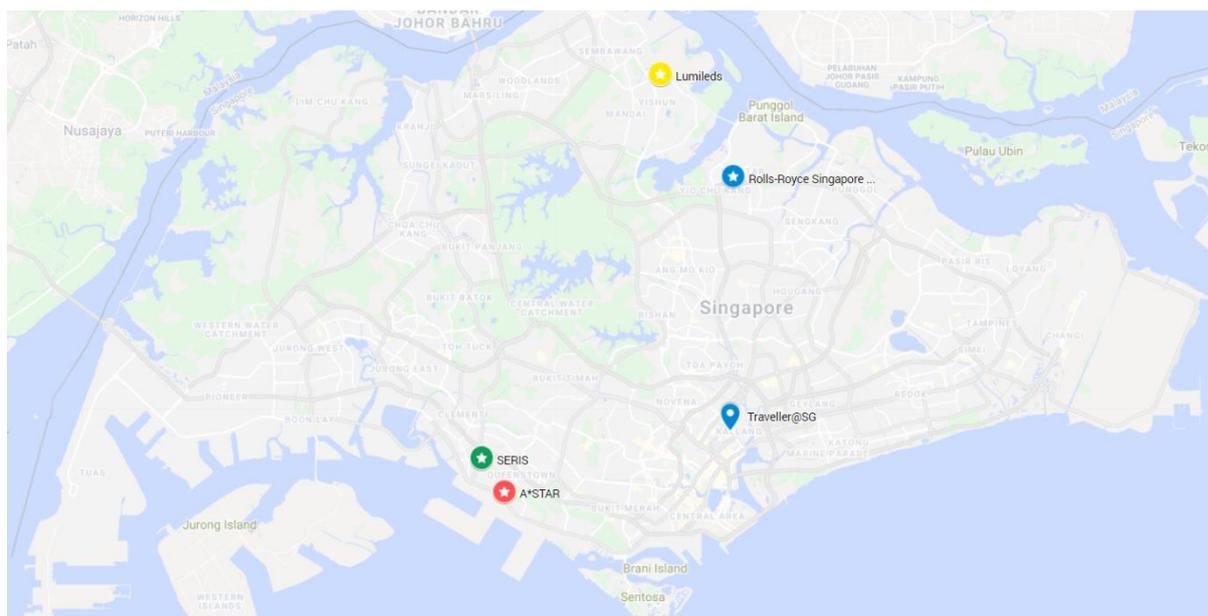


## Oxford Materials 2019 Industrial Tour to Singapore

The 2019 Department of Materials Industrial Tour took 18 undergraduate students and member of staff Dr Barbara Gabrys to Singapore for 10 days. We wish to record our thanks to the following organisations for sponsorship towards the costs of the tour: The Worshipful Company of Armourers and Brasiers; The Worshipful Company of Ironmongers and the Department of Materials at Oxford.

The tour consisted of four industrial visits:

- The Solar Energy Research Institute of Singapore (SERIS)
- LUMILEDS – a global leading company in LED lighting
- The Agency for Science, Technology and Research (A\*STAR)
- Rolls-Royce



Map of Singapore including the accommodation location (Traveller@SG) as well as the four Industrial Visit sites.

### **Sunday 10<sup>th</sup> March 2019 - Monday 11<sup>th</sup> March 2019**

We were set to depart from Heathrow Airport at 3pm on Sunday 10<sup>th</sup> March but due to adverse weather conditions we were delayed by three hours. Thankfully, our coach company was following the updates of the flight and was prepared to meet us at Changi Airport despite our late arrival. After almost 16 hours in the air, we arrived in Singapore at 8pm local time and used the evening to settle into our accommodation and have an exploratory walk. In this walk, we encountered our first of many hawker centres which are open-air food centres.

### **Tuesday 12<sup>th</sup> March 2019 SERIS Visit + Chinatown, Dinner**

The first visit was to SERIS, the Solar Energy Research Institute of Singapore. SERIS was founded in 2008 as part of the National University of Singapore, after seeing solar developments in Europe. They conduct research in 4 different areas: solar energy systems, novel photovoltaic (PV) concepts, PV modules, and silicon materials in cells. In the institute,

Eddy Blokken explained to us that real-time data from different instruments all over Singapore is collected to track the efficiency of the solar cells with time and weather. It was fascinating applying the knowledge we have acquired in lectures about band gaps and semiconductors to engineering applications like solar cells that will become a key player in the future of energy.



The party and our hosts at the Solar Energy Research Institute of Singapore.

In the evening, we had the pleasure of exploring Chinatown, in which many of us had our first and rather unforgettable experience with durian fruit! Singapore has a very comprehensive underground transport system called MRT we utilised this to travel to Chinatown. At the end of the day, we had the opportunity to have a group dinner in a traditional Chinese restaurant.

### **Wednesday 13<sup>th</sup> March 2019 LUMILEDS + Marina Bay Area**

9.30am Wednesday morning, our coach arrived at our hostel to take us to LUMILEDS, manufacturing company tightly intertwined with the history of LEDs. Swee Theng the Senior HR Manager kindly welcomed us to the site. She explained that the wafer processing and die fabrication in the Singapore site turns sapphire wafers with a thin InGaN layer into Thin Film Flip Chip (TFFC) technology, which is then exported to the factory in Penang, China. Swee Theng also explained that she had managed to convince the company to provide us with the unique opportunity to enter a clean room to witness the Chip Scale Package (CSP) die process ourselves. The preparation to enter a clean room involved wearing full clean suits and masks, as the diodes are extremely sensitive to contamination, so we all were truly grateful to see this process live. It was captivating to learn that the CSP die process allows Lumileds to produce the largest wafers, pushing the boundaries of light and providing innovative lighting solutions.



The Oxford party in our protective clothing while at the clean room at LUMILEDS

After Lumileds our coach driver kindly dropped us off in in the Marina Bay area, by far the most luxurious area of Singapore. We had the entire afternoon and evening to explore everything from the Singapore Mall, the Gardens by the bay, the Singapore Skywalk as well as the Marina Bay Sands Hotel. In amongst the many highlights of the day was the 15 minute light and water show extravaganza displayed over the water by the Marina Bay. It was such a lovely moment to enjoy the show with the whole group!



Laser Light Show by the Marina Bay

## Thursday 14<sup>th</sup> March 2019 A\*STAR + Botanic Gardens, Newton Hawker centre

The visit on Thursday morning to the Agency for Science, Technology and Research (A\*STAR) was coordinated largely through the help of Dr Janaki Shanmugam, an alumnus of the Oxford Materials Department. A\*STAR is a research institution that drives scientific discovery and technological innovation for commercial applications that ultimately enhance the economy. In this visit, we were shown many of the innovative scientific breakthroughs that have gone on to become commercialised products including a flexible tape that could emit light efficiently to a special stick-on screen that uses lenticular lenses to make images appear 3D without the need for 3D glasses.



Tour Students with Dr Janaki Shanmugam at A\*STAR

However, for us all, the most interesting part of the tour occurred when one of the scientists took us into his lab to show us his work on coloured, non-toxic quantum dots. His explanations of the potential future applications of his research in energy-efficient lighting, solar cells and high-resolution screens work really enabled us to apply and solidify our understanding of Quantum Mechanics. Given the location of A\*STAR, we were able to use public transport to travel to the Botanical Gardens, a UNESCO World Heritage Site. The gardens paled in comparison to the botanical gardens located in Oxford! Whilst there we saw everything from the National Orchid Gardens, to monitor lizards roaming freely within the gardens and the trip culminated in us having a picnic in the sun. On the way back to our hostel, we visited perhaps the most famous hawker centre in Singapore, Newton Hawker Centre. The food centre was bustling with locals and tourists and despite the various meals we decided to have, we all were extremely satisfied.



Tour students enjoying a picnic at the Singapore Botanic Gardens

### **Friday 15<sup>th</sup> March 2019- National University Singapore Visit**

After three consecutive intense days of industrial visits, Friday provided some relief from this intensity in that we had the opportunity to visit the National University of Singapore, specifically meeting a group of Materials Science and Engineering Students. Chong Hon, the president of the Materials Society at NUS pleasantly welcomed us and gave us a tour of their department. It was interesting to note that some of the characterisation equipment in their department came directly from Oxford Instruments!



The party and our Materials Science undergraduate friends at NUS

### **Saturday 16<sup>th</sup> March 2019**

The weekend provided free time for everyone to pursue their own activities and exploration. A large group of us decided to head to Sentosa Island upon the recommendation of the students from NUS. The island included many tourist attractions such as Universal Studios, a Sea World Aquarium, a butterfly park as well as a beach all of which our group had a chance to explore. On the other hand, a smaller more adventure-driven group of us, took a short cruise to Pulau Ubin island where they went on bike rides to tour the scenery of the island. They reported back to the group that their step away from the more tourist style activities really enabled them to gauge a better sense of the beauty of the country.



Sentosa Island with the iconic Merlion statue in the background

### **Sunday 17<sup>th</sup> March 2019**

With Sunday being another free day, and activities included some visiting the 5,000-seater megachurch in Singapore, some heading to the “Wild Wild Wet” water park, some going to Singapore Zoo and some going on a River Cruise and Safari.

### **Monday 18<sup>th</sup> March 2019- Rolls-Royce Visit**

In our final industrial visit, we toured the Rolls-Royce Seletar site that assembles three different types of commercial engine: the Trent 1000, Trent 7000 and Trent 900; combining all stages of the production under one roof in the Seletar Assembly and Test Unit (SATU) building. We were greeted by the external relations manager Anne Benguerba who informed us that unfortunately, we would not be able to view the turbine blade manufacturing warehouse. Nonetheless we were presented the opportunity see the engine construction facility, where they manually assemble all 18000 components of each jet engine, as well as perform tests on completed products. We learnt that in the wide chord fan blade manufacturing facility (FBSG), robots developed in Singapore are used to create hollow titanium fan blades. Additionally, superplastic forming is used to manufacture the wide-chord fan blades, and it was amazing to see this case study taken from the creep lecture series and put into practice.

Collectively, we all found the failure investigation department to be very intriguing, particularly because of its parallels to forensic science! Our tour of this department was led by Dave Nicholls who completed a Masters in Materials Science at the University of Birmingham and worked in the Bristol site before moving to Singapore. He mentioned how parts and components from failure sites would be shipped to the Singapore site for examination. Non-destructive testing would then be used to examine the surface, alongside Scanning Electron Microscopy and Energy-Dispersive X-ray Spectroscopy to determine the microstructure of the sample and thus ascertain a cause of failure. We had learnt about these techniques in our Microstructural Characterisation course, and it was fascinating seeing how they were applied to identify the cause of engine failure.

The evening once again provided everyone with free time to pursue their own activities and many of us used this as an opportunity to see the light and water show by Marina Bay again!

### **Tuesday 19<sup>th</sup> March 2019 Tour Dinner**

To end the trip, we had our tour dinner at upon the recommendation of the friends we had made at NUS at Bayang, a restaurant located in the high-end area of Clarke Quay. Unfortunately, they could not join us since they had a polymers exam the following day. It proved to be a fitting end to a thoroughly enjoyable end tour.



The final tour dinner at Bayang

Feedback from students:

*“For me, the industrial highlight of the tour was understanding the failure investigation department within Rolls-Royce. Dave Nicholls really did a brilliant job at conveying how fun the job can be, so much so that I am inspired to look into this in my career!”*

*“I had never previously visited Asia and this trip has inspired me to travel more in future and consider career opportunities outside of the UK. I am very grateful to have received a grant to facilitate this incredible experience.”*

*“The entire tour was organised so well. It had the perfect balance of industrial visit, group activities and free time. Thank you so much for organising!”*

By

Anthony Akinwale, Student Tour Organiser 2019

