
NON-TECHNICAL A&B REPORT: EMPA, THUN

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I chose to apply for a CaMPUS European placement to allow me to make a more informed decision about whether to continue my studies beyond the four-year undergrad course in Materials Science. Studying in Europe provided an exciting alternative to spending another two months in a Cambridge placement, and I was excited to pick up some language skills along the way. My selection criteria were simple. First, narrow down the options by finding the topics I was most interested in. Second, type the location into Google images and go from there. My decision to apply for Thun, in Switzerland, turned out to be an easy one. Tall looming mountains, diving steeply into a clear turquoise lake bordered by a castle laden town were more than enough to make me excited.

So, in early July, I found myself at Thun train station, in the heart of Switzerland and the beautiful Bernese Alps, met by torrential rain and fog. Not a great start. I was glad I had taken my supervisor's advice of buying a decent rain jacket. Remaining naively optimistic about the prospect of spending 10 weeks alone in a foreign country with little knowledge of the niche local language (a heavy dialect of Swiss German), I was kindly met by my supervisor, Aidan, and we caught a bus to the apartment I was sharing with another EMPA employee, Lex, to have lunch. Promises of mountain views through the dense clouds were soon met, and with the balmy weather that followed for the next two months, I soon discovered one of the most beautiful places I have ever been.

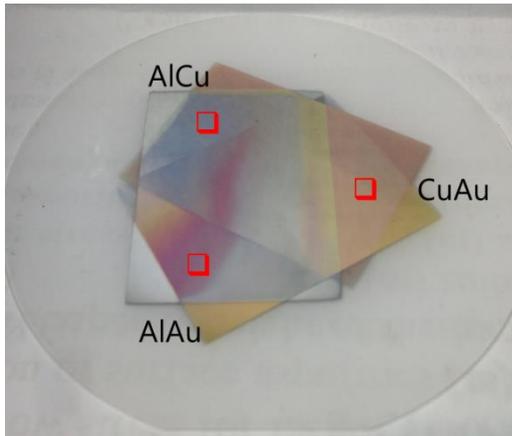
EMPA is the Swiss federal laboratory for materials and technology research, based Dübendorf with smaller offices in St. Gallen and Thun, where I was stationed. They work closely with Swiss companies, with most projects funded in part by the government in order to promote Swiss industry, meaning much of the research being done was directly applicable to the real world. Many of my colleagues were working on projects developing cutting edge Swiss watch components, and indeed my project was inspired by a company project trying to grow low-temperature diamond coatings on temperature sensitive materials for use in a watch. I have always flirted with the idea of switching to engineering for its obvious applicability and sense of purpose when doing projects, so working in a lab where most of the research involved mechanical testing of materials for use in industry was a great experience.

Having never worked in a research environment, I wasn't sure what to expect. I was taken perhaps by surprise to find that everyone I met was extremely welcoming, social and incredibly active. Within the first two days of arriving, accompanied by my host Lex, I had explored the entirety of Thun, hiked up the nearby Niederhorn mountain to find breath-taking views of the surrounding area and was invited to drinks at a classic cocktail bar by my supervisor, Aidan, and my future colleagues. With only around 50 people in the office it wasn't long before I knew almost everyone. The friendly atmosphere at the office extended beyond working hours, and there was never a weekend when people weren't organising a bbq by the lake, floating down the River Aare to Bern on an inflatable raft or venturing on extreme hikes and road biking trips.

The project I inherited over summer was on the adhesion of thin films. My supervisor had been working closely with a company that wanted to grow diamond coatings at low temperatures (around



Daily views of Niesen and Lake Thun from Thun centre. The weather stayed like this almost the entire time!



The sample I was working on with its many colours corresponding to the different phases. There are 900 tiny indents on the surface.

300°C). However, the coatings that were grown under these conditions did not stick very well to the material on which they were grown. A common way to improve the adhesion of thin films is to include an intermediate ‘adhesion layer’ that acts in a similar way to a glue by adhering better to both the film and substrate. The choice of adhesion layer is rarely obvious, and direct testing of different compositions must be done to optimise the adhesion of the film. This can be a time consuming process, requiring tests on many different samples for a given film/adhesion layer/substrate system.

wedges of three different elements at 120° to each other, areas of single element, binary and ternary systems were created on a single sample. We could then locally test the adhesion of each composition by using nanoindentation to create a tiny circular delamination called a ‘blister’, about 10 times smaller than the width of a human hair. By comparing the diameter of the blisters across the sample, we could locate the composition which gave the best adhesion. Coatings are widely used to improve the surface properties of a material, meaning this method can be applied whenever film/substrate adhesion is poor, particularly in industry and engineering when the integrity of the coating is of greater priority than a knowledge of the peculiar chemistries of the interfaces.

The title of the project was “Interfacial Adhesion Investigation of Combinatorial Ternary FCC Alloy Adhesion Layers using Nanoindentation”. More simply, we were developing a method to test many different adhesion layer compositions on a single sample in an efficient and comparative manner. By depositing thickness-varying

In science, it’s very rare that you know exactly what to do and in which direction your project is heading – it often involves considerable preliminary testing and stabbing around in the dark before you find a promising route to investigate further. I was fortunate to adopt a fairly well-defined project, and my role was to try to finish the bulk of the work so that we could publish in the near future, the main part of which was indenting, measuring and manually inputting data into excel for 900 indents. Although parts of the project were repetitive, my supervisor gave me generous responsibility to decide how to carry out many of the tasks required to complete the project, which I found very rewarding. While this independence gave me a fantastic taste of life as an experimentalist, overcoming problems as they presented themselves, there was always excellent and enthusiastic support given when I needed it, not only from my supervisor but from other post docs and PhD students too. Indeed, I got the opportunity to receive training on various machines, and my constant questions were always met with constructive replies, no matter how obvious they may have been.

Although I spent some time refreshing my German using online websites such as Douingo, my language skills didn’t improve as much as I had hoped. The local language was a Swiss dialect of German making it hard to develop my basic knowledge, and at EMPA I was surrounded by a huge number of nationalities, including Swiss, German, French, Italian, Polish, Hungarian, Russian, Brazilian, Japanese, Indian, American and English, meaning the spoken language at work was English. Nevertheless, my stay has made me excited to learn German next year as part of our third year language option, particularly after seeing the prevalence of German in science and industry.

Outside of work, I took full advantage of living in the Alps. Both my host and my supervisor were incredibly active



Enjoying hiking around the Oeschinensee near Kandersteg, just a 45 minute drive from work!

people, and I received endless advice on where to explore during the weekends. I borrowed a road bike and joined them on stunning bike rides with gruelling climbs and exhilarating descents. I went hiking up nearby mountains with colleagues, discovering azure alpine lakes and monumental glaciers. During one weekend, we travelled to Lausanne and spent the day swimming, sunbathing and playing beach volleyball beside Lake Geneva, surrounded by snow-capped peaks, after which we went to the famous Montreux jazz festival. Perhaps the highlight of my stay was going paragliding in the valley of Lauterbrunnen alongside steep valley cliffs and enormous waterfalls. Switzerland is a jaw-droppingly beautiful place, and I would highly recommend visiting the Alps during summer.



A picture taken by a paraglider of me paragliding (top red and white chute) in the Lauterbrunnen Valley. Paragliding-ception.

I had an amazing summer, not only developing invaluable scientific skills, but also enjoying the opportunity to explore an incredible part of the world and live independently in a foreign country for 10 weeks. Although I'm still unsure whether I will do a PhD, my summer has given me invaluable experience to draw upon when the time to decide arrives. I would like to thank the Worshipful Company of Armourers and Brasiers for their continued support, without which none of this would be possible, Christ's College and everyone at EMPA, including my supervisor Dr. Aidan Taylor and his colleague Dr. Rachel Schoepner for their support and guidance, my host Dr. Lex Pillatsch for putting up with me, and Dr. Ivo Utke for organising my placement. I hope to stay in contact with the friends that I have made during my stay, and I will definitely be returning to Switzerland in the near future.