

# Microforming Processes - Fundamental Studies and Developments

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*The following paper discusses the summer experience of Kristi Bond while traveling to Nagoya, Japan on a research grant from the National Science Foundation. She spent 90 days at the Nagoya Institute of Technology working under Professor Kuniaki Dohda studying the frictional behavior of Magnesium alloy and conducting tests utilizing a new high temperature trimeter testing apparatus. The paper also discussed the overall abroad experience and the benefits of researching internationally.*

## INTRODUCTION

My name is Kristi Bond and I spent the the summer researching at the Nagoya Institute of Technology under Professor Kuniaki Dohda from June 2007 to September 2007. While working in his laboratory I began by joining the research projects of some of the other students to learn about both the equipment and their methods. Later, I was able to set-up my own set of experiments on a new high temperature tri-meter machine that was assembled and calibrated during my stay. I was able to learn a tremendous amount about the operational procedures of the Japanese University and also about Japanese culture. I learned many things that may benefit both my personal research design and also the teaching methods utilized in the US, and I also found many strengths in our current system.

## **RESEARCH ACTIVITIES AND ACCOMPLISHMENTS OF THE INTERNATIONAL COOPERATION**

In the following sections I have described the various research subjects and experimentation I completed at the Nagoya Institute of Technology during my stay. The individual sections go in chronological order concluding with the final results I was able to obtain and a brief description of where the research will continue after my departure.

### *Strip-ironing friction testing*

I began the summer observing strip-ironing friction tests of Magnesium alloy AZ31. We used several different lubricants and performed multiple tests on Professor Dohda's testing apparatus. Our objective was to begin gain an understanding of the basic frictional behavior of AZ31 at room temperature to prepare us for the new testing apparatus that was due to arrive later in the summer.

### *Compression testing*

Before the new machine arrived to the NIT campus we also ran some compression tests on the same material, AZ31, used in the strip-ironing friction tests. We used several different lubricants and also took surface images of the samples after testing to study adhesion effects. One limitation in the initial compression testing was the 50kN maximum force capacity of the testing machine. After realizing this problem we decreased the diameter of the samples to ensure complete testing results including the yield point.

### *Magnesium research*

While doing the initial strip-ironing and compression tests I also became familiar with both online resources and the NIT library doing research. I used the library to both locate articles and also read about the properties and current applications of Magnesium. I also utilized 2 online databases, [www.sciencedirect.com](http://www.sciencedirect.com) and [www.scopus.com](http://www.scopus.com), to search for recent research publications. The goal of this research was to learn both what had previously been done and what researchers were currently working on regarding the frictional effects of Magnesium alloy at elevated temperatures. We would use this information to design the initial experiments of the new elevated temperature tri-meter friction testing apparatus to obtain the best results to be included in the publication regarding the development of the machine to illustrate the types of results and initial performance capabilities of the machine.

### *Trimeter machine set-up and operation manual development*

At the end of July, the new testing apparatus arrived. With the help of company employees we assembled the machine and established a testing procedure to ensure safety and efficiency of the machine. After running a few test samples I developed an operation manual written in English for the use of future international researchers. We ran into a

few set-backs in the initial trials with the force sensors and also the temperature control system. After ironing out these difficulties the machine was up and running and ready for testing.

### *Initial results*

With the new warm temperature tri-meter ready for experimentation, we developed our design for experiments with the goal of obtaining two separate graphs for use in the development paper. One graph would maintain a constant reduction rate of 15% with temperature varying from 100 to 250°C. The other would maintain a constant temperature of 150°C and vary the reduction rate from 10 to 20%. Because of the time constraint we were only able to complete the first graph and I have shown it below alongside a graphical representation of the change in temperature during the test run.

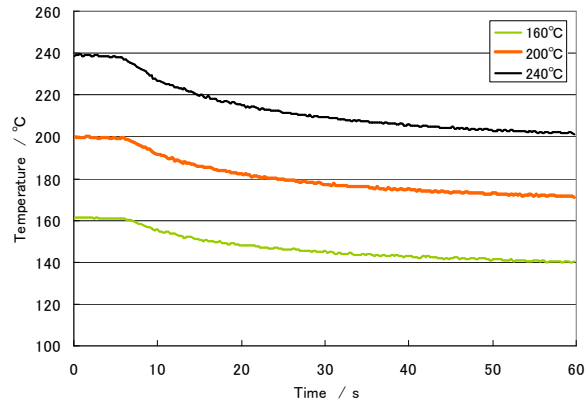


Figure 1: Temperature loss during tri-meter test of Magnesium alloy AZ31

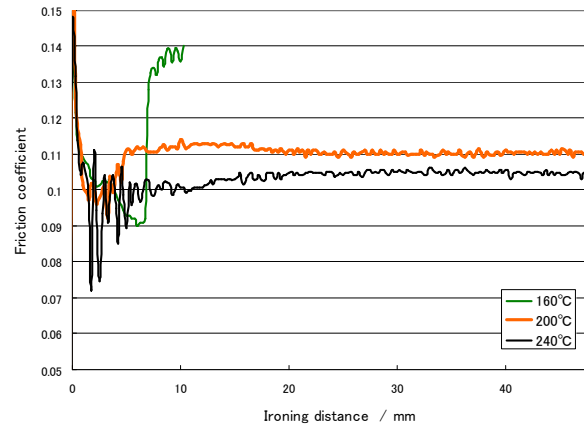


Figure 2: Friction coefficient of Magnesium alloy AZ31 different temperatures

*Future steps*

After completing the set-up and initial results of the machine it is ready to be used for any variety of experiments. One of the master's students at NIT was very involved in my research and will be continuing with it for his own research.

**BROADER IMPACTS OF THE INTERNATIONAL TRAVEL**

As a citizen of the U.S., I have not had much exposure to the world of international study and research. During my stay I was able to interact with the Japanese students studying at the Nagoya Institute of Technology. As my friendships with these students developed, I was able to absorb many things about their culture and daily experiences. Because of the strong friendships we formed during the summer I am confident that we will continue to communicate and benefit from those relations as our careers develop.

I had never been to Japan before this trip, or spent any significant time abroad. At first I was overwhelmed by the experience, especially communication issues. But as I settled into my research and living arrangement, I began to feel comfortable and was able to communicate more effectively. My communication skills were greatly improved as a result of this trip. Due to the language barrier I was forced to use alternative forms of communication to ask questions or understand answers which I am sure will be a useful skill for me in the global endeavors of today.

During my stay, I was also able to tour some companies working in the field of micro-manufacturing. These companies are producing amazing new precision tools and parts and the new technologies they are utilizing were fascinating to observe. Even the ability to witness the business operation was beneficial to understand the strengths and weaknesses of US companies in this area. I will use this knowledge later in my career to bring fresh ideas and a new perspective to the company of my employment.

The most important thing I realized on my trip was the importance of collaboration in the research world of today. People all around the world are conducting research in similar areas and could benefit immensely from the ability to bounce ideas off each other both on the academic and business level. It is essential that we work together and have a forum to communicate ideas freely.

**DISCUSSION AND SUMMARY**

The most significant accomplishment from my experience abroad was an understanding of the methods used in Japan to conduct research. I had very limited exposure to the research industry, especially internationally, and I will still be soaking in all of the things I learned from this trip.

The second most important benefit from the trip is the connections I made with the Japanese students. I learned so much about their culture and was also able to teach them so much about ours. I will never be the same after spending this time with them. I plan

to stay in touch with each of them throughout my career because you never know when we may be able to collaborate again.

My only recommendation for the IREE program would be to make sure that undergraduate students have enough work to do and receive the proper training to do it. I ending up spending the beginning of my time figuring out what I should do with my project because I had never designed anything like that from scratch before. Undergraduates need a little more guidance from professors and post-docs and I think everyone would benefit from taking a little more time to prepare them before the trip so that they can be more productive and independent once there.

### **BRIEF BIOGRAPHIES OF RESEARCHERS**

**Kristi Bond** is pursueing a BS degree in Mechanical Engineering and a Certificate in Design from Northwestern University and will graduate in June of 2008. She has been involved in micro-extrusion research at Northwestern University and plans to continue her involvement in the research sector following graduation.