

# Max-Planck Institute for Iron Research

Düsseldorf, Germany

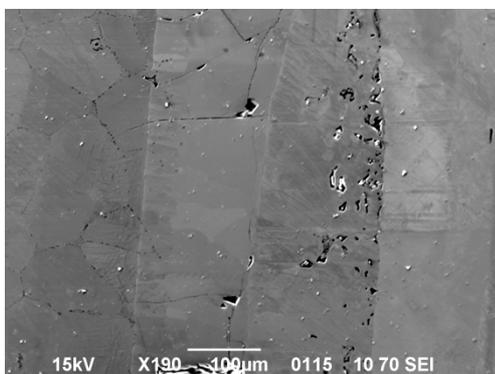
Non-Technical Report

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Before going into my final year as an undergraduate student I was given the opportunity to do a research placement at a European institute through the CAMPUS scheme. My decision was made after getting advice from a student at my college who had done a placement at the same institute a year previously: The Max-Planck Institute in Düsseldorf would be my first choice, with an interesting project and a beautiful city in Germany, a country I had always wanted to explore. Another reason for choosing MPIE was that there were 2 places, so I knew I would not be alone from Cambridge.

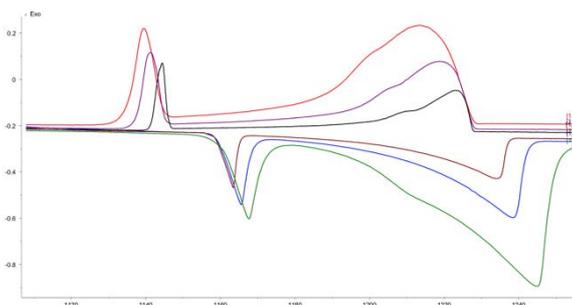
After reading some of the previous CAMPUS reports I thought I knew what to expect when it came to working in a research environment. However, I didn't appreciate this until I actually spent my time at the institute. I experienced delays and practical difficulties, but also an extremely friendly working environment and a sense of satisfaction when weeks of hard work paid off with results.



*A micrograph of the diffusion couple that I took line profiles of. The 4 phases are visible*

My research project was titled 'experimental investigations of phase relations in Co-rich Co-Ti alloys'. Essentially, I was checking the accuracy of literature phase diagrams for the Co-Ti system as there are not many and they are often inconsistent or incorrect. This binary system exhibits Laves phases, which are close-packed brittle  $AB_2$  phases, and my investigation was particularly focused around the cubic and hexagonal Laves phases in this system to see if a two-phase region existed between the phases.

After a slow first week in which much of the time was spent reading up on past literature and being given introductions on the scanning electron microscope (SEM) and metallography labs, I began my work on my project. I prepared diffusion couples of single phase alloys to take line profiles of composition at the interface using energy dispersive X-ray spectroscopy (EDS) and also used this to verify the compositions of various samples that had been cast, which I prepared by mechanical grinding and polishing. Under normal circumstances, electron probe microanalysis (EPMA) would have been used to measure



*An example of DSC curves that I analysed*

compositional data of this precision but due to the logistical problem of the technician being away on holiday I had to calibrate my EDS data against some previous EPMA data to obtain higher accuracy. I also analysed X-ray diffraction (XRD) spectra to observe the phases present before and after heat treatment. Finally, I used differential scanning calorimetry (DSC) to verify reaction temperatures on the phase diagrams.

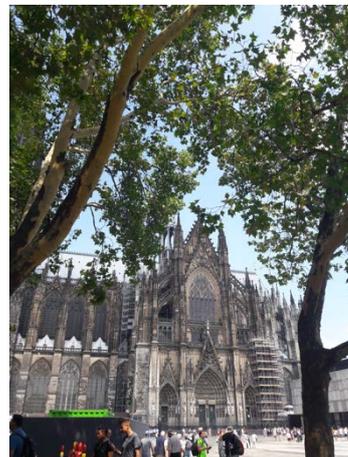
I spent a lot of time in the metallography lab and struggled initially with lots of small samples to work with, but one of the PhD students who was undertaking a very similar project was happy to show me a workaround. I greatly improved my SEM skills and learned a variety of new techniques whilst also being able to understand why certain methods were used in favour of others.

The majority of people at the institute were PhD students or postdocs so initially I felt slightly out of place, being the only one without having completed my degree! But attending the weekly seminars on people's progress and having lunch alongside everyone else showed me that didn't matter and most people had limited knowledge of the specialisms in other people's fields. Everyone was extremely helpful if I didn't quite understand something straight away and my supervisor gave me access to all the literature I would need upon arriving at the institute.

The people at the institute were from all over the world, coming from Spain, China, India, Japan, Iran and many more. The common language in the office was English, which made things very straightforward. Studying German at A level meant I was able to communicate with technicians, many of whom didn't speak very good English. It also helped in shops and restaurants, although it was not essential to have knowledge of the language before coming.



*At the highest point in the Netherlands with Chris*



*Cologne cathedral*

Having spent the previous summer commuting to London for over an hour every day meant that I wasn't keen on repeating that so I looked for accommodation close to the institute and found a one-bedroom apartment within walking distance of the institute. It took me less than 15 minutes by tram to get to the 'Altstadt' (old town) and the main train station where I could travel to other cities. We were very fortunate with great weather throughout the two months.

With Düsseldorf having great travel links, Chris (the other student from Cambridge) and I spent our weekends travelling to cities in the surrounding area such as Cologne, Aachen and Dortmund, and even Maastricht in the Netherlands. We managed to get tickets to see Borussia Mönchengladbach's opening Bundesliga match against Bayer Leverkusen in August and I also visited the legendary Signal Iduna Park to watch Borussia Dortmund against RB Leipzig. If we didn't have any travel plans during the weekends there was always something going on in Düsseldorf, with the annual French festival, Rheinkirmes (giant funfair), the World Cup Final and other parades all taking place during our visit.



*Borussia Dortmund vs RB Leipzig at the Signal Iduna Park*

Moving away for a two-month university term isn't too big a change for most – home is not too far away and you can speak the language. Living abroad is a whole new experience, one which I cannot recommend enough. I gained a deeper insight into the world of research and experienced the rich German culture, greatly improving my spoken German. I am grateful to the Worshipful Company of Armourers and Brasiers and St Catharine's College for their generous support and the Department of Materials Science for providing me with this phenomenal opportunity to work at such a prestigious institute.