

Max-Planck-Institut für Eisenforschung, Düsseldorf, Germany

Non-Technical Report

CaMPUS Scheme, 2019

Noah Milton, Queens' College

During the summer between completing my third and fourth year of studying, I was offered the opportunity to spend two months working in a European research facility via the CaMPUS scheme. Considering the paths I could take after university, I was excited by the opportunity to gain experience in a research institute as well as the opportunity to spend a summer living and working in another country. The Max-Planck Institut für Eisenforschung (MPIE, or 'Max Planck Institute for Iron Research') stood out to me, especially after having visited other regions of Germany for holidays and enjoying the culture. I had heard good things from previous CaMPUS students about Düsseldorf which further attracted me.



Collecting liquid nitrogen at the institute for use in cooling an electrical stage.

My research project, titled 'Macroscale Electrical Characterisation of Single Grain Boundaries in Bulk Material' was part of a much larger project in the 'SN' department (Structure and Nano-/Micromechanics) which aims to correlate the state and properties of grain boundaries. This larger project is in an emerging field, which may enable a new level of materials' design that allows tailoring of functional materials useful in applications like micro-/nanoelectronics. The aim of my project was to measure the electrical properties of a single grain boundary. These values are very small and so were only measured for the first time very recently, at MPIE; I was to check the results using a new piece of equipment and then investigate the temperature dependence of the electrical properties. Since the equipment was fairly new, I developed a measurement method which can be used in the future by my supervisor to measure such small values. My work involved the use of scanning electron microscopy (SEM), electron backscattered diffraction (EBSD)

analysis, confocal microscopy, electrical equipment and this new device involving cooling samples using liquid nitrogen and heating to over 400°C. In addition to this main project, additional work with my supervisor involved the use of physical vapour deposition (PVD), to deposit thin films on samples, and focussed ion beam milling (FIB). I spent a significant amount of time performing accurate calibration measurements (necessary for the use of a new device) and compiled documents to help people using this device in the future.

In order to ensure everybody in the department was aware of each other's projects, weekly seminars were held which gave the opportunity for two people to present their work. Although slightly nervous before, I enjoyed presenting my progress to my colleagues and answering their questions about the project. Occasional presentations from guest speakers on a wide range of topics were very interesting and gave me some insight into further research areas in materials science. In addition to my work at the MPIE, I was able

to help my supervisor in my spare time with some proofreading and language alterations for a research review, recently accepted for publishing.

Having only studied German for two years early in my secondary school, I knew I might struggle communicating with everyone in Düsseldorf, but I was excited to meet new people and experience a new environment. The MPIE is largely international, with researchers in my department from countries including Italy, Iran, Israel, Mexico, Kazakhstan, India and China, to name a few! As a result, English is spoken well by everybody, which made the institute very welcoming. I especially enjoyed working in such an international department since many people would introduce parts of their own culture – typically in the form of food from home (Indian ‘Soan papdi’ and Korean sweets being amongst my favourites). Keen to promote some typically British food, I baked scones and brought English tea and Devonshire clotted cream to let everybody make their own traditional cream tea (cream before jam, of course).



Smiles all-round sampling the cream tea; some concentrating faces as colleagues took care in applying cream before jam.

There were several social events, a group go-karting trip, the monthly ‘BB’ (Boardgames and Beer) night and various BBQs, organised by the PhD students. They ensured we felt welcomed and provided some fun things to do in the evenings. We were fortunate to have Düsseldorf Summer Festival of Art for a week or so, which involved a number of art styles, including free music gigs.

Coming from rural Devon, I was keen to make the most of the transport links in Düsseldorf. The airport is very near to the city and proved to be very convenient; weekend trips included one to a cousin’s wedding in the south west of France and a weekend in London at a music festival. Via a local car-pool system, I was able to visit Amsterdam for only €50, where I visited a Dutch friend and watched the Amsterdam Pride parade.



Amsterdam Pride festival

The surrounding areas of Düsseldorf are filled with lots to do and see too; a ‘Department day out’ to the town of Kaiserswerth, an old shipping-tax town was interesting and a great way to get to know people from the department. Cologne is only a short train-trip away and so a visit to one of Germany’s most popular tourist attractions, Cologne Cathedral, as well as the rest of the city, was a fun way to spend a Saturday when a friend came to visit. Other places I visited around Düsseldorf included Benrath Schloß, a Baroque-style summer residence, and ‘Unterbacher See’, a large lake with beaches, paddleboards and a high ropes’ course. With several friends and family coming to visit over the summer, I was happy to have exciting things to show them. This included a ‘Gourmet food festival’ and the ‘Biggest funfair on the Rhine’: a free-of-charge fairground with around 4 million visitors over its nine-day duration and that culminated with a twenty-five-minute firework display, as well as the numerous ‘brewhouses’, famous for their local beer ‘Altbier’, in Düsseldorf old town. In the local football stadium ‘Merkur Spiel-Arena’, I was fortunate to watch the famous Borussia Dortmund vs KFC Uerdingen, a much smaller team based just outside of Düsseldorf.

I was able to source a bicycle via 'eBay local' which provided me a cheap and fun method for commuting the short distance to work each morning. This also allowed me to explore more of the city, cycling to some attractions towards the outskirts of the city like the Japanese gardens and to make the most of being near such a beautiful river during the summertime, as most locals do on their weekends. A ninety-kilometre cycling trip took me to Cologne and back, whilst viewing some more rural regions and villages along the way.

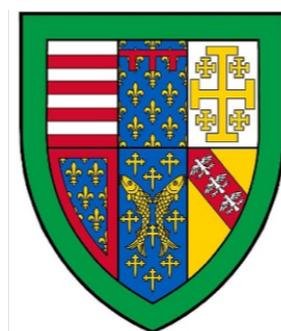


The Düsseldorf Japanese Gardens, a short cycle outside of town.

My time in Düsseldorf exceeded my expectations for the summer; I really enjoyed being able to dedicate myself to the research project and found the work more interesting than I had imagined. I was exposed to many fields in materials' science through seminars and presentations from others at the Institute, really broadening my knowledge about materials' research. Those working in the Institute were extremely welcoming and made my time even more enjoyable. They were very helpful and aided my learning of research practices, including the use of equipment and scientific analysis. My expectations about a research career have been changed for the better by this placement and I am very grateful for the opportunity to complete this internship. I should like to thank the Worshipful Company of Armourers and Brasiers, as well as Queens' College, for their generous support which allowed me to fulfil this placement. Their financial support enabled me to feel welcome in a foreign country and to really make the most of this unique opportunity.



ARMOURERS &
BRASIERS' COMPANY



QUEENS' COLLEGE,
CAMBRIDGE



**UNIVERSITY OF
CAMBRIDGE**

Department of Materials
Science and Metallurgy



MAX-PLANCK-INSTITUT FÜR EISENFORSCHUNG