

Microforming Processes - Fundamental Studies and Developments

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As part of the IREE supplemental award, Numpon Mahayotsanun visited Nagoya Institute of Technology (NIT), Japan during the summer of 2007 to conduct a research project in designing a friction testing machine for microforming applications. During his stay at NIT, he performed experimental tests in the existing friction testing machine and also designed a similar type of machine for micro-forming applications. The experiences and the results that he gained were considered valuable and helpful to better understand micro-forming.

INTRODUCTION

Northwestern University was awarded a supplemental award to support a graduate student, Numpon Mahayotsanun, and an undergraduate student, Kristi Bond, to visit Nagoya Institute of Technology (NIT), Japan, from July 10 to September 5, 2007. The main objective of their visit was to collaboratively investigate the tribological phenomena in forming of sub-millimeter metallic parts. Not only did this supplement enable the furthering collaboration between Northwestern University and NIT, it also provided the students with the educational experience, global knowledge, and foreign culture.

Numpon was supervised by Professor Kuniaki Dohda, whose main area of research is in micro/meso forming and tribology. In addition, Professor Dohda's laboratory was instrumented with various apparatuses to study tribological phenomena in metal forming. By using one of the apparatuses, the strip-type ironing machine, Numpon conducted experimental research to understand its tribological mechanisms and how the friction forces were acquired. This type of friction measurement provided direct friction forces and could be implemented to the micro-forming applications, particularly measuring friction in the microextrusion process.

After understanding and gaining the experiences on the friction testing apparatus at NIT, Numpon designed a friction testing device for a microextrusion process, which is currently being integrated to the existing microextrusion machine at Northwestern University.

RESEARCH ACTIVITIES AND ACCOMPLISHMENTS OF THE INTERNATIONAL COOPERATION

At the beginning of the travel, the research activities involved laboratory tour and company visit. Professor Dohda introduced Numpon to the students and staff in his laboratory and demonstrated all the research projects and testing apparatuses. It was considered helpful to Numpon because he could familiarize himself with the new laboratory environment and start learning the new equipments and technologies immediately. Since the area of research that Numpon and professor Dohda collaborated was tribology in micro-forming, visiting companies that produced microparts and micromachines greatly benefited the collaborative project. Professor Doda and Numpon visited Misuzu Industries Cooperation that produced sub-micron parts by using ultra-precision machining technology. Also, they gave a visit to Takashima Sangyo Co., LTD, which constructed desktop micromachines using advanced micromanufacturing technologies.

Numpon's main research project at NIT was divided into two main parts; experimental testing and machine designing. In his experimental part, he was working with Professor Dohda's master student who was working on the investigation of tribological phenomena in the strip-type ironing test of stainless steels. Numpon's experimental activities involved material preparation, setting up the tools, carrying ironing tests, and data analysis. Figure 1 presents the experimental setup of the strip-type ironing test that Numpon was working on during the summer at NIT.



Figure 1. Strip-type ironing test apparatus

The experiences and techniques he gained from the experiments were useful towards his machine design part. The strip-type ironing machine provided a direct measurement of the friction forces, which was useful to designing a friction testing device in

microforming applications where frictions could not be easily acquired. Consequently, Numpon implemented the concept and technique used in the existing ironing test apparatus to his microextrusion machine at Northwestern University. The designs of the friction testing device in the microextrusion machine are shown in Figures 2 and 3.

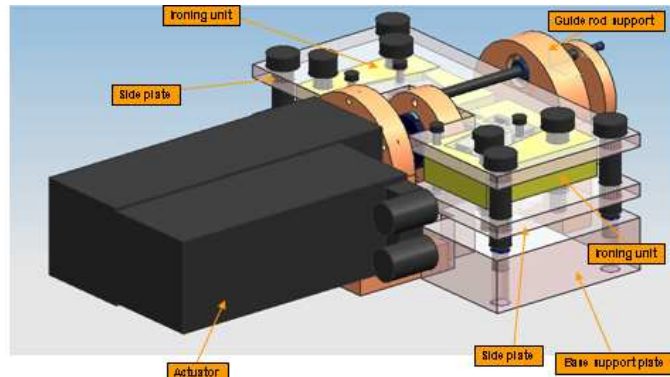


Figure 2. 1st design of the friction testing device in the microextrusion machine

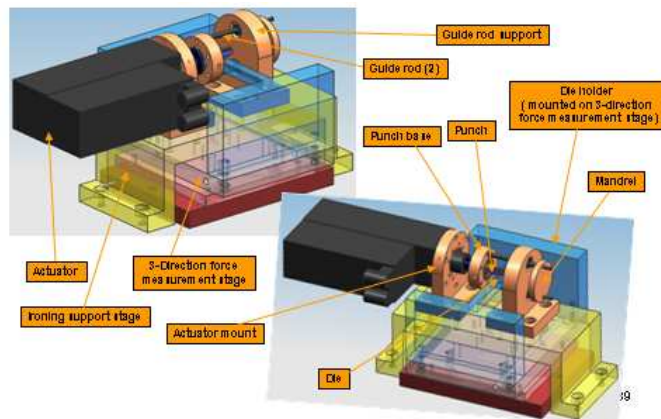


Figure 3. 2nd design of the friction testing device in the microextrusion machine

The designs have been constantly advised by Professor Dohda and Professor Cao at Northwestern University, USA (NU.) This collaborative project is still ongoing and being implemented at NU. Not only will the results of this collaborative enhance the understanding of tribological phenomena in microforming, they will also further increase more collaboration among NIT, Japanese micromanufacturing companies, and NU.

BROADER IMPACTS OF THE INTERNATIONAL TRAVEL

During Numpon's stay at NIT, Numpon had a great opportunity to interact with many native students both during the research hours and recreational hours. Not only did the interaction help the students exchange technical knowledge, the students also learned new

languages and cultures. Apart from conducting research work, Numpon participated in the introductory to Japanese class for foreigners as well. In this class he learned basic Japanese language skills for everyday life, which was considered very helpful for staying in Japan. He also interacted with the other foreign students in the class, which helped him gain more diverse knowledge.

Numpon had paid a few visits to the leading micromanufacturing companies and exchanged technical knowledge with the companies' technical staff. This interaction also increased the opportunity for future technical supports and collaborative projects from the companies.

The project that Numpon carried out at NIT is critical to a better understanding of the tribological phenomena in microforming, which is one of the main focuses of Numpon's research objectives. As a result, Numpon will continue this collaborative project at NU as part of his doctoral thesis under the supervision of both Professor Dohda and Professor Cao.

DISCUSSION AND SUMMARY

The supplemental award provided a valuable opportunity to Numpon to conduct research at NIT. He gained both technical knowledge and cultural experiences from the visit. He learned some crucial concepts and techniques used in the existing friction testing machine at NIT. He also accomplished designing the friction testing device for the microextrusion process, which is being implemented at NU. More importantly, the collaborative project between NIT and NU has continued as more related projects and publications have already been planned and conducted.

For "Best Practices" in future operation of the IREE program, it is also crucial for students to have an opportunity to visit and/or conduct research work in industries. Due to the experience Numpon gained during this summer, it was very beneficial to visit those companies as he learned more practical and advanced technologies that could also be applied to his research work. In addition, the collaborative supports and projects between the companies and university were enhanced during the visit.

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BRIEF BIOGRAPHIES OF RESEARCHERS

Numpon Mahayotsanun received the B.S. /M.S. degree in Mechanical Engineering from Northwestern University in 2005. He has been a PhD student of Mechanical Engineering at Northwestern University. Research interests include microforming and draw-in sensor.