University of Missouri South African Education Program (UMSAEP)

Report on trip to Columbia, Missouri

Period: 22nd of May to 22nd July 2019
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Riccarda MacDonald, an MSc NanoScience student registered at the University of the Western Cape who is supervised by Prof Leslie Petrik, was privileged to spend nine weeks under the mentorship of Prof Maria Fidalgo at the University of Missouri, in Columbia Missouri. Her visit was from 22nd of May to 22nd July 2019 as part of the University of Missouri South African Education Program (UMSAEP).

Thus far research has been mainly focused on carbon-based nanomaterials (carbon nanotubes and fullerenes) and metal or metal-oxide nanoparticles (e.g. ultrafine titanium dioxide, TiO2), which makes this study quite relevant, as the toxicity of carbon nanodots and LIG has not fully been investigated. Riccarda's principle activities at Columbia during the exchange visit included discussions and planning with Prof Maria Fidalgo. Initially the plan was to test the effect of ionic strength on the colloidal stability of carbon dots & amine-capped carbon dots, but her plans had to be revised. Her experimental work focused on graphene, and the adsorption of pharmaceuticals, such as sulphamethazine (SMZ), on its surface. The experimental plan for SMZ included studies on the effect of changes in the concentration of SMZ, pH levels, and ionic strength on the adsorption process of SMZ onto graphene. During her stay, she received training on several analysis techniques, namely: Atomic Absorption Spectroscopy (AAS), Brunauer-Emmett-Teller (BET) surface area analysis, Ultraviolet-Visible (UV-Vis) Spectroscopy and Fourier-transform Infrared (FTIR) Spectroscopy. Riccarda was also been taught how to use the CO_2 infrared laser for Laser-Induced Graphene synthesis.

Riccarda's experimental techniques used in this study, for the characterization and testing of CDs, a-CDs and LIG, are described below:

- UV-Vis was used in order to obtain the absorption spectra for synthesised materials, with possible scanning range of 200-600nm. From the absorbance spectrum, the optical band gap of the CDs and a-CDs was determined.
- Zeta potential and hydrodynamic size measurements were carried out in order to investigate the stability of colloidal carbon-dots. Surface charges and hydrodynamic properties were measured under a wide range of solution compositions, including monovalent and divalent electrolytes (NaCl and CaCl2 respectively).
- FTIR was conducted for the investigation of the surface functional groups of synthesized materials and to determine changes in functional groups on the surfaces of the carbon-dots.
- HR-TEM was used for the study of changes of the surface morphology of the CDs before and after aminolysis. The information obtained from these images included (a) particle size values which in turn allows for the construction of the essential number size distribution of nanoparticles, (b) information regarding the shape of particles, (c)

visualization of the degree of particle aggregation or agglomeration, (d) information about the electronic structure, chemical identity, crystal orientation, and sample-induced electron phase shift (Manta Instruments n.d.).

- Contact angle measurements were done to analyse the variations in hydrophobicity and hydrophilicity of the CDs before and after modification.
- TD-Rheometry was used to measures the visco-elastic properties of solids, semi-solids and fluids.
- Photoluminescence was used in order to probe the electronic structure of materials and the photoluminescence of the CDs before and after modification. It was also used to measure changes in pH, ionic strength and the presence of NOM.
- Raman spectroscopy was used to study the surface chemistry of synthesised materials.
- Small Angle X-ray Scattering was used for the determination of the structure of particle systems in terms of averaged particle sizes or shapes.
- Atomic Force Microscopy was used to measures the attractive or repulsive forces between the probe tip and the sample surface (Filipponi & Sutherland 2013), elucidating local chemical and mechanical properties such as adhesion and elasticity, thickness of adsorbed molecular layers or bond rupture lengths.

Riccarda says that nine weeks at Columbia might seem like a short time span, but she has learnt much and met outstanding fellow researchers. Dr Fidalgo and her research team made their best efforts to ensure that her stay was as comfortable as possible. This included help with transportation, grocery shopping as well as much needed breaks. Riccarda says that it was such a blessing to visit Dr Maria Fidalgo and her research team of the Department of Civil and Environmental Engineering at the University of Missouri, supported by her supervisor, Prof. Leslie Petrik, from the University of the Western Cape.

The students Riccarda met were friendly and welcoming. During her visit she worked closely with Dr Fidalgo's research team, consisting of the following members: Mohamed Bayati, Mohammed Numaan, Zahra Salahshoor, Sally Qasim, and Abbas Kadhem. Riccarda gained a lot of support from them and found them very knowledgeable and she was able to learn a lot from them. Dr Fidalgo treated Riccarda very kindly, and is a goal-oriented mentor to all of her PhD students. The team at Columbia was very helpful during her stay in Missouri and created an inspiring and supportive environment for her to work in. Riccarda not only found them diligent scientists but also wonderful people. Whenever she needed anything, they were always there to lend a helping hand. Riccarda would like to express her deep gratitude for the kindness and wisdom that this team have imparted. During conversation, she realized that her longing for home wasn't as bad as she had thought as it has been years since they'd seen their families.

In the last week of June, Riccarda met Yan Li, a PhD student in the chemical engineering department who assisted her with training on AAS. Another student, Shivam, trained her on the laser and was very helpful during her time there. Early in June she met a fellow UWC student from the Chemistry Department and she was delighted to find a fellow South African could relate to my experience. Every interaction that she had at the University of Missouri moulded her into a better researcher.

Riccarda says: "For an American it might be something trivial to go to Walmart to pick up a few things, but when I got there it felt so surreal to be in a shopping centre that I had only heard of and saw in movies. Walking through the isles in Walmart, it hit me – I am in America! Never in my wildest dreams would I have imagined that I would be granted this amazing opportunity to travel while studying".

Riccarda attended *Art in the Park* at Stephens Lake. She says: “There were about 40 stalls, each with unique and breath-taking art. I walked through most of the stalls, got a few souvenirs here and there and then made my way to the food trucks. A yellow bedazzled truck with “corn dogs” written in big red font caught my eye. Naturally, I had to try one. I planted myself on a patch of grass across the lake and enjoyed my $5 corn dog. I also grabbed some Jamaican food – jerk pork steaks – for dinner. The last thing I had to do was to get a caricature of myself and then took on the long walk home”.

Riccarda was encouraged to sign up for a trip to Kansas City – and ended up signing up for three. On the bus trip to Kansas City, she met a journalist from Beijing who covers the French section of their station in China. She taught Riccarda several things about her country and her culture, the basic greetings, and they conversed about the dynasties and the Forbidden City in China. About 20 minutes out of Kansas City, one of the tyres of the bus burst and they were stranded on the side of the road for six hours. Luckily there was a Denny’s nearby where she met two other girls, both from China, who were in Missouri for a year internship to teach Chinese. They shared a table, a meal, pleasantries and got to know each other better. On the second Saturday-trip, Riccarda went to Six Flags/Hurricane Harbor. Riccarda says: “It was a blast! I went on a total of seven thrilling rides. This theme park was nothing like the one we had back home in Cape Town. There were so many different rides: American Thunder, Pandemonium, Super Girl, Mr Freeze and the list goes on. Riccarda said: “These rides were so exhilarating, even standing in line wasn’t that much of a bore”. Her third and final trip fell on her birthday to go to St Louis, where she spent her day with 3 students who were all from Africa. They visited the Gateway Arch, which was followed by a visit to the old Cathedral Basilica and the Old Courthouse of St Louis and learnt about the history of slavery of African Americans in the US. The last stop on this trip was the zoo. Although there were many amazing animals to behold, she was most happy to see elephants and hippos for the first time in real life.

On Independence Day, 4th of July, Riccarda spent watching the fireworks with Zahra, a very kind and hard-working fellow student. The atmosphere was vibrant and some shops were open late, from coffee shops to the ice cream shop, Sparky’s. People were camping out everywhere on lawn chairs and it looked as though they’ve spent the whole day down town with their families. Riccarda found it to be a heart-warming to see people so proud of their country. Everywhere you go you would see the American flag and she felt honoured to experience such a wonderful tradition.

Riccarda also visited a Bible study group on Tuesdays which filled a spiritual gap during her time alone where prayer and discussions were held about the things that people struggle with in their daily lives, and then they played volleyball afterwards.

There were many amazing aspects of her stay but some parts were rather difficult. Riccarda recalls while flipping through television channels on her 3rd day, she stopped at the news channel and saw that there was a huge tornado in Jefferson City. Being from a small town in South Africa, she was not used to this kind of weather. As she saw all the damage that the tornado left, she felt so helpless, but then Dr Fidalgo contacted her to hear how she was doing and reassured her of her safety.

Her family reminded her that for the next two months she should think of Missouri as her new home filled with several opportunities to meet diverse and culturally-rich people. Gradually, she started to leave her things around the apartment, decided to use the work space in the living room and switched on the TV as soon as she walked through the door – these tiny acts made her feel much more at home. She was reminded of a sermon *Planted Not Buriedby* Pastor

Michael Todd's reminding her that she is a planted seed. And as a seed she realised that she had the potential for growth and that she was there for a reason.

The purpose of this journey was to broaden her mind and skills as a researcher, but how she flourished as a person went far beyond the academic aspects. As weeks went by, and as she met different people – both inside and outside the lab; from all walks of life – she realised that this experience could teach her how to go through life confidently. If she could use one word to describe this trip it would be *independence*. Because she was on the other side of the world all by herself, she had to become accustomed to doing things on her own and being left alone with her thoughts and enjoy something as simple as walking and admiring nature. It was the perfect time to work on her relationship with God. She remembers saying my goodbyes and walking through Cape Town International Airport saying: "Okay, God. Now it is just You and me!"

This trip took her completely out of her comfort zone and it also allowed her to view parts of her life in a more objective manner. Her stay in the US also changed her perspective and outlook on her academic career. With all the ups and downs that accompanied her research thus far, her outlook regarding further studies was rather bleak. Her determination for completing her masters was definitely there, but the thing that was lacking was enthusiasm. She began to understand that she had much more potential than previously believed. Seeing the drive of the team that she worked with, and appraising herself with a better standard, she quickly grew to enjoy her long hours in the lab; the *need* to do things changed into a *want* to do them. She came back home with a more positive mindset regarding her studies and work that requires completion. She has now decided to take the next step in her academic future - doing her PhD.

She found that research is not just about writing a thesis or writing papers; it is about much more than that. As scientists and researchers, we stand at the forefront of making the promise of a better world a reality as we are changing the world with every small step we take.