MY TIME AT ESI

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BEFORE arriving to Leoben, I was both afraid and excited. I enjoyed the materials science course, especially the parts involving mechanics of materials, which is why I decided to visit ESI in the first place. However, my German skills have laid dormant since high school, and I would be working with PhDs and postdocs, which was slightly scary for someone who has just finished his 2nd year.

My fears completely disintegrated the moment I set foot in the institute. I was greeted by Daniel Kiener, the head of the research group, and Nadine, a PhD student I would be working with. They showed me the office, which I would share with four other people (3 PhD students and one postdoc), all of whom were very friendly and immediately made me feel welcome. Over the next few days, I got to meet other people at the institute and was given my first research tasks to do.

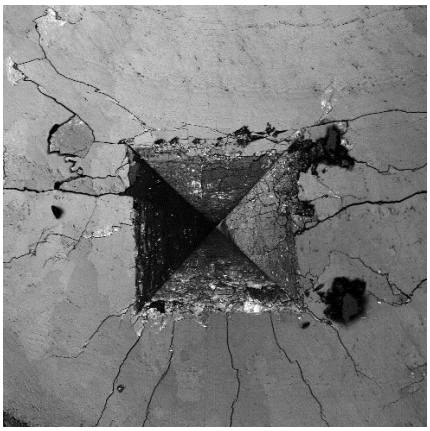
The main research project I was working on was *ex situ* nanoindentation of HPT deformed NbTiZr alloys. That is a mouthful, but the concept is in fact quite simple. They had already prepared several specimens of these alloys, with different compositions and subjected to different heat treatments, and wanted to study how their mechanical properties are affected. HPT, or high-pressure torsion, is a method of producing materials with extremely fine grain sizes, which gives them both enhanced strength and toughness. Nanoindentation is a method commonly used to study mechanical properties. While usually done *in situ* (i.e., inside an SEM), the research group was interested in doing the experiments outside of an SEM, which should in principle be much easier. However, it required a specialised setup that had to be built in-house (and involved some very expensive equipment, so I was slightly afraid of breaking it). Due to several delays, I was only able to fully start working on this project in the beginning of August – though I have at least been reading nanoindentation literature in July.

Is this an SEM or a Star Trek *prop?*

Until that time, I was given several smaller projects by my fellow coworkers. In fact, I very much enjoyed that opportunity, since it gave me experience with many more experimental methods than a single project would. Thus, I worked on measuring the microhardness of tungsten wires, analysing a different nanoindentation experiment involving solder and looking at the mechanical properties of kidney stones. For the last project, I was even asked to summarize my results in a small presentation.

While I was shown many tools and techniques throughout my time in Austria, a few core ones were used over and over in multiple projects. For example, I have spent a lot of time on a scanning laser confocal microscope, which is an optical microscope that can also measure surface profiles with high resolution (and much more quickly than other techniques like AFM) – it is indeed an amazing instrument! I also did quite a bit of specimen preparation involving grinding and polishing – the practicals at Cambridge have prepared me well for that, but I was shown some more advanced techniques. An especially tricky case was polishing the NbTiZr alloys – it took us two days to get it right!

Our ex situ *nanoindentation setup.*



An indent in a kidney stone showing brittle fracture.

However, the majority of my time was spent not doing experiments but analysing data. It turned out that most people in the office were using Python to do data analysis. That was lucky, since I had known a bit of Python programming before I arrived – but by the end of August, I have learned a whole host of new skills. I also learned to work with the software Gwyddion, which is used to analyse the output images from the scanning confocal microscope.

Due to the late start of the nanoindentation project, I was not able to measure all the specimens. However, it turned out that the measurement was the easy part – one just had to press a button and wait for a few hours. The difficult part was analysing the resulting data. My work in August has thus been mainly focused on writing a graphical user interface in Python to help with the data analysis. By the end, I had a working application that automated most of the process and that other people could continue using. In the final week, I delivered a presentation at the institute where I summarized what I achieved during the two months across all the projects.

Outside of research, I spent my time travelling around Austria and socialising with my colleagues. I visited most of the larger cities in the country – Vienna, Graz, and Linz, and I also went hiking in the Alps. It also turned out that the Italian city of Venice is not that far from Leoben – so when my girlfriend visited me, we decided to travel by a night train and spend a day there, which we thoroughly enjoyed.

Even though Leoben is a small city (I found it refreshing compared to the tourist-overflowing Cambridge), it still has its share of good restaurants, which we visited with colleagues. We often had *Frittatensuppe* for lunch (which I was able to order in German) and went to get tapas for dinner a few times. And every Thursday, it was a custom at ESI that they would cook pasta together for lunch in the kitchen – one of the things that made me feel welcome very quickly.

The amazing sight of Grüner See.

In conclusion, I thoroughly enjoyed my time in Austria, both the research and the leisure side. I got to learn a lot not only about micromechanics, but also about many experimental and data analysis techniques. My German skills also improved, up to the point where I could arrange something at the city hall by myself. I felt welcome at the institute, thanks to the friendly atmosphere and being treated like any other member of the team – for example, even though all my coworkers were older and much more knowledgeable than I was, they still asked for my opinion and even wanted me to review their manuscripts sometimes.

I would like to use this opportunity to thank the Worshipful Company of Armourers and Braziers for their generous support, which allowed me to embark on this engaging experience. I have learned a lot about materials science over the summer and am looking forward to learning more.