



Stoos, Schwyz

## CaMPUS - Non-technical report

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**ETH**

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Natural Sciences affords us the opportunity for real breadth in study. Having studied a range of physical science disciplines in my first two years, I decided to focus on a specific scientific area for a summer internship. My placement at ETH Zürich provided the chance to take part in research at the forefront of Materials Science as well as to live independently in a foreign country.

Prior to arriving, like any good scientist, I did some research... After a little time on *Google* I repeatedly found websites placing Zürich as one of the world's top student cities - quite a badge of honour! The more I read, the more excited I became, but would Zürich live up to the hype?

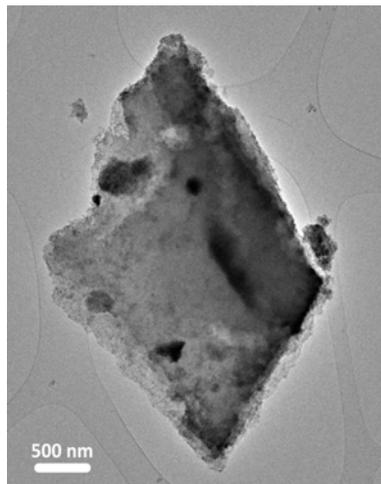
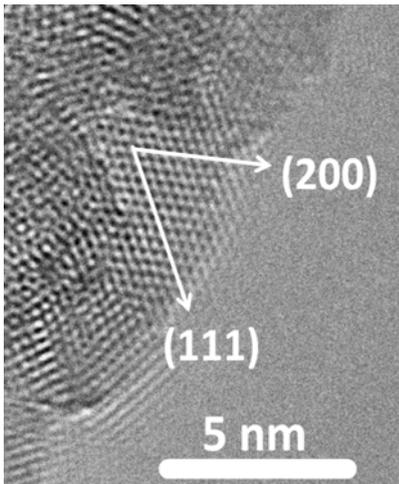
The Swiss Federal Institute of Technology in Zürich, or *Eidgenössische Technische Hochschule Zürich* (ETH) is a science, technology, engineering and mathematics university founded in 1854. Much like in Cambridge, the university is split between a host of central buildings and a hill campus, Höggerberg. The Materials Science department, again much like in Cambridge, is on the 'hill,' however being a Swiss 'hill' Höggerberg has a little more height to it.

I was based in the Laboratory for Multifunctional Materials headed by Professor Markus Niederberger. The focus of the group, affectionately known as the 'Mutlimats', is *the wet-chemical synthesis of a broad range of materials for possible applications in energy storage and conversion, sensing, optics and catalysis*. The 'Multimats' are a truly international group with multiple languages filling the labs, often simultaneously. Much to my relief however, English was a common-ground and lunchtimes did not leave me scrabbling around in my basic German!

I was assigned to work with Xi Chen on his PhD project which is broadly focussed on improving the capacity and charge/discharge rates of lithium-ion batteries through trying out novel materials in the cathode. My project focussed on experimenting with zinc sulphide nanoparticles as the cathode's active material. The first challenge was to reliably synthesise these ZnS nanoparticles and once this was achieved, to collect data from them using lithium-ion test cells. Naturally, the work involved learning many new experimental techniques for both the synthesis and then the characterisation of the nanoparticles. In the end, we collected some good battery performance results, as well as some impressive images, and of course plenty more remained to be investigated! All of my work was summarised in a technical report titled *Preliminary investigation into ZnS quantum dots for use in lithium-ion batteries* which was submitted to Xi and also Professor Niederberger.

As a second-year undergraduate surrounded by Masters and PhD students, as well as many postgraduate researchers, a very real worry of mine was that I would not be competent enough in the lab. However, my project drew on practical skills I had developed in Chemistry and linked to knowledge from lecture courses across many subjects from both Parts IA and IB of Natural Sciences; this immediately showed me the value of the breadth of my studies and set my worries to rest.

The imperfect nature of research is something one hears time and time again from those higher up in the scientific ladder, but something I only *really* experienced this summer. Experiments cannot be designed to work when the experiment is being done for the first time. I learnt to be patient and persevere; and to work methodically. I was told you can never write enough in your lab notebook, especially when there is a chance a supervisor might actually need to read it as a detailed record of your investigations. Experimentally, I developed many wet chemistry techniques, collected x-ray diffraction and battery performance data. I improved my data analysis skills using *MATLAB* and *Origin* and refined my report presentation skills, learning to use *LaTeX* for typesetting. It was not just my computing languages that improved, as over time navigating everyday life in Switzerland did improve my (Swiss!) German.



[L] Electron microscope (HRTEM) image of an individual ZnS nanoparticle (~3 nm)

[M] Electron microscope (TEM) image of carbon particle that has ZnS nanoparticles grown on surface

[R] Assembling lithium-ion test batteries, working inside an argon filled glovebox due to lithium's reactivity with air and moisture

With time, I developed experimental autonomy. In my third week I was able to complete a full synthesis from start to finish, and by week four I ran all of the tests. Working in a glovebox was a new experience for me and despite looking insanely cool, it could be incredibly frustrating. Wearing three pairs of gloves quite drastically reduces dexterity and this made the delicate process of battery assembly quite tricky – precisely cutting and mounting 5p piece sized lithium disks without contamination is easier said than done.

The summer of 2018 rewarded us all with some fantastic weather, and I was told this was even the case back in the UK! In Zürich, warm weather means swimming and lots of it. Whether in the River Limmat that flows through the centre of Zürich, down by the lake or at public baths, swimming was the perfect way to cool off after a day in the lab. Switzerland is famous for its mountains, and fortunately being a small country they are never too far away. At weekends I made the most of this and thoroughly enjoyed hiking, biking and of course learning more about Swiss culture and history. I was not alone in these adventures as there were three other CaMPUSers in Zürich - we met up often to explore a new Swiss city and were able to compare our experiences of Swiss culture and research life.



[L] The hills are alive, with the sound of music...

[M] Feeling on top of the world (2412 m) and ready for some downhill

[R] A day trip to nearby Lucerne provided ample opportunity to soak up some stunning Swiss heritage

I can fully recommend taking part in CaMPUS at a European university to any student who enjoys their science and would like to experience both research and living abroad. It has undoubtedly been a worthwhile experience and I have learnt so much from it. The placement was an excellent way to gain first-hand experience of what a research career in materials science is like. Naturally, there was some apprehension associated living and working in a foreign country where I didn't speak any of the four national languages fluently, but this is part of what made the trip so rewarding, and has strongly encouraged me to take up German as a *transferable skill* option in Part II. In short, returning to my initial question: Zurich certainly lived up to the hype!

I would like to thank the Worshipful Company of Armourers & Brasiers and Fitzwilliam College for their generous sponsorship, without which the internship would not have been possible. A special thank you to Xi Chen for guiding me through my project and to all the 'Multimats' for always answering my many questions in the lab and steering me clear of any experimental disasters. Also, a thank you to Professor Niederberger and the Cambridge Materials Science department for facilitating the opportunity, and of course to Lianne Sallows for all her very helpful behind-the-scenes organisational work.

View from Uetliberg (869 m), Zurich's 'mountain'

