

# Armourers & Brasiers' Company Non-technical Report

Jacob Allen, Sidney Sussex College  
Institute for Polymer and Composites  
Hamburg University of Technology



Three years of my undergraduate degree left me searching for a taste of what could come next. A two-month placement at TUHH was the perfect opportunity to get involved with current research in materials science. With the generosity of The Armourers & Brasiers' Company, a summer in Germany became an offer I could not refuse.

Reflecting back to spring, I applied to TUHH after reading about the progress that Professor Bodo Fiedler's group had made in the field of composites, after gaining an interest in the topic from my course. Correspondence with members of the group revealed that I would be offered a high degree of freedom as to what I wished to investigate. In addition, having topped up my German with a year's course at the engineering department, I was eager to test my language skills. TUHH was an ideal location in which to do this.



After introducing myself to the department and conducting a literature review on the RTM process and the durability of composites, I chose to examine the fibre-matrix interface in GFRP (glass fibre-reinforced polymers). Moisture degradation over a range of temperatures should, with further work, lead to estimations of the composite's lifetime in a marine application. Each specimen consisted of an epoxy resin cruciform with a roving (bundle of fibres) suspended across the central arms. It took a huge amount of perseverance to ensure that there was equal roving tension, that the roving was untwisted and that it was embedded midway through the 0.5 mm sheet.

When working independently, further difficulties were encountered with the sample geometry. Repetitive failure at the pin holes following a change of resin literally took me back to the drawing board. I used Inventor to model each design and CAM software to mill specimens out of the resin plates. Coming from a Natural Sciences background, CAD was a completely new experience for me.



RTM (Resin Transfer Mould) press  
in the department.

Since my method had not been used in the department before, I encountered numerous issues when trying to manufacture large batches. New post-curing cycles and embedded metal spacers meant that the plate was often unusably fragile or buckled. Before I knew it, my time was almost up, with little remaining to actually examine the interface. I was able to find the UTS of moisture-degraded samples and offer thermally-aged samples for further testing. Micrographs of fatigue-induced fracture surfaces enabled me to understand how the fracture initiated. I was able to leave TUHH with an appropriate manufacturing method and what I hope is a great deal of valuable data.



Fatigue fracture surface. A glass fibre is visible along the top edge.

Nothing could have prepared me for the initial language shock. Frantically scanning train timetables at Hamburg central station, suitcases in hand, mobile data dwindling, is an experience I will not easily forget. However, due to the friendliness of my colleagues and hosts I noticed a rapid improvement in my speaking and listening ability after the first week. The only significant language barrier I encountered was that of the German-only version of Autodesk Inventor. Fragmented questions and lots of pointing from my fellow students got me there in the end.

I explored my local area whenever I got the chance. Midweek world cup games were the perfect opportunity to escape into the city and sample the country's famous beers and sausages. I must admit that Germany's early exit and England's successful run was a welcome surprise, even if it made me unpopular in the department. My accommodation in the district of Harburg felt almost as though I was living in the countryside. I made full use of forest on my doorstep to improve my running, and with the unusually hot summer regularly producing temperatures in excess of 35°C, I enjoyed relaxing in the outdoor pools of the town.



View of the Elbphilharmonie concert hall from a ferry on the Elbe.

Having quickly devoured the tourist attractions of Hamburg I found myself searching for new experiences. Joining Schlagermove, cheering for Johnny Brownlee in the World Triathlon Series and listening to an open-air concert by the State Philharmonic Orchestra were all memorable events. On weekends I even squeezed in brief visits to Denmark and then Sweden via the magnificent Oresund bridge.



Nyhavn in Copenhagen.

My placement at TUHH has provided me with skills that I will use throughout my life. I developed laboratory techniques far past those I had experienced so far in my degree, and my communication and teamwork abilities were undoubtedly tested. My first research experience exceeded all expectations and has absolutely made me consider it as a future career path. It was an unforgettable trip and I am grateful to The Armourers & Brasiers' Company for making it possible.