



An ADVENTURE into RESEARCH

Michael Lee explores the world of science through National Junior College's trailblazing Science Training and Research (STaR) program.

by Michael Lee Dao Kang

Introduction

Michael's research journey started in his third year in the Integrated Program (Grade 9) at the National Junior College (NJC), where he was given the opportunity to start a research project under the Special Program in Inquiry REsearch (SPIRE). Having already explored some computer coding independently, he chose a computer science project on Android app development at the National University of Singapore (NUS), as it sounded applicable and interesting. The following year, he advanced his interests in the

field by registering for another project taking a different approach to app development at the Institute of Infocomm Research (I²R), Agency for Science, Technology and Research (A*STAR). In the same year, he was given another unexpected opportunity to take part in the inaugural international science research exchange program with Illinois Mathematics and Science Academy (IMSA). The project was a computational study of the novel 2-dimensional material, silicene – the silicon analogue of graphene. So far, experimentalists have only been able to grow silicene in epitaxy on silver in under ultra-high vacuum. Computational studies on



Michael (right), and his teammate (Sean), at the Finals of the Singapore Science and Engineering Fair (SSEF) 2013.

silicene showed interesting properties of the material which had since prompted more research to be done. Michael soon found out that computational chemistry was very different from computer science – a field he did not know to exist. This field of research was hard to grasp at first, but fortunately, his teacher mentor not only guided him on how to run simulations, but also on theoretical fundamentals of the computer simulations, Density Functional Theory (DFT). These computer simulations calculated how energetically feasible it was for different configurations of metal atoms to be adsorbed on silicene. And over the past 4 years, NJC's computational lab had grown from only a few computers to more than 10 computers equipped with significantly processing power. Given the capabilities of the lab, Michael managed to amass data quickly. Indeed, after he was familiar with how to run the simulations, new data would be churned out every few days, and this kept the research experience fast-paced and full of interesting surprises.

Going to IMSA and Back

One of the most unforgettable moments of Michael's research journey was to visit Illinois, United States in November 2012 as part of the college's international science exchange program. At IMSA, students live in a boarding school during the weekdays, and can go back to home in the weekend. Even though it was windy and cold outside, the people he met within the school were extremely warm and welcoming. He was able to experience classes, enjoy meals and dorm suppers, just like any student there. He played video games, a popular American pastime – which Singapore students equally enjoyed – and broke the ice with his new-found friends at IMSA. Through discussions of their differing experiences, Michael learnt more about IMSA and the American

culture. In the weekend, he home-stayed with his American buddy, and had a lot of fun cycling around the neighbourhood and visiting a local park. The amount of scenic open space and lakes was unbelievable – something he had never seen in Singapore.

On another day, he was brought on a tour in Fermilab, and found many aspects of the facility interesting – the 24-hour operation room filled with screens and controls, the vast amount of equipment that supported the Fermilab particle accelerator and how a room of scientists were monitoring experiments done at the Large Hadron Collider of the European Organization for Nuclear Research (CERN). Indeed, Michael enjoyed interesting and refreshing experiences which were an eye-opener into the scientific and natural world.

The other side of Michael's exchange was to do research with his American counterparts. While the Singapore team had more time to work with the simulations, and were thus more experienced, the Americans had asked questions which Michael had never thought about or just taken for granted. Through constant inquiry and discussions, and with the expertise of his research mentor, both groups gained a deeper understanding and clarity of the science underlying the research.

Michael's time at Illinois, through his interaction with his teammates from the United States, had expanded his worldview on science and scientific thought.

The following March in 2013, Michael hosted his buddy in Singapore and was keen on reciprocating the hospitality that he was shown in Illinois. In the interim between November 2012 and March 2013, the two teams from Singapore and Illinois corresponded with each other through email, where they shared data and typed out a report. Later, the project was shortlisted for the second stage of Singapore Science and Engineering Fair (SSEF) 2013 and won the State Championships in Illinois. Further work continued on data analysis and presentation. In June 2013, the project was presented at the 4th Singapore International Science Challenge (SISC) by his Singapore and American team members,



The Singapore (front row) and American (back row) team at the science research exchange program between NJC and Illinois Mathematics and Science Academy (USA).



Michael (far right) taking part in a science practical with American students he had just met at the science research exchange program between NJC and Illinois Mathematics and Science Academy (USA).

while Michael presented it at the International Conference on Materials for Advanced Technologies (ICMAT) 2013. The 4th SISC was hosted by NJC and sponsored by A*STAR and Ministry of Education (Singapore).

At ICMAT 2013, Michael presented a poster of his research, alongside many undergraduates and scientists from other countries. While presenting his poster, he was asked some challenging questions, which required the full extent of preparation he had done nights before. Besides this, he attended talks which provided much insight into vast range of fields of advanced materials and possible future areas of study for him. Honestly, the presentations were not easy to follow from start to finish, but they were certainly an eye-opener. During meals, he felt intimidated as there were many experienced scientists and even a few Nobel laureates. Despite this, Michael soon found out it was easy to sit at a table and have a friendly discussion with the people there.

After his presentation at ICMAT, Michael was invited to give a lecture at the International Union of Pure and Applied Chemistry (IUPAC): 9th International Conference on Novel Materials and their Synthesis (NMS-VIII) 2013. He also presented the project with his team member Sean Ng Peng Nam at the Asian Chemical Congress (ACC) 2013. His paper is currently being reviewed for submission to a scientific journal.

Initially, Michael was glad and quite satisfied that his project was accepted by SSEF 2013, but it was a pleasant surprise how the project abstract was also accepted by ICMAT and ACC 2013. He was further invited to give a lecture at the IUPAC NMS-VIII 2013 conference. These scientific conferences exposed him to novel research done worldwide and challenged his depth of knowledge of his project.

Experimental Research — A New Experience

These experiences and the wide range of possibilities inspired Michael to venture into experimental research instead of computer

science or computational projects. After ICMAT 2013, he was privileged to be accepted for a project about Schottky diodes under Dr Cedric Troadec at the Institute for Materials Research and Engineering (IMRE). In the institute, the most memorable moments were active discussions with more senior university students in the lab or over lunch. The research staff and interns were knowledgeable and had superior expertise in experiment procedures and data analysis. This was not just due to their years of experience, but also because they built their tools and measuring devices from separate components, and wrote their own programs to analyze data. He experienced what was the norm there when tasked to build an *in-situ* probe in a vacuum annealing chamber, and write a program to collect data at both high and low current. Although the task was time-consuming and an engineering challenge, Michael was glad he could experience a typical researcher's work – to innovate outside the box when other options are unfeasible or too costly. He also developed a more accurate method of image processing for his mentor's research group to use.



An educational visit to Willis Towers, Chicago, USA.

As Steve Jobs once said, “You can't connect the dots looking forward; you can only connect them looking backwards.” Indeed, looking back, Michael enjoyed his journey into research – not because it was predictable or easy, but because of the changes in fields of study – from computers to computational chemistry to experimental material research. The unexpected challenges he encountered were confusing then, but working to solve them made the journey meaningful at the end. Research is a never-ending adventure – there are novel materials to discover and then analyze, as well as different conditions to study the same system under and much controversy in science which has to be reconciled. It is truly up to the individual whether to step into research, an obstacle course full of surprises. 🚫

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