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European Vacation Placement Report

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I was made aware of the European Vacation placements scheme in my first year of university, and thought then that it sounded like a marvellous opportunity. The prospect that I could get help in arranging a summer research project at one of several large institutions involved in cutting-edge materials research had not occurred to me. The fact that these institutions were all located in very attractive parts of continental Europe made it even more appealing, as it opened up the possibility of broadening my cultural horizons as well as my academic ones.

I decided I would wait a year before applying for a placement, as I felt a greater starting knowledge would allow me to gain more from the experience. Having studied French at school for many years I was keen for a placement somewhere that would allow me to use this. I was fortunate to be given a placement in Thun, Switzerland, as though in the German-speaking region, it was close enough to the French-speaking side that I could still fall back on my French if my basic German let me down in shops. Helpfully it was not necessary to know any language other than English while working at EMPA, the Swiss Federal Research Lab whose department in Thun I was working at, as it was a common language for everyone working there. I came across people of 12 different nationalities during my time there, ranging from Swedish to Australian to Japanese. Doubtless I would have come across others had I stayed longer.

My previous experience of laboratories having been confined to teaching labs, I wasn’t quite sure what to expect from a research lab. All I had to go on was snatched glances through doors in the department, and my Director of Studies telling me it was (unsurprisingly) very different to a teaching lab. On arrival I quickly realised I had nothing to worry about though, as I was quickly made to feel welcome – within an hour I was added to the ‘Frisbee’ email list (one lunchtime a week the department would go and play frisbee and football on a nearby sports pitch). As it was such a cosmopolitan department that was used to visiting students and researchers I was able to settle in quickly.

EMPA itself is quite a large institution, based in Dübendorf, with two satellite sites at St Gallen and Thun, the latter being where I was working for the summer. Overall it carries out research in many different areas of materials science, and works closely with industry to gain direction. The site in Thun concentrates mainly on nanostructuring of metals and nanomechanics. These were not things I had come across before, but I was provided with various papers and reviews to read to get me up to speed on what I needed to know. The main process I would be using was focused electron beam induced deposition (FEBID). This process has been around in a basic form for about 40 years, but systematic investigation of it only started around 20 years ago. It involves using an electron beam to
dissociate a gas introduced inside a vacuum chamber, after it has adsorbed onto the surface of a substrate. The broken up pieces of gas molecules form new bonds to each other creating a network which is no longer able to leave the surface. In this way material can be built up on the surface of a substrate as required. Ion beams can also be used in place of electron beams for deposition (FIBID).

As electron and ion beams can be focused to diameters of less than 10nm, this provides a useful tool for locally altering structures on a nanometre length scale. This has potential uses in the integrated circuit industry, for making or repairing the photolithography masks currently used for patterning the surface of the silicon wafers, and also in microscopy, for shaping scanning probe tips, which allow sub-nanometre resolution of surface features.

The title I had been given for my project was ‘SEM integrated compression of FEB and FIB deposited pillars’ (SEM = scanning electron microscope, FEB = focused electron beam, FIB = focused ion beam). I produced pillars ~3μm high by 1μm wide by FIBID and FEBID using different starting gases, and also by milling (essentially carving) pillars out of bulk metal samples using an ion beam. These samples were then compressed to determine their yield stress and elastic modulus. The size of the pillars meant that a SEM was required to image them clearly, as an optical microscope could not resolve enough detail on them. The microindenter used to compress the pillars was also mounted inside a SEM to allow accurate positioning of the indenter tip. This also meant that videos of the compression could be recorded, providing more information about the deformation process.

It was found that the deposited pillars had much higher compressive yield stresses than the bulk metal pillars in this study. The elastic moduli of the deposits were lower than those of the bulk metals though. No other compressive studies of FIB or FEB deposits could be found in literature with which to compare these results, so it is believed that these were the first of such tests.

I feel I gained an awful lot from this placement. I know a great deal more about Switzerland and its culture, from sightseeing locally and from speaking to my Swiss flat-mate, Urs. I also made friends and picked up some Swiss-German words and phrases. The experience of working in a research lab was the most important one though. Aside from learning how to use the equipment, I have a better feeling for the atmosphere and work ethos of the place. What surprised me was that your position in the social hierarchy seemed to depend more on how long you’d worked there than on whether you were a PhD student or a Post-Doc, as this affected how good you were at fixing the equipment! I was also pleasantly surprised (and slightly nervous, I must admit) when I realised how much they were expecting me to do on my own. My only wish now is that I’d had a bit more time, as it was in the final few weeks that I felt I’d finally got the hang of things, although everyone I mentioned this to at EMPA told me it was always like that no matter how long you stay!

I had considered a career in research before, but only as part of a list of things I could do when I have to leave university. All the things on the list seemed more like abstract concepts than genuine possibilities, but having spent my summer at EMPA I could actually imagine myself doing that on a long term basis. I wouldn’t be afraid to look abroad for a PhD or Post-Doc (if I get there) either; now I know the wider world isn’t that inhospitable.

I would like to thank the Armourers & Brasiers for their support of my placement, as without their financial assistance my time in Switzerland would have been considerably more difficult, and may not even have taken place at all.