# PRAKTIKUM: FFG PRAKTIKUM / SOMMER 2020

## bei: Forschungsinstitut für Textilchemie und Textilphysik
## Von Laura Dür aus Bildstein

## 1. MEIN PRAKTIKUM

My internship consisted of four weeks working in Dornbirn at the Research Institute for Textile Chemistry and Textile Physics and attending the Summerschool in Innsbruck for one week, where I got an insight into several MINT – subjects (Figure 1).

*Figure 1. Me measuring the pH during my internship*

My internship was about development on conductive textiles focusing on the construction of copper coatings on textiles, and the production of textile-based electrodes made of carbon. While the preparation of conductive coatings aims on the production of smart textiles and wearables, the production of textile-based electrode focuses on the development of energy storage media. Developments in this area are future-oriented since conductive textiles, and electrochemical energy storage devices are becoming popular in daily life products, such as sensors for healthcare and protective clothing, mobile phones and laptops. The work done during the internship helps to understand deposition processes of copper on various textile materials, and also gave me an insight in developments on textiles, conductive materials, energy storage and textile chemistry.

## 2. ORGANISATION UND BETREUUNG

My internship at the Research Institute for Textile Chemistry and Textile Physics was managed by Univ.-Prof. Dr. Tung Pham, Dr. Avinash Manian, Dr. Noemí Aguiló-Aguayo, and MSc. Justus Landsiedel. Dr. Noemí Aguiló-Aguayo supervised me throughout the four-week program and explained me all questions concerning my project (Figure 3). She introduced me into the work in chemical laboratories and taught me how to work with testing equipment and how to analyze the data generated during the experiments. Whenever a new process was started, she explained it in an easy understandable way and was willing to go more in detail if I asked her. Furthermore, she explained me why the projects I was working on, are important for future development in science and what impact the results could have. A PhD student from the Research Institute, MSc. Justus Landsiedel, also supported me in the lab activities and help me whenever I needed.

*Figure 2. From left to right: Me, Julia (a girl also attending an internship), Dr. Noemí Aguiló-Aguayo, Dr. Avinash Manian*

The Research Institute for Textile Chemistry and Textile Physics was founded in 1982 and is located in Dornbirn/Vorarlberg, where an important part of the Austrian textile industry is based at. The institute is part of the University of Innsbruck and was founded from the Ministry of Science and Research and the ministry of Education and Art. Since 1989 the institute is settled down in the building of the HTL-Dornbirn (Figure 3).

*Figure 3. Main building of the Institute/HTL Dornbirn*

2018 the Institute of Textile Chemistry and Textile Physics got an additional building at the Rundfunkplatz 4 (Figure 4). The buildings are about 500 meters away from each other, so changing the buildings by foot is quite possible. All in all, the two buildings have an area about 1500m$^2$ where the scientists have access to a lot of devices and instruments. Since 1998 Univ.-Prof. Dr. Bechtold has been the head of the institute until 2018, as Univ.-Prof. Dr. Tung Pham took over. The former head Univ.-Prof. Dr. Thomas Bechtold is still working here.

*Figure 4. New building at the Rundfunkplatz 4*

The institute is specialized about the research of textile chemistry and textile physics, but also different parts of engineering and materials science are important. The research areas include technical textiles, textile composites, polymer materials, electrochemistry, as well as developments in the area of electronic textiles. I engaged in the research field of electrochemistry and electronic textiles.

After the internship I spent one week attending the "Summerschool MINT" in Innsbruck. This is an only girls summer school (Figure 5), with the aim to give them a broad insight into the various technical and scientific studies which include pharmacies, chemistry, different kinds of physics and biology, geology, engineering, mathematics, informatics, electronics and mechatronics. The "Summerschool – MINT" was attended by 19 girls from different places of Austria, Southern Tyrol and Germany. Ulrike Pfeiffenberger and Doris Stetter organized the program and coordinated all

*Figure 5: The girls attending the Summerschool MINT*

the seminars, presentations and excursions we had during the week as well as the stay at the Kolpinghaus in Innsbruck for all girls not living in Tyrol.

The Leopold-Franzens-University was founded in 1669 by the Emperor Leopold I. and is the most important University in west Austria. 52,7% of the 27,095 of the students studying there in the winter semester 2019/2020 were women.

*Figure 6. Campus technic of the university of Innsbruck*

Even though there are more female then male students the number of women attending a scientific study is very low and everyone working at the university wants to see more girls attending a scientific or technical study. We were attending seminars in the main building of the University and at the Campus of Chemistry and Biomedicine but we spent most of the time at the Campus Technik (Figure 6) which is a little bit outside the city.

## 3. PROJEKT UND TÄTIGKEITEN IM PRAKTIKUM

My internship at the Research Institute for Textile Chemistry and Textile Physics took place from the 13$^{th}$ of July to the 7$^{th}$ of August. I had to work for 40 hours per week, including extra hours and holidays, starting at 08:00 in the morning until 16:00 in the afternoon. I had a 30 min lunch break at around noon, which I mostly spend with the other researchers at the institute, talking about since and life.

Two times I attended a lecture, which is held by a scientist from the institute who is talking about his current work and its latest development. It was very interesting for me to get an insight in some of the current work of the institute. After the scientist has explained his project the other scientists attending this lecture asked questions or gave some advices. These discussions were followed by an update about organization matters or safety issues through Dr. Tung Pham.

The main time of the internship I spent working on the development of conductive textiles. The internship was split in two main areas: (a) imparting non-conductive textile materials with electrical conductivity and simultaneous coloration by structural coloration, and (b) improvement of textile-based electrodes for the construction of lithium-ion and redox-flow batteries. At the end I had to write a short report about my work at the institute and gave it to Dr. Tung Pham.

The work on imparting textiles with electrical conductivity included multiple deposition steps and the characterization of the materials before and after the deposition. The characterization of the surfaces was performed by optical microscopy and confocal laser scanning microscopy (Figure 7. Confocal laser scanning color). Afterwards I had to collect the captured images and compared them in a word file.

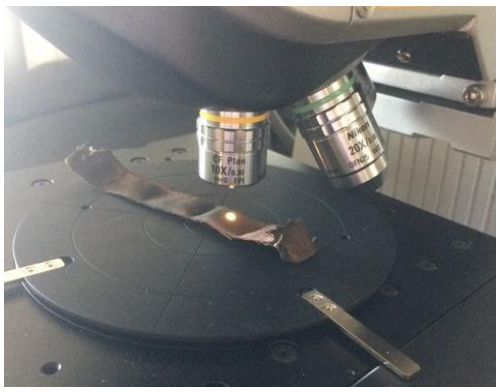


*Figure 7. Confocal laser scanning color microscope.*

Before I could start with my experiments Dr. Noemí Aguiló-Aguayo explained me what is happening with the complexes in the solution and what we expect from the experiment (Figure 8). She also told me what I should do with the collected data and how to plot the graphs in an excel file.

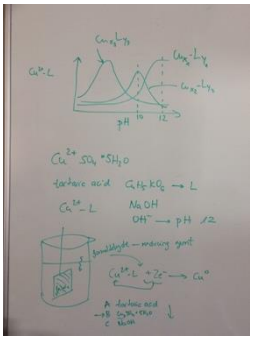
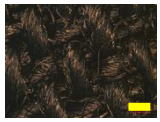
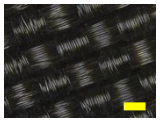
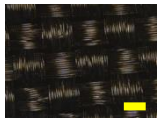
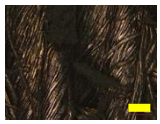
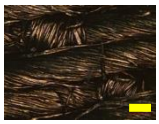
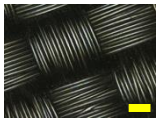
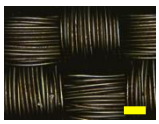
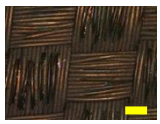
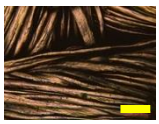
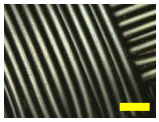
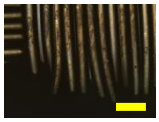
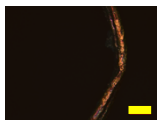
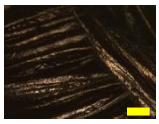
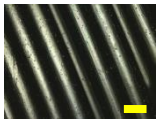
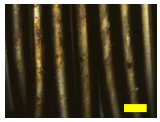
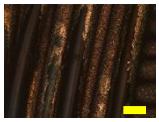


*Figure 8. Dr. Noemí Aguiló - Aguayo explaining the experiment*

For the experiments we used one cotton fabric coated with TESPSA (a siloxane precursor coated with sol – gel), one cotton fabric without TESPSA, one PA 66 (polyamide) fabric with TESPSA and two PA 66 fabrics (polyamide) without TESPSA. TESPSA is a natural substance which is improving the liability of tin and silver on the textiles.

For the copper deposition, all fabrics were initially coated with tin and silver also by electroless deposition. I investigated the effect of TESPSA on the copper deposition at different types of fabric (cotton and PA 66). Representative samples with different magnifications are shown in Table 1.

*Table 1. Laser-confocal microscope images at different magnifications (x10 scale bar: 200 µm; x20 scale bar: 100 x50µm scale bar: 50 µm; x100 scale bar: 20 µm) from the samples.*

| | Cotton, uncoated | Cotton without TESPSA, Cu coated cotton, 23.07.2020 | Cotton with TESPSA, Cu coated cotton, 23.07.2020 | PA66, uncoated | PA66, coated with Cu, without TESPSA, 20.7.2020 | PA66 (2), coated with Cu, without TESPSA, 20.07.2020 |
|---|---|---|---|---|---|---|
| X 10 |  |  |  |  |  |  |
| X 20 |  |  |  |  |  |  |
| X 50 |  |  |  |  |  |  |
| X 1000 |  |  |  |  |  |  |

For the copper electroless deposition, I firstly had to cut the samples in the correct size and secondly, I made a tin and silver deposition. After I had to dry the fabrics, I put them into a copper solution with formaldehyde, which had a pH of 13 (100 ml alkaline

*Figure 9. Experimental set-up. From left to right: computer, cooler device, beaker with the fabric placed at the stirrer and immersed in Cu-tartrate solution.*

copper tartrate solution and 2.6 ml formaldehyde), what is also shown in Figure 10. The duration of the process is about 1 hour. The liquid was stirred and cooled down at 18°C the whole time (Figure 9).

The temperature is very important because if the liquid is warmer than 20°C the process is going faster, and it is more difficult to control the development of the samples. Additionally, you can control the size of the copper particles if the process is going slower. That improves the conductivity and it makes it possible to also reach beautiful colors. The colors are a result of the light reflection of the copper particles deposited on the fabric. If the particles have not similar sizes the light is reflected differently, and the colors turn into brown and black. I also had to measure the colors of the fabrics with a CM3610d spectrophotometer (d/8 geometry) from Konica Minolta, Japan.

Furthermore, the deposition process was monitored via pH-measurements and measurements of the redox potential (Figure 10). With the collected data I made an excel file which allowed me an overview of the measurements. To conclude, I observed that the Cu-coated fabrics exhibited better conductivity (2 Ohm/square) when they were initially coated with TESPSA. The conductivity measurements were performed following the four-point probe method. The current is applied on the outer points with a power supply and the voltage is measured on the inner points with a multimeter. The measurements are related to ASTM Standards F76.2, F84-93 and F5129-94.

*Figure 10. Measuring the potential and the pH in the Cu-tartrate solution*

After the internship I attended the "Summerschool – MINT" in Innsbruck (Figure 11). Even though the official program started on Monday, I arrived at Sunday evening at the Kolpinghaus in Innsbruck where I already met some of the girls staying there with me for that week. On Monday morning the program started with a short introduction of the University and what the week was going to look like. In the afternoon we had a presentation about pharmacies. The following days looked nearly similar. Every day we started around 8:00 a.m. and around midday we had lunch at one of the university canteens. When we finished the afternoon presentations, we had some leisure time to go to the city and have some food but mostly we were too tired and spent our evenings relaxing together at our hostel.

*Figure 11: Girls attending the summerschool MINT*

On Thursday morning we made an excursion to the building of the botanic where we got an insight in their lab work. Because of our straight timetable we had not enough time to see the botanic garden. The afternoon we spent at the Hungenburg with some geologic experts who made us familiar with the equipment they need for their work. Afterwards we took a short walk, where we were allowed to try out their equipment by ourselves. So we could analyze different kinds of stones and rocks which are typical for this area.

## 4. MEINE PERSÖNLICHEN EINDRÜCKE

During the time I was working in Dornbirn I learned a lot of new things. I got an insight into what lab work is like and met a lot of nice people. The work aroused my interest about several themes I wasn't interested in before. Because the main language at the Institute was English it was possible for me to improve my language skills as well as my knowledge about science.

In addition to this great experience I spent one week attending the “Summerschool – MINT” in Innsbruck to gain an impression of various scientific and technical studies. In a number of different seminars, some professors and students of the University of Innsbruck gave us an insight into their subjects and their current projects. All of them were very enthusiastic and they always took enough time to answer all our questions honestly and carefully. Besides the studies I was interested before I got also some information about different studies I had not been interested in, which turned out very fascinating.
It was very nice to meet so many girls with the same interests and to get an insight into what it is live like a student of university.

At the end of those five weeks, I would definitely say that I am very glad that I had the chance to attend this internship as well as “the Summerschool-Project” in Innsbruck (Figure 12). It showed me what benefits a scientific or technical study has. In my daily social environment, there are a lot of people who are not very enthusiastic about girls working or studying something technical but the people I met during the five weeks were looking at it very differently. All of them were very open minded about girls working and studying in these sectors and showed me that girls are as suited as boys for a job in the scientific area.

*Figure 12: The girls staying at the Kolplinghaus*

# LIST OF FIGURES



Figure 5 and 11 were sent to me by Ulrike Pfeiffenberger.

Every figure that can't be found on the list of figures was taken by myself.