EU-Japan exchange program

Study at TUDelft and DTU

Home University: Osaka University

Name: Kenshiro Hida

1. Personal Data

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Home institute

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Host institute

1/Sep./2004 to 27/Dec./2004

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Supervisor: Ir. J, J, L Neve

27/Dec./2004 to 31/Jan./2005

Name: Technical University of Denmark

Faculty: Manufacturing Engineering and Management

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2. Executive summary

In this project I studied at two universities in Europe. In this report I am going to introduce which universities I chose and how long I stayed there. Next I am going to describe about how I felt and studied. Finally I am going to make suggestions based on my experience.

3. Travel schedule

1/Sep./2004 to 27/Dec./2004 Delft University of Technology (Netherlands)

27/Dec./2004 to 31/Jan./2005 Technical University of Denmark (Denmark)

4.1 Research and lectures in TUDelft

Research title: Generation of the Surface Structures by Micro-Abrasive-Blasting

Background

Recently micro-electro-mechanical-system (MEMS) has been developed by various techniques such as etching. But conventional techniques are expensive. Now industry requires the economical technique for MEMS. We propose a Micro-Abrasive-Blasting as an economical technique for MEMS especially composed from brittle materials such as glass and silicon. This technique has been widely applied to the technique to produce a television flat screen in industry because of its economical efficiency. This technique realizes economically viable MEMS. The overview of Micro-Abrasive-Blasting is shown in Fig1.

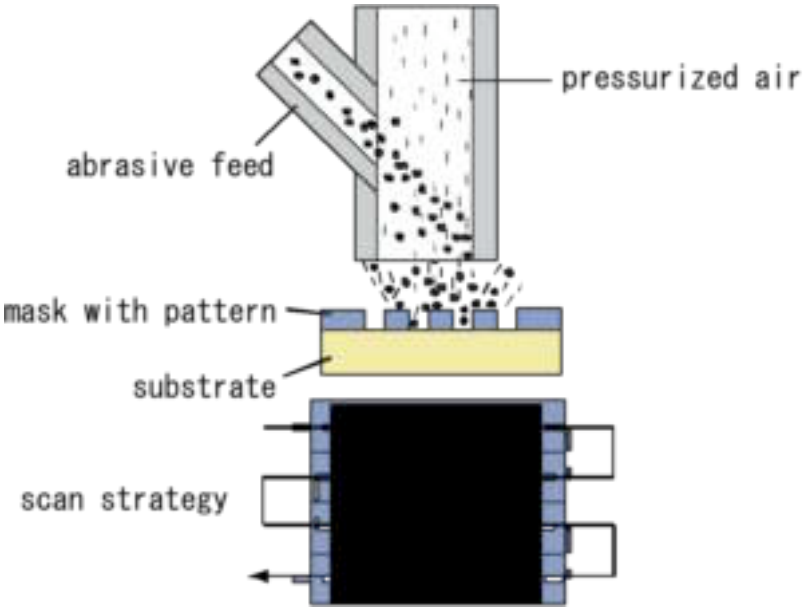


Fig1 Overview of micro abrasive blasting

This technique is based on the erosion of a brittle substrate by a high-velocity particle beam. On this technique the substrate is covered with mask pattered with the desired contour instead of direct blasting and the mask pattern is transferred to the substrate

by blasting. The mask determines the accuracy of the dimensions in the plane of the desired structure. The mask size and scan speed directly influence the machining speed. So the scan strategy is of great importance for generating an arbitral shape.

Experimental set-up

All experiments have been conducted on the abrasive blasting set-up shown in Fig2. A SS-White Airbrasive unit, model HME (a) mixes dehumidified compressed air (b) with abrasives and feeds it to the blasting chamber (c). A CNC (d) five-axis guiding system (e) with a working area of 600mm×600mm×300mm realizes the scanning motion of the nozzle (f). A cyclone type air filter (g) evacuates abrasives from the hermetical closed blasting chamber.

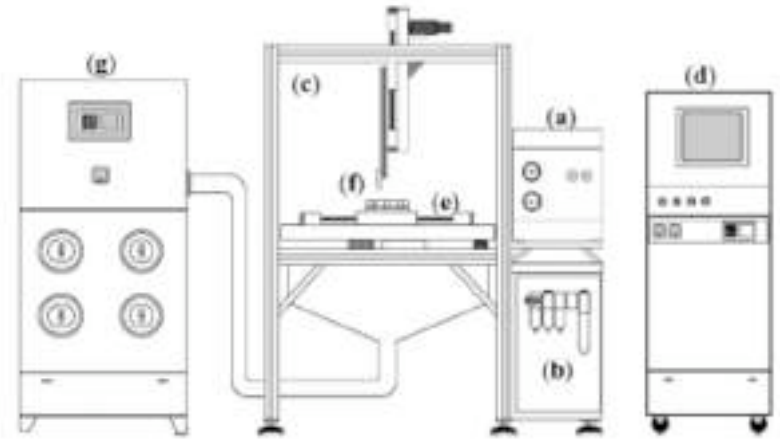


Fig2. Schematic abrasive blasting set-up

Results

To generate an arbitral shape, the scan strategy needs to be constructed. Therefore relation among hole width, hole depth and machining speed need to be obtained. Then the experiments that the glass plate is machined with several machining speed against circle and square mask has been conducted.

In the above experiment it is found that the relation among hole width, hole depth and machining speed could be formulated into the following equation.

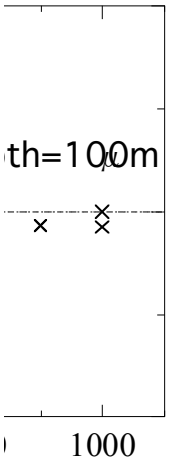
Equation for circle mask

$$V = 0.72D^{-0.88} - 0.18W^{-1.73} \quad (1)$$

Equation for square mask

$$V - 0.88D^{-0.73} - 0.17W^{-1.55} \quad (2)$$

To verify the constructed scan strategy the experiment to machine with constant depth 0.1mm has been conducted (see Fig3).



(a) Circle hole

(b) Square hole

Fig3. Results of machining with constant depth 0.1mm

As the results of above experiments, it is found that the circle holes can be machined with the average depth 0.101mm and the standard deviation 0.00825mm and the square holes can be machined with the average depth 0.0987mm and the standard deviation 0.0131mm by using the constructed scan strategy.

Conclusion

In this report, the relation among hole width, hole depth and machining speed has been formulated into the equation to generate an arbitral shape. The constructed equation has been verified by the experiment to machine with constant depth.

Lecture description

Control theory

This course serves as an introduction to the concepts and techniques currently used in basic modern control theory. This course requires the development of the technical skills involved in state space system theory. It also extends the notions of control system design towards time-domain techniques based on pole placement and linear optimal control using quadratic performance criteria. The exercises in this course stress the use of a computational linear-algebra environment (Matlab or similar) for linear control system design. The exercises familiarize the student with model-based control design, supported by modern computational tools for dynamic analysis, simulation and control performance assessment. The remark of this course was evaluated by the examination and exercises.

Biomedical Engineering Design

This course gives an introduction in the field of prostheses and orthoses, and presents a design philosophy and a design method, illustrated by a presentation of the entire design process (system components) of several prosthetic/orthotic products. The goal of this course is to provide knowledge and understanding of the design process based upon system theory and control theory. The remark of this course was evaluated by a conceptual engineering design project.

Design of Production System

The topics of this course are the following; CIM, design, process planning, production control, production scheduling, system design, reference models, manufacturing, assembly logistics and computer vision. The goal of this course is to get the knowledge of modern flexible manufacturing methods and conditions; being able to recognize and use paradigms of automation technology in factory design. The remark of this course was evaluated by a written open book examination.

4.2 Research and Lectures in DTU

Lecture title: Project Course in Process Technology

This lecture is consisted from literature study, planning of experimental investigation, theoretical and experimental work, data acquisition, analysis of experimental results, conclusion, reporting and presentation. In this lecture I did a group work on the following experiment theme with foreign students. I made a report on the theme.

Experiment theme:

Investigation of lubricant and extreme pressure additives in Ironing

Background

The major role of the lubricant film in metal forming is to ensure the separation of the contacting workpiece and tool surface. The limit of lubrication is understood as the threshold at which the lubricant film breaks down leading to the direct contact between the tool and the workpiece surface, which is normally fatal to a production, because it means that the tool surface pick-up the workpiece material. The picked up workpiece material becomes very hard and brittle when oxidized and causes scoring of subsequent workpiece surfaces being formed by the damaged tool surface. industry and the method to predict when the lubricant film breakdown occurs has been dev This effect, known as a galling, leads to a poor product quality and a severe stressing of the tool.

As mentioned above, the lubricant film break down is a problem ineloped in the past research. However how the characteristic of lubricants influences on the lubricant film breakdown is not still clear. Then, in this paper, the influences have been investigated by conducting the strip reduction test.

Experimental conditions

In the present work the limits of lubrication have been studied applying a strip reduction test, simulating the conditions in ironing, see Figure 1.

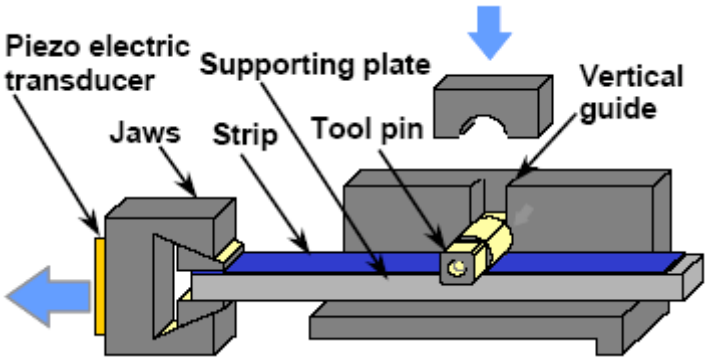


Fig1. Strip testing set-up

The thickness of the strip is reduced between a non-rotating hardened tool pin simulating the conical die and a supporting plate simulating the cylindrical punch in ironing of a cylindrical can wall. The strip and the supporting plate are clamped together at the front end with a set of jaws. Ironing is performed by drawing in the direction of the arrow. The two ends of the tool pin are machined with square cross-sections in both ends fitting into two vertical guides allowing the gap and thereby the reduction to be varied.

In the experiment, the following lubricants shown in Table1 were used.

Table1. Code and Description of tested lubricants

Code	Description	Viscosity[cSt](40℃)
CR5	Pure Mineral Oil	660
125P	Pure Mineral Oil	125
CP15	125P (85%) + CP3179 (15%)	134
CP3179	Pure additive, Chlorinated Paraffin (containing Cl)	-

Results

Firstly to investigate the influence of viscosity on lubricant film breakdown, the strip test using CR5 and 125P, only the viscosity of witch is different, has been conducted. The experiments have been carried out on the following condition; reduction-30%, tool temperature- 20℃. The result is shown in Fig2

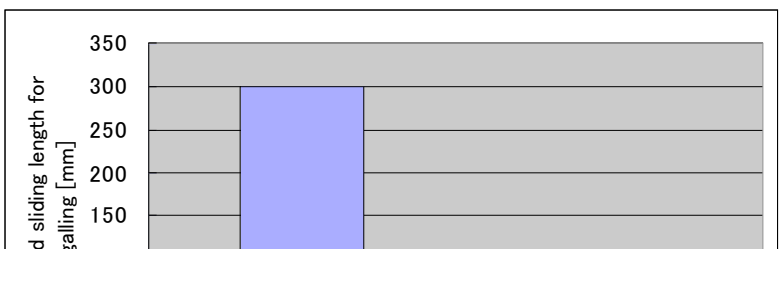
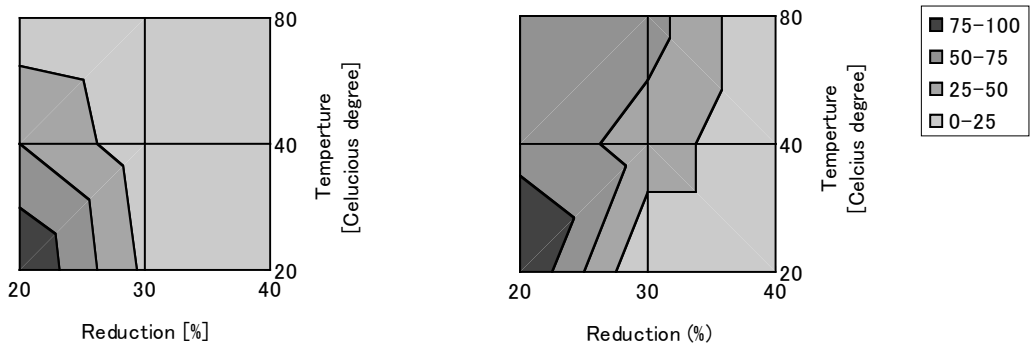


Fig2. Comparison between CR5 and 125P

It is found that the threshold sliding length for galling of CR5, which has higher viscosity than 125P, is longer than that of 125P in Fig2. Both of CP5 and 125P are pure mineral oil. Only the viscosity is different between these two lubricants. Thus it is found that the lubricants that have higher viscosity show better results at the condition; tool temperature is equal to 20 degree Celsius.

Secondly to investigate the influence of additive on lubricant film breakdown, the strip test using CP15 containing 15% CP3179 in 125P has been conducted on the several conditions (temperature[20,40 and 80℃]-reduction[20,30 and 40%]). More than three times experiments have been conducted on each condition. In order to see the result more clearly, the distribution which shows the success rate on each condition between reduction and initial temperature of tool was made. Success rate means the percentage of samples which don't have any galling in 300 mm drawing on the more than three times experiments. Comparison between expected result and CP15 one is shown in Fig3. The expected result was made from the previous research that shows a lubricant film is broken down earlier in the processing if either contact pressure or temperature increases. Fig3 (a) is not an exact graph. But, it shows that the success rate is decreasing if the reduction is increasing, and also it shows that the success rate is decreasing if the initial temperature of tool is increasing.



(a) Expected result (b) Result using CP15

Fig3. Comparison of success rate between expected result and one using CP15

In the case that initial temperature of tool is focused, the different result from expected one is found when the reduction is 30%. And it is also found that success rate is decreasing rapidly as reduction is increasing when the initial temperature of tool is 20℃, but success rate is decreasing slowly when the initial temperature of tool is 80℃.

The difference between expected result and result using CP15 could be lead by only the existence of chemical additive in lubricant. It means that the Chlorinated Paraffin leads some chemical effect easily on the workpiece or the tool surface (or both) in high temperature and this chemical effect work to prevent the occurrence of pick-up.

Conclusion

In this report, the influences of lubricant viscosity and chemical additive on lubricant film breakdown have been investigated. It has been found that the result become better as the viscosity of lubricant increase. And also it has been found that the lubricant containing chemical additive shows better results on sever conditions than one not containing chemical additive.

5. Exchange student life

I studied at TUDelft in September to December. I took lectures and did a research there. Next I studied at DTU in January. I took a three-week intensive lecture. I could experience many things which I haven't eve done in Japan through this exchange program. But, of course, there were a lot of troubles that I couldn't imagine at the beginning. The first problem was to talk in English. Before going to Netherlands, I did

not have enough experience to speak and hear English in Japan. Therefore I struggled to get accustomed to communicating in English during first several weeks. In addition, there were a lot of differences in lifestyle, traffic rule and so on. Unfortunately I met traffic accidents and I was injured and treated in Hospital. I was very surprised at many troubles. However I've got used to new life in Netherlands and become to enjoy fresh life naturally. In the following section, I am going to write about my precious experience at TUDelft and DTU.

Firstly I am going to write about the lectures in Europe. Both universities, which I stayed, focus on international exchanges. Thus many lectures are conducted in English. It was very good for me because there were a lot of students whose nationalities are different and I could talk with them. The lecture contents in both countries are not widely different from that in Japan. But there are many group work in which several students progress the same project together. Actually at DTU I did group works with foreign students and make one presentation and report together. So I could discuss with them and I could get touch with many different ideas. It was very impressive for me that many foreign students always enjoy studying and always express their thinking clearly. And I find that there is a difference in curriculum. In Japan master students take lectures and do research at the same time. On the other hand, in Europe master students only take lectures at first grade because they focused on getting wide knowledge to adapt to rapidly changing technological needs. Now, in the world, it is highly demanded for us to be generalist. So Japan might need to import European style in the near future. While taking lectures, I also find that it is very important for understanding lectures not only to hear English but also to be familiar with technical terms. I think that we should learn many technical terms daily to communicate with foreign engineer in the future.

Secondly I am going to write about my research in Netherlands. I did the 4 month closed research which was different from my research in Japan. Then I was surprised at the difference of research style between in Netherlands and Japan. In Japan I belong to a laboratory and there are some professors and a lot of students. I always progress my research discussing with professor and colleague. On the other hand in Netherlands master students follow to one PhD student as an assistant. And they always progress their research discussing each other. Both of style has unique advantages. The style in Japan has the advantages to get many different ideas because there are many persons to discuss. On the other hand, the style in Europe has the advantages to get practical knowledge deeply from the PhD student because they always discuss on each step in detail. I was very interested in this difference because I felt that the style in

Netherlands reflected their nationality to focus on their individuality. And many researches in Europe are conducted cooperating with companies. So the research themes are very practical and reasonable. Actually experiment set-up I used was the form which could be introduced to the factories instantly.

Of course, I could make foreign friends whose nationality is different because both of universities highly welcomed international students. After school, most students go to the parties organized by students or bar in the town because European students really like talking and beer is very cheep in Europe. Most of the opportunities to meet with many foreign students were commonly at parties or bar. As I go to the parties or bar, I could have some friends with whom I can talk more deeply. Sometimes I cooked dinner and played soccer with them. And in the weekend I often go to the disco because it was the most popular spot to excite their soul in Europe and I could feel European spirits directly. To meet and talk with many foreign students was the most precious experience for me. Each topic, which we talked each other casually, remains my memory deeply.

I wrote about what I felt thorough studying abroad and what I could know. My exchange experience could be summarized as the following; “the exchange life was full of surprise and fun”. I believe the experience in foreign countries would be my confidence in the future.

6. Suggestions to the Project

Suggestion 1

In both countries I lived with only Japanese students. But It is not good to live with Japanese. It is better to live with foreign students because it is very good chance to live with foreigner for the sake of getting in touch with foreign custom. So next time please arrange to live with foreign students.

Suggestion 2

In this program I had no choice to write my master thesis at Host University. But I think it is very attractive to write thesis in foreign university. So please give us the chance to write master thesis during our staying.

Suggestion 3

I go to two countries for five months. But I think we don’t need to go two countries necessarily. Usually the lecture term takes five month in Europe. But we have to leave one university for four month at least. Therefore we couldn’t take lectures witch we

really want to take. It is problem. The system should be changed more flexibly.

7. Summary

Thorough this exchange program I could experience many things that I haven't ever done in Japan. Now I think that this program was a good chance to know the world and it was good for me to study in Europe. In the future I will take initiative in the world as an engineer. Finally thank for everyone who supports me.