

Growing Diamonds (and other adventures in Deutschland)

I was delighted to get the opportunity to travel to Germany this summer and undertake eight weeks of research in a world-class institute. The project was a great success, and opportunities for sightseeing and learning about the culture were not wasted. With such achievements, I found my summer placement in Erlangen both useful and very enjoyable!

During the eight weeks I spent in Germany, I was working within the *Werkstoffkunde und Technologie der Metalle* (WTM) research group in the *Freiedrich-Alexander Universität Erlangen-Nürnberg* (FAU). My particular research was on the subject of nano-crystalline diamond (NCD) coatings and their development into free-standing foils. Currently used in high friction applications, such as pump bearings, NCD coatings dramatically reduce friction losses and increase the usable life of components. The purpose of growing free-standing films is that they can be joined to substrates that will not normally tolerate the high processing temperatures ($>2200^{\circ}\text{C}$), but may be shaped into complex components more easily. Industrially grown by Hot-Filament Chemical Vapour Deposition (HF-CVD), my project focussed around optimising the growth rate, quality and topology of the NCD coatings. By conceiving and introducing a new coating set-up, and also systematically studying the coating parameters, I improved the coating rate by 350% whilst increasing the homogeneity and maintaining a high quality of NCD.



The CemeCon 800 Coating Machine used to grow NCD foils, owned by the WTM research group, FAU

The independence of being able to conduct my own research was a fantastic experience. Having the chance to explore my own ideas, design my own experiments and develop the project along lines interesting to me, has confirmed my inclination towards a career in research and development. Particularly I enjoyed the hands-on approach to real scientific research; often an experiment doesn't quite go to plan, and it is up to oneself to decide how best to get around this problem – does one assume the results are of sufficient quality anyway, simply repeat the trial or modify the set-up to try and avoid the initial problems? And then, once the data is collected, what's the best way to analyse and interpret it? Are the methods suitable and not excessively time intensive? Is there sufficient evidence to really back up one's claims, or is one simply being over-optimistic; only after debate with other scientists can these questions really be answered and methods justified.

I am delighted with the way in which my placement was organised by the placement coordinators in Erlangen, Dr A. Haase and Jennifer Kohlhage. Despite my assigned supervisor unfortunately having to miss the first half of my placement, a temporary supervisor from the group took charge of me and everything ran smoothly all through my project. The accommodation that had been arranged for me was excellent, and I was delighted to discover that they had arranged a bicycle for me. On loan from a current student, this bike not only allowed me to travel to and from work for free, quickly and at times most suitable to me, but also allowed me the freedom to explore Erlangen and the surrounding countryside independently. Unbeknown to them I love cycling, and getting out into the beautiful countryside in the glorious weather, made for wonderful recreation in the evenings and weekends.

My accommodation was a privately rented 2 bedroom flat, paid for by FAU. I was lucky enough to be sharing the flat with a girl named Conny (her usual flatmate having gone to America for the summer). The week I arrived, Conny was just finishing her final university exams in her quest to become a French teacher. Not only providing very useful advice, but with a bright personality, adeptness at vegetarian cooking, and equally happy to engage in debate and friendly conversation, she made excellent company. I had been learning German during the previous year, but my skill with it, particularly in conversation was not of a great standard; she was sympathetic to my attempts at conversation, and helped increase my confidence and knowledge of the language. Being a language teacher-in-training, she was particularly apt at this, and in return, she was most pleased to be able to reawaken her nine years of schooled English. By the time I came home, having passed her exams, Conny was preparing to start a two year training placement in Munich, and I am sure she will make a fantastic teacher when she is fully qualified.

Outside of work I'm pleased to have been quite culturally active. In addition to attending weekly concerts in the university gardens, I took advantage of the generous bursary I received from the Worshipful Company of Armourers and Brasiers' (not spent on daily travel) and Germany's excellent transport links, and visited as many places as I could. Having seen so much, I wouldn't hope, or even try, to relate everything in this short report. However, I've outlined some of my most prominent memories below to give the Reader a flavour of my travelling experiences.



Nuremberg Castle

In my first weekend, I visited the nearby city of Nuremberg. With delightful medieval architecture, Nuremberg has played a vitally important city in Germany's history since Roman times, though much of this is overshadowed by the city's pivotal role during the early 20th century and the rise of the Nazi Party. Having never studied the background to WWII in depth, I found this an invaluable chance to understand the history of the 20th Century from what turned out to be a relatively unbiased source.

Two visits were made to Munich, the largest city in Bavaria. The first visit gave me a chance to understand Munich's character as a thriving centre, largely rebuilt and reinvigorated after significant war damages; the city has definitely earned its reputation as a fun, tolerant and robust place. The second visit allowed me to combine both personal pleasures and also a sobering opportunity to grasp a part of Germany's darkest hour. With great enjoyment I attended the final day of the *European Juggling Convention* (EJC), a massive week-long event that brought together jugglers, acrobats and proponents of all other circus skills, with the aim of displaying new acts, exchanging ideas and generally being unique in a crowd of like-minded people. Overnight, I stayed in a hostel called 'The Tent' (which is literally what it was); a most novel experience, both very cheap with facilities surpassing expectation, I wish I could have stayed there longer. The following morning, I made the wonderful and completely accidental discovery of the gardens of *Schloss Nymphenberg*. Having mistaken my travel directions, I wandered into them and fell in love. An enchanting mix of woodland and water features in the 'English' style of landscaping that I would base the gardens of my 'dream house' around them. Sadly, I couldn't stay long and made my way to my intended destination: the *Dachau Memorial*. As a former concentration camp, it has been



Night-time fire juggling at EJC 2012

largely preserved and opened to the public, giving the chance to try and understand the terror such camps represented. It was a moving visit and gave me much to think about. Although the memorial works are well planned and I now have a better comprehension of the conditions suffered by the inmates, I found it was impossible to truly appreciate what life there must have been like.

Near the end of my placement I took a three day trip to Berlin, a city steeped in history and historical significance. It was an informative trip, with much sightseeing and many chances to further enhance my knowledge of the culture and history, but I found Berlin more difficult to engage with than any other city I visited. This was a shame, as many times it was recommended that I visit the city, but it didn't appeal to me as a whole. The mid – late 20th century history of the city is largely iconic in the memories of many as a symbol of the Cold War, and there are pertinent reminders of the occupation across the city. That said, I was pleasantly surprised to find how unified and cohesive the city is today after its decades of segregation – the centre bears very few scars of the four decade division. On my final day in Berlin, I visited the town of Potsdam; in the years of the German Kaisers, palaces in Potsdam served the same purpose as Versailles in France – a retreat for the Royals, away from the bustle and disease of the city, and now the grand buildings are open to the public, and made for a very interesting, though brief, tour.

At the end of my stay, I managed to squeeze in an afternoon visit to the city of Bamberg, a UNESCO World Heritage Site. The city is full of winding streets, with charming baroque architecture and painted artwork round every corner making it delightful to explore. My visit



UNESCO city of Bamberg with baroque housing

coincided with the Sandkerwa festival, Bamberg's largest beer festival, in a city famed for its wide selection of excellent breweries. A most enjoyable time was had as the day light began to fade, drinking a German speciality, Spezi, while watching an open air jazz concert beneath the Cathedral walls.

I consider myself to have been very lucky in having the chance to work in Erlangen this summer. Placement-wise, I got to work with the enthusiastic, friendly and helpful team of WTM, leading to the successful completion of an interesting and useful project. The experience confirmed that I would like to continue in Materials Science research once I have graduated next year. On top of the work, I had the opportunity to explore and learn more about the culture, language, and history of a country I realise now I previously knew very little about, and had had no particular desire to visit. Without this placement I might well have never chosen to visit, and would have never learnt what a truly wonderful country Germany is.

Hopefully the Reader will recognise how much I enjoyed the experience, for which I owe a great deal of thanks to many people; the Department of MSM, Cambridge University, for arranging the placement; the Worshipful Company of Armourers and Brasiers' and Robinson College, Cambridge for providing the generous bursaries; the department of WTM, FAU, for running the placement and especially Dr A. Haase, Jennifer Kohlhage, Prof. Dr. R. Singer, Dr. S. Rosiwal, Dipl. J. Fecher, Dipl. M. Lodes and all those I was lucky enough to work with; and lastly to Conny for putting up with my poor German!

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