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University of Missouri South African Education Program (UMSAEP)

Report on trip to Columbia, Missouri

Period: 22nd of May to 22nd July 2019
Student: Riccarda Thelma MacDonald
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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