

# Demamech Exchange student report

Eu-Japan student exchange program

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Home University: TU Delft

Hosting University: Keio University



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# 1 Personal data

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Supervisor: Prof. Tojiro Aoyama

## 2 Executive summary

I participated in the DeMaMech EU-Japan exchange program in 2004. I went to Keio University where Professor Tojiro Aoyama was my host professor. During five months I worked on a single project in his laboratory.

The research was part of my second year Master program and was regarded as my internship. The goal was to research a new application of an advanced material in a small torque converter. This material is a direct development of Electro Rheological Fluid, but now embedded in a gel base.

Research was very interesting. I was able to work with a very advanced material with many unexplored opportunities. The environment of research is very interesting itself. The Master program in Japan is different from my home university, but I learned many things in both research approach as personal development.

During my time in Japan I had many opportunities to travel. The place I lived is Hiyoshi, which is in Yokohama. Tokyo is very close and fully explored. It is a great city to shop and to go out. Trips to other areas include the Gunma area, Kyoto, Nara, Narita and suburbs of Tokyo.

Life in Japan for an exchange student is very different from Europe:

- The level of English is very low of the average student. Patience, pen and paper and creativity is needed to communicate.
- Students don't help you or give you suggestions unless you ask them a specific question. I had to initiate most of the conversations and be active and communicative on my own.
- Without a decent scholarship living costs in Tokyo can be expensive. However it's not more expensive than The Netherlands if you know where to shop.
- The University in Japan is always open. Normally students arrive in the morning and leave late in the evening. When necessary they stay overnight.

To live in Japan was a very good experience for me. While the knowledge of English is very low of the majority of the Japanese people, the commitment when they try to help you compensate for that. Japanese are very polite and patience. Living in Japan also showed me that many things can be different in the way of living, social life and safety.

### **3 Travel Schedule**

**Japan:** 14 September 2004 – 3 March 2005

Direct flight from Schiphol to Narita airport. KLM offers a special student ticket with good conditions especially for students.

**Kyoto & Nara:** 29 November – 2 December

Travel by Shinkansen / Bullet train with a special arrangement of JR West for foreigners. Good price with a very good hotel. Kyoto is the old capital of Japan. A very beautiful city and compared to Tokyo much less crowded. There are many temples and Shrines to visit. During the autumn it is also very popular by tourist to see the changing colours of the leaves.

**Thailand & Malaysia:** 24 December – 6 January

This was not planned, because nobody told me that the university would be closed during the year change for two weeks. When someone asked me to join for a trip to Thailand I just said yes not knowing the extremely high ticket prices before saying that. It was still a nice trip.

The weekends are always used to go to a place in Yokohama or Tokyo. I visited many places and the public transportation is very good in Tokyo and its surroundings. Language problems with travelling are almost not present since there are almost always English signs. Otherwise you can always ask people.

It is possible to get lost in a large station in Tokyo, however everything in the large stations is bilingual so finding a proper exit is just a matter of following signs.

I was not satisfied during my time in Japan. I definitely want to explore Japan more in the future.

## 4 Assignment

Aoyama Laboratory is very similar to my own laboratory at the TU Delft. The description is 'Laboratory for Manufacturing Science'. Research is carried out in the following fields:

- Application of ERG
- Micro grinding by application of ERG
- Application of EHD fluids to Cooling Systems
- Near Dry Cutting
- Study of Downsized Machine Tools
- Performance of Aerostatic Bearings considering the Generation of Vortex Flow
- Thermal Deformation Analysis of Machine Tool Components with FEM

### 4.1 Introduction

Electro-Rheological Fluids (ERF's) are composed by suspending particles into a non-conductive liquid. ERF's increase their viscosity rapidly with reversibility, in response to an electric field, due to the formation of particle chains that bridge the electrodes. ERF's are mixtures of non-conductive silicone oil and inorganic/organic composite electro-rheological particles. One of the disadvantages of ERF for long-term application is the sedimentation and separation over time of the ER particles from the silicone oil due to the difference in density between the ER particles and the insulating oil. The sedimentation reduces the ER effect. In order to overcome this problem a new material has been developed and researched in this laboratory. This new functional material is called Gel structured ERF (ERG). The ER particles are embedded in a gel base and thus will not have the mentioned disadvantages of the ERF.

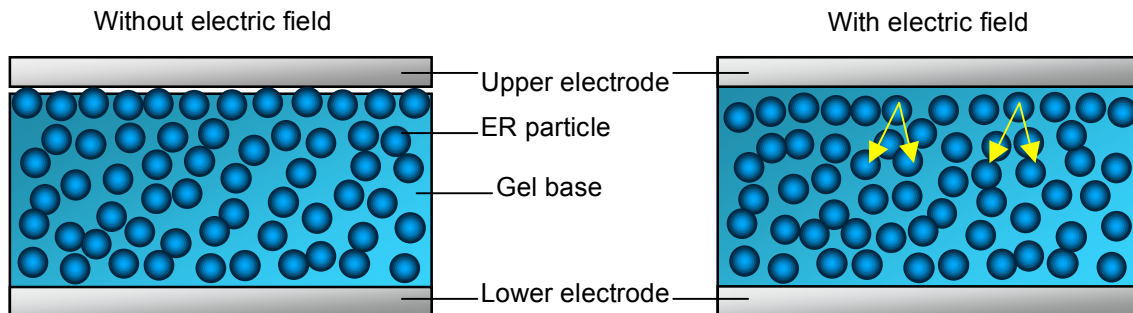


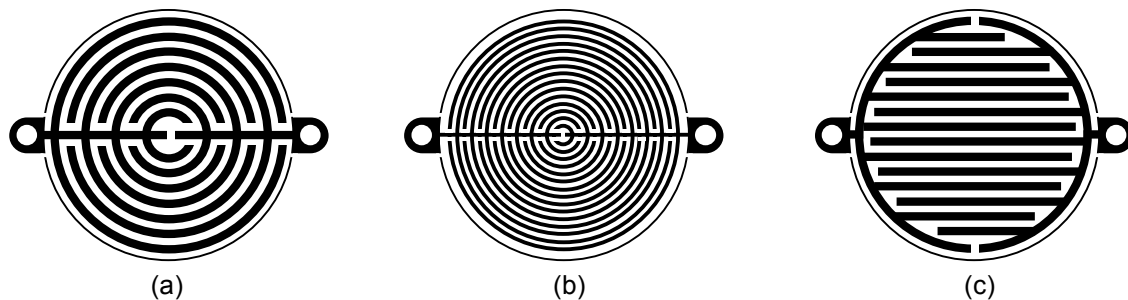
Figure 1: ERG mechanism

Figure 1 shows the principle of ERG. By applying an electric field the ER particles will attract each other. This will

The principle of ERG is different from ERF, thus new applications have to be tested. While in ERF the ER particles are mixed with non-conductive silicone oil the ER particles in ERG are embedded in a solid gel base. In Aoyama Laboratory this new material is

applied in different conditions and applications. New applications of this material are still researched. The assignment was to develop a new application and test it under different conditions. The torque converter is a simple application of ERG. By using a small device and a small electrode with ERG material on it, it is possible to influence the torque transfer by changing the electric field.

The difficulty in this research object was to find a suitable electrode, which meet all the requirements. The difficulty was in size and design. A solution for the electrode is found in the use of PCB material for the electrode. This widely available material is easy to use and the desired electrodes are easy to make with simple equipment. PCB's can be found it every electric device. It is the board that connects different electric components with each other like computer chips. The electrodes are made in the laboratory and tested on the torque converter.



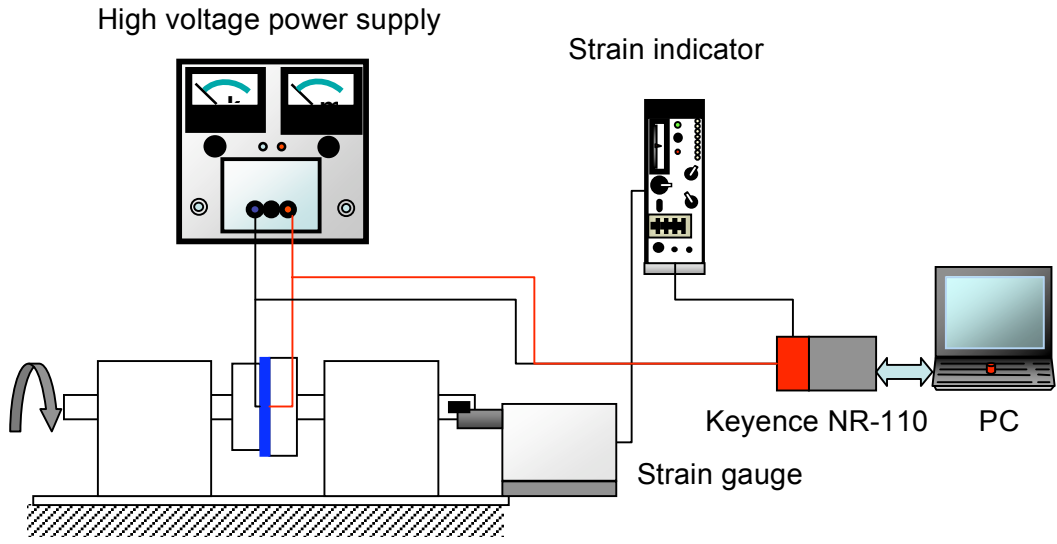
**Figure 2: Electrode design**

With the application of PCB it was also possible to design complex electrode patterns. With machine-milled electrodes the complexity was limited to large electrodes compared to what is possible with a chemical process. It is also very difficult to manufacture a complex pattern like the patterns shown in figure 2. The dimension of the PCB electrode is 30mm in diameter for the electrode pattern. This is also one of the reasons why machine milled solutions are limited.

## **4.2 The Torque converter**

The torque converter was kept as simple as possible. The basic design consists of two bearing houses with two shafts. An electro motor continuously drives one shaft while on the other shaft the PCB electrode is attached. A strain gauge sensor and data acquisition computer makes the data gathering possible. When turning on the motor the surface of the driven shaft is slipping on the surface of the ERG material. By applying an electric field on the electrode more or less torque is measured by the strain gauge.

Measured values are torque in different conditions. Variables are rotational speed of the driven shaft, applied electric field, input frequency of the electric field and different electrode patterns. The basic test setup is like in figure 3:

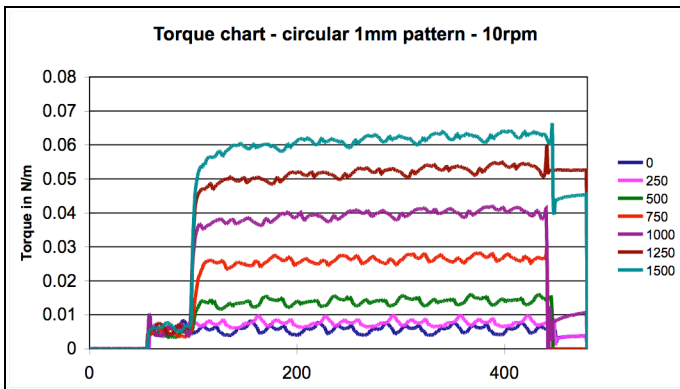


**Figure 3: Test setup for static test**

Figure 3 is the basic setup for the static measurement. The variables are rotational speed, applied electric field and electrode pattern. In the more complex dynamic test a frequency generator is used to simulate a changing electric field.

### 4.3 The results

The static tests show that the PCB ERG electrode it has a good response on the applied electric field. By changing the electric field to a higher voltage the torque transferred is linearly higher for each step. Each change in input voltage show a significant change in torque transfer.

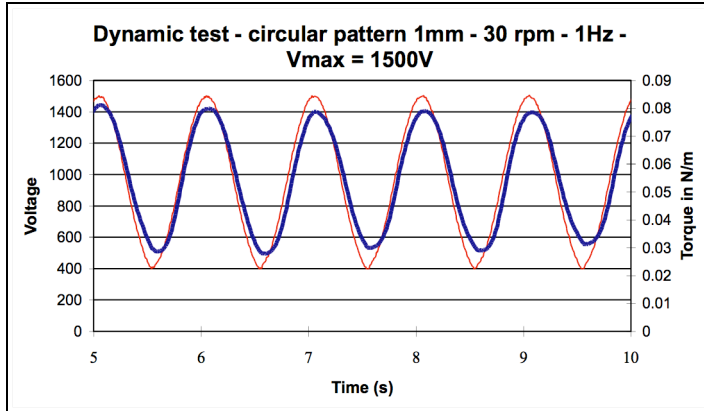


**Figure 4: Static test result**

Figure 4 show one of the results of the static test. The y-axis is the transferred torque in N/m and the x-axis is the time. Each line corresponds to the applied electric field. This changes from 0V to 1500V per mm ERG material.



In the dynamic tests the PCB ERG electrode is tested under dynamically changing electric field. The input is a sinus and the torque transfer shows a good pattern and it follows the input electric field. However with higher frequencies it is not possible to measure the torque change. The first point is the test equipment that is not capable to produce a fast changing electric field and second is the delay of the whole test setup.



**Figure 5: Dynamic test**

Figure 5 is one of the results from the dynamic test. The voltage is varying from 400V to 1500V. The transferred torque by the ERG changes with the applied electric field. For more higher frequencies ( $> 20$  Hz) the input behaves like an DC voltage and change in electric transferred torque is similar to the static tests.

The response speed of ERG was tested with a block input of the electric field. It was very difficult to calculate this. The build-up delay is lower than the release delay. Overall system delay is about 0.05s. This also means that changes higher than 20Hz are not possible and in practice lower values like 10Hz are more realistic.

#### **4.4 Conclusion**

The research was finished in time and the results are promising. The new electrode type made with PCB is suitable for more application than for this small torque converter.

## **5 Student life**

First I like to say that student life in Japan is completely different from student life in Holland. My experiences are interesting and challenging. Not everything is positive, but overall it was very nice.

### **5.1 Laboratory**

The system is very different from my home university. One professor has one laboratory with its students. They all share the same space in office style, only more student like. Each of them has his/her own desk. While sitting all together in the same room everybody is doing his or her research or doing experiments in the test lab in the same building.

When present in the lab they are not always working. Social contact between the students is very easy when sitting with each other in one room. Except everything is in Japanese. For me the level of English of the students was really low and my Japanese just not enough to say more than 'hello'. The language barrier differs from lab to lab. My experience is neutral. Social contact has to come from yourself, since the students don't even try to speak English with you, but when yourself initiate a chat they are always very happy to talk to you.

The language barrier has one drawback for research in general. It is sometimes difficult to understand the present research. In my case it was worse because all the papers are in Japanese as well. Answers are only given to specific questions and this is what was difficult in the beginning. To understand the topic I had to understand diagrams and pictures. While only almost at the end of my research they came up with an English paper written for a seminar.

### **5.2 Social life in Japan**

The students are very kind to help you, but only if they know they can. People are very kind, but also shy (it seems). It is funny to see that the professor has absolute authority. He points a student to organize something for example and they student just has to do it. He does it without complaints though. Drinking together is very nice and you learn them from another side. Even with the professor present they can be more loose when outside the laboratory.

While Dutch students have many activities next to the university, Japanese Master students don't have many. Especially if the students live with their parents it's basically only the university and so now and then Karaoke or drinking. An exchange program like this is also very interesting for them, but they all hesitate to participate. I think one of the reasons is the language problem and second is that it is an unknown factor in their student career.

Outside university I think Japanese people are very friendly. Depending on the situation and location they are very polite and formal or less formal but always very friendly and helpful. In a crowded city like Tokyo it is very nice to see and experience how so many people together can create a very pleasant environment. Even in over-crowded area's people behave very social. The group mentality is a very nice experience.

## **6 Suggestions**

Be prepared to face a language barrier when arriving in your laboratory. While most professors manage to have a conversation in English it is definitely not the case with the students. Have patience.

Life in Japan is not necessarily expensive. The scholarship itself is sufficient for all the basic needs. You don't even have to cook to stay within that budget. But for all other activities and traveling one must be prepared to spend some money.

Try to learn some basic Japanese before going. That way arriving in Japan is still a shock, but you can also manage the basic language which is not that difficult.

## 7 Summary

My goal was to finish my assignment during my stay at Keio University and I managed to do this.

I had a lot of possibilities to explore Tokyo and its surrounding, but also further parts of Japan. Life in Japan is very pleasant.

The level of English in Japan is very low, but with patience and creativity everything is possible. Due to the language barrier you must be active by yourself, but this is not necessary negative.

My time in Japan was very pleasant. The environment provided by Keio University was excellent and the overall experience was very positive. If I have the possibility to go to Japan again I certainly won't hesitate.