sub components, I was able to efficiently complete my work within the required time period.

"Some people say they feel very small when they think about space. I felt more expansive, very connected to the universe". Mae Jemison

One of my favorite parts about my internship experience has been the public lecture series in which astronauts have spoken about life in Space. At the start of his speech, Harrison Schmitt (Apollo 17), the most recent living person to have walked on the Moon, threw three miniature moon-shaped balls into the audience and I caught the first one! Apparently this means that it is now my duty to go to space. Before working at NASA I would never have considered such an experience but after hearing about the way that spaceflight makes one truly appreciate the vastness of the universe, I say sign me up.

"We look at science as something very elite, which only a few people can learn. That's just not true. You just have to start early and give kids a foundation. Kids live up, or down, to expectations." – Mae Jemison

"Never limit yourself because of others' limited imagination; never limit others because of your own limited imagination." - Mae Jemison

Over the past few weeks, I have been blessed to meet some of the most intellectually vivacious and passionate young people that I have ever encountered. My first trip with other interns was to Panther beach in California. As we sat around a bonfire roasting sweet potatoes and sausages, we discussed our research projects, hometowns and colleges. Amidst the sound of breaking waves, it was truly beautiful

to hear about those studying the impact of spaceflight on the nervous system and those improving the flight capabilities of drones.

Don't let anyone rob you of your imagination, your creativity, or your curiosity. It's your place in the world; it's your life. Go on and do all you can with it, and make it the life you want to live.

My mentor, Jessica Koehne, received the Presidential Early Career award from President Obama. This initially made me a bit reluctant when it came to providing suggestions regarding the direction of the project. However Dr Koehne was a supportive and encouraging mentor who gave me immense amounts of scientific and creative freedom in designing and executing the project. By encouraging questions and requesting my input at each step of the process, Dr. Koehne affirmed my capabilities and helped contribute to an environment in which my imagination, creativity and curiosity flourished.

Tasks Undertaken

Spaceflight osteopenia is the term used to describe the characteristic decrease in bone density during extended space flight. Astronauts are reported to lose over 1% bone mass per month in space, which raises concerns regarding their ability to endure long space missions. Paper based devices are cost-effective, allow for rapid prototyping and can be more easily assembled in space. My project was aligned with the goal of designing an effective and easy-to-use paper based device to monitor bone loss by detecting Ca2+ concentrations excreted by astronauts.

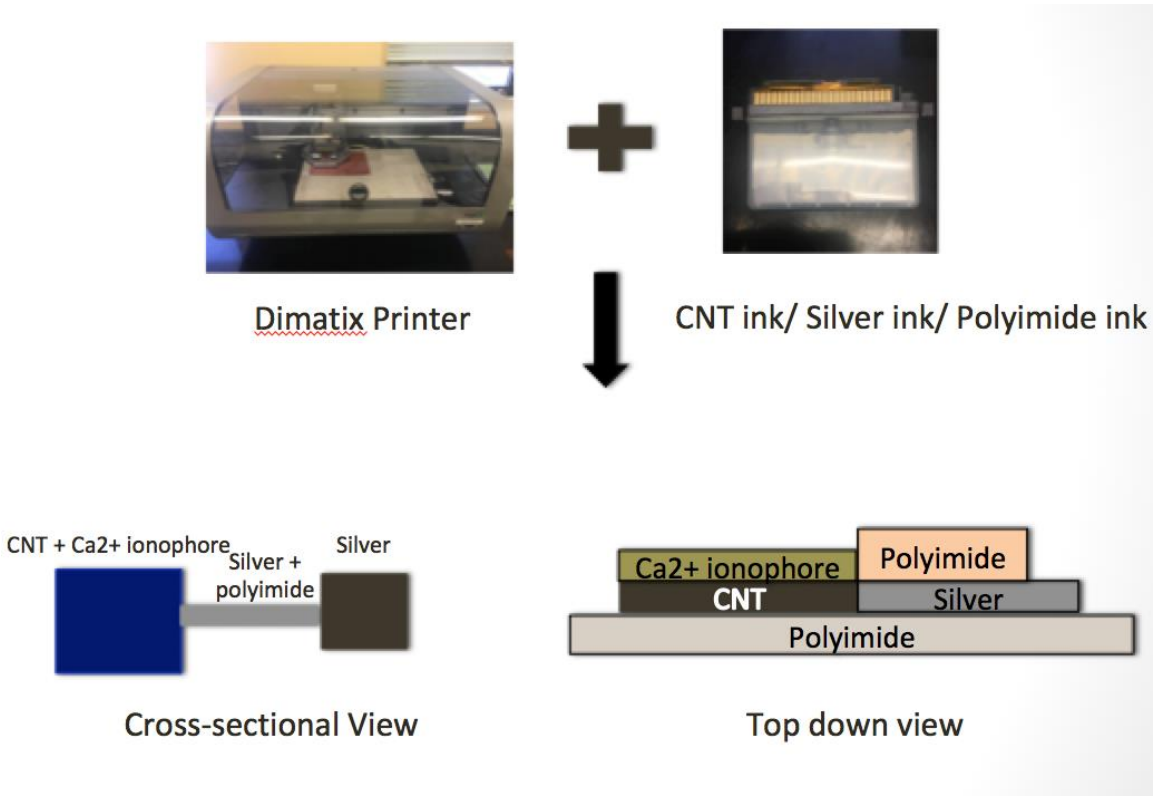

Figure 1: Experimental Design

This project was centered on determining the best design and choice of materials to create this paper based diagnostic device.

The first phase of my research investigation involved the testing of ionophores so as to find a conductive ionophore membrane for coating the carbon electrodes. This was done using chronopotentiometry over a series of calcium concentration (as shown in Figure 2). My responsibility was to examine scientific publications for ionophore membrane designs and choose the most appropriate ones to be tested for possible incorporation in the biosensor. Two membranes – one comprised of an ionophore in ethanol solution and the other – a cocktail were selected as the best possible options. Chronopotentiograms were obtained over Ca2+ concentrations from 10^{-10} to 10^{0}. The maximum/ plateau values obtained for each concentration were then plotted and the resulting graphs were analyzed so as to determine the sensitivity of each membrane option.

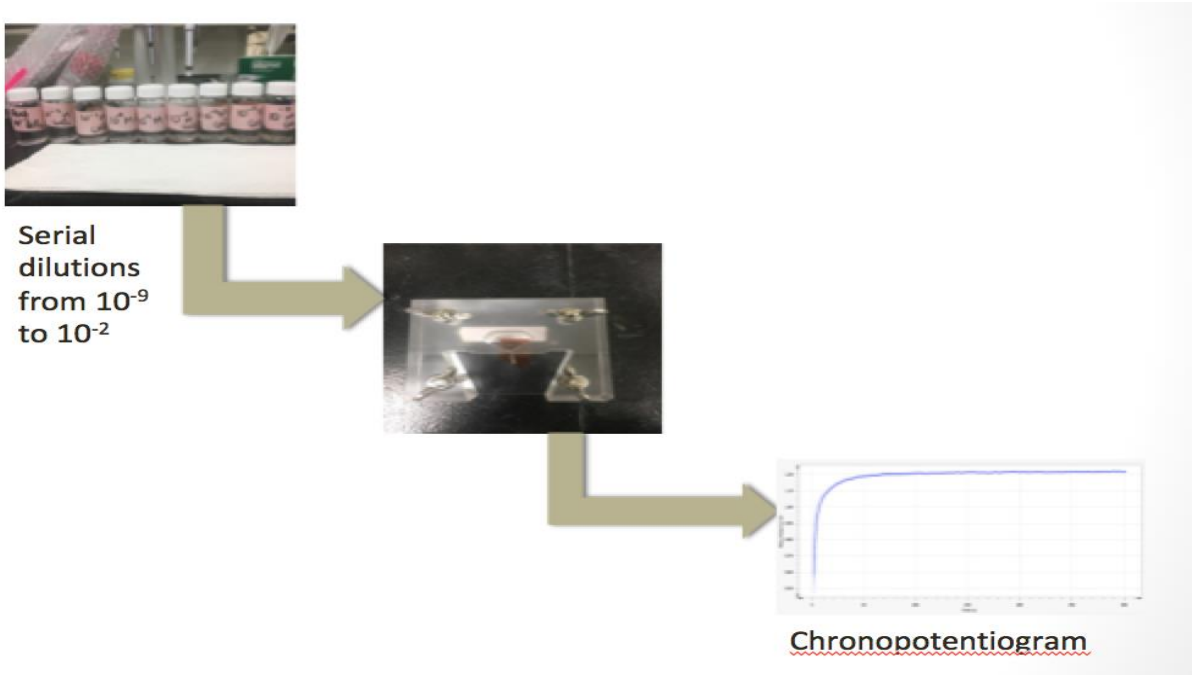

Figure 2: Chronopotentiometry setup

There has also been rapid development in electrochemical sensors as a form of instrumentation within the sphere of nanotechnology. This is demonstrated by the emergence of carbon nanotubes (CNTs) as nano electrodes (NEs) for electro analysis. This NE technology is integrated with paper-based analytical devices, in which an analytical response is obtained when an analyte interfaces with a particular reagent or electrochemically marked region. In the creation of my device, I make use of the currently available carbon nanotube (CNT) technology as potentiometric ion sensors by testing their conductivity and compatibility as printable electrodes for electrochemistry

This takes us to the second phase of my project which involved checking the compatibility of the CNT ink as an electrode for electrochemistry using cyclic voltammetry to look at redox events. I was initially responsible for evaluating the electrochemistry of the unprocessed CNT ink by performing cyclic voltammetry on its drop-casted form. This was done as a precursor to using the CNT ink in its printed form.

The use of Carbon nanotubes as a printable electrode was still a relatively novel endeavor in the lab and hence a major segment of my time was spent processing the commercial carbon nanotube ink so that it could reliably produce a printed design. This involved the use of dispersion mechanisms such as ultra sonication, centrifuging and finally printing.

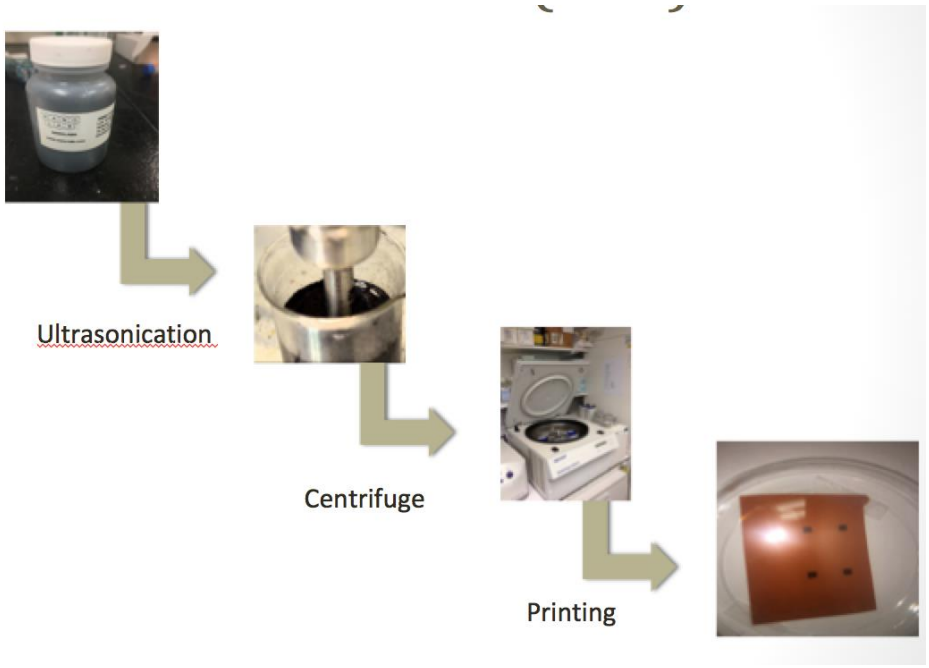

Figure 3: Processing of the Carbon nanotube ink to be used as a printable electrode

The final stage of my project involved putting all the individual components of the design together and then testing the prototype for calcium selectivity.. These chronopotentiometry results suggested that the printed CNT electrodes with the chosen calcium membrane can be used as reliable Ca2+ sensors.

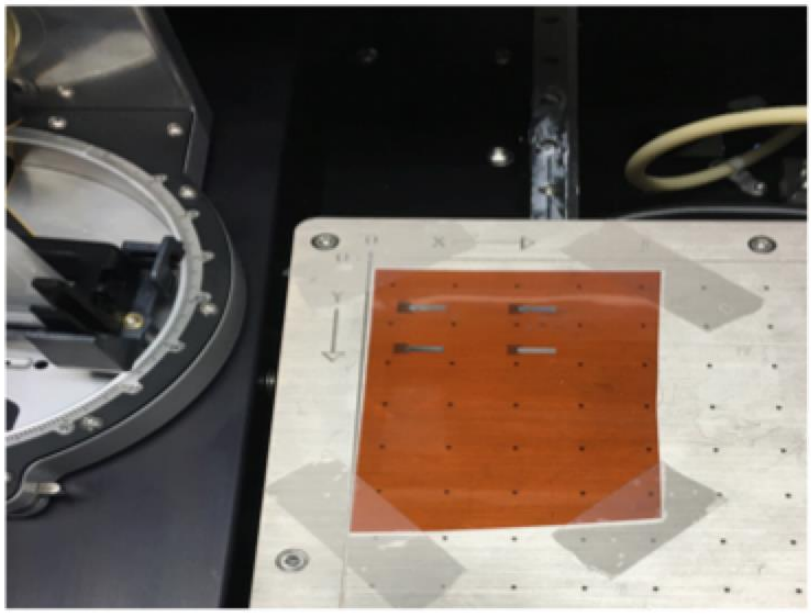

Figure 4: Final printable form of electrode

Lessons Learnt

1. Flexibility

My internship underscored the significance of flexibility, as the original experimental design did not always work out as hypothesized. I often encountered unexpected challenges that led to changes in the materials or processes involved in executing the project. All in all, I honed the ability to address problems that arise and quickly adjust the design plan to suit.

2. Communication is key

Communicating science is an important skill. From addressing the second in power at AMES (when my poster won best in TSS division) to presenting my research back home at UWI, I learnt the importance of being able to eloquently deliver my research to different audiences.

3. Teamwork

After this experience, I also have a deeper appreciation for teamwork. My team at NASA comprised a physicist, chemical engineer, biology major and electrical engineer. We all used slightly different scientific terminology to describe certain problems and had diverse approaches to various challenges. We were all from different cultures (due to the international component of the program) and hailed from different colleges, which contributed to each of us drawing from our own pool of knowledge. These varied perspectives contributed to determining the best possible solutions to problems encountered as we pursued our individual tasks.

3. Time

The role of time in the scientific process - no one, not even a renowned scientist, can rush science. Experiments take time. Repeating experiments for validation,

generating numerous serial dilutions, and dealing with each obstacle that arises in the process ultimately leads to time delays.

Impact of Research on the future of Trinidad and Tobago

In preparing for space travel we prepare to confront very challenging environments characterized by uncertainty in regard to the basic elements, which support human life - food, water, clean air and even shelter. Preparing to meet such uncertainties requires innovation and creativity. Increasingly this has come to characterize the challenges which many countries now face on planet earth and Trinidad and Tobago whilst safer than many is no exception. What then are the benefits that developing nations such as ours derive from my experiences at the recent semester?

The challenges in regard to health are generally one of accessibility and availability particularly by the most vulnerable groups such as women, children and the poor. We have found that the development of printable biosensors can allow for rapid, easily accessible and accurate health diagnostics. Biosensors specifically allow for self-administered health care diagnostics extremely appropriate for areas where there is limited or often no access to trained health care professionals. Biosensor design can be modified to detect other compounds of biological significance, which can enhance their suitability and extend their reach.