

# Report on Visit to Sungkyunkwan University in Korea by International Training Program

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I participated in long-term dispatch of International Training Program (ITP) and researched at Sungkyunkwan University (SKKU) in Korea for 60 days from December 9th, 2011 to February 6th, 2012, so I will report it.

### About host institution

Sungkyunkwan University has campuses in Seoul city and Suwon city. I visited Center for Advanced Plasma Surface Technology (CAPST) of the Suwon campuses where physical science departments gathered in.

In CAPST, the advanced research in various fields such as the development and evaluation of new functionality film materials made with plasma and plasma diagnostics are performed. This is in spacious building which has experimental equipment for common use in the basement and another building. For example, clean room, X-Ray Diffraction (XRD) are. This time, I am assigned to the laboratory of professor Han who is director of CAPST and researched.

The laboratory of Professor Han is researching chiefly plasma enhanced chemical vapor deposition (PECVD) and magnetron sputtering and there are so many experimental devices and film evaluation devices in there so they have advanced technologies of depositing and thin film analysis.

### About experiment

#### • Research theme in Korea

In my master course, I have studied trajectory of ions in RF magnetron plasma to improve the deposition process, but I had not deposited oxide thin films. So I would like to apply to this ITP program which provides precious chances for students on purpose to learn deposition technique and equipment to analyze thin film properties in Sungkyunkwan University.

When I visited laboratory of Professor Han, Mr. Shim

Byeong Cheol was first grader of master course. He studied deposition of ZnO thin film as transparent Conductive Oxide (TCO) using magnetron plasma sputtering and the thin film analysis, so I did research with him.

#### • Research Purpose

TCO thin film is widely used as photovoltaic system, organic electroluminescence, touch panel, display and so on. At the present time, the most major TCO thin film is Indium Tin Oxide (ITO) which is easily processed and has low electrical resistivity. But ITO is made from rare metals, so it's high costs.

In contrast AZO which is ZnO doped  $Al_2O_3$  is very reasonable. Then our purpose is deposition of AZO thin film which has low electrical resistivity and high transmittance. The details are as fellows, electrical resistivity is less than  $10^{-14} \Omega \cdot cm$  and transmittance is more than 90%.

#### • Experiment

As stated above, I did my research with laboratory of Professor Han's graduate student Mr. Shim.



Fig.1 CAPST is in this Building

We used RF Facing Target Sputtering equipment to deposit AZO film. Sputter Target metal was  $\text{AnO}/\text{Al}_2\text{O}_3$  (98:2 wt %). Ar and  $\text{O}_2$  as insert gas were provided from the chamber upper part of the position distant 12 cm. Also we evacuate from the bottom by rotary pump and turbo-molecular pump. We used glass as substrate. Adjustable process parameters are distance between target and substrate, input power density, working pressure and ratio of Ar to  $\text{O}_2$ .

What we did for film analysis are follow. First film thickness was measured by surface roughness measuring instrument by stylus method and deposition rate was calculated. Next we measured the film by XRD and checked the crystal structure of the AZO thin film. And we calculated grain size from full width at half maximum.

### About lifestyle

#### • Lifestyle in the laboratory

There were laboratory meeting at every Tuesday and the doctor in the laboratory reported about the study reports last week and this week's schedule. At the first week I and Mr. Sadasue introduced each theme in Japan. After that when we talked about theme in Korea with Professor Lee, I decided to research with Mr. Shim. At the first time, Mr. Shim has to do term examinations and laboratory-moving. For that reasons, he can't do a research together so I studied about magnetron plasma sputtering by reading a book and an article that Ms. Kim introduced me. Also I don't have knowledge about TCO thin film so it was helpful for research about TCO thin film with Mr. Shim. We did an experiment about deposition of thin film together on the late half. Deposition of TCO film using RF magnetron plasma took about 1 hour to make 1 sample. I was surprised that he get back home at 2 a.m. For a long time when we emit plasma for deposition, we have to stay in front of equipment. When Mr. shim used this time to do date reduction, his presentation slides were made already by English. That's why I realized their high English skills.

Another Korean student's characteristic which I found is they have an animated discussion about experiment with one's fellow students. When they didn't understand, they went their senior for advice. At that time, student who was doctor consider studiously and advice about what we have to do. Then I felt a strong connection between students. That's



Fig.2 Lunch of food delivery service

why I thought that I should follow their attitude.

We usually eat lunch at some cafeterias in the university and the price was very inexpensive that was about 250 yen. That university has three more cafeterias whose menu is different. I was surprised because my university's cafeterias provide us with similar menu. We eat in the laboratory using food delivery service when they were busy for an exam or an experiment. I thought students in Korea have very high motivation for study because they saved even lunch time.

When It became January, three overseas students from Thailand and Mr. Lu who was a overseas student from my university came to the laboratory of Professor Han. Laboratory had six overseas students. I was asked to show Thai students around the laboratory and town. Then I had a chance to explain my theme by English. The experience taught me it's difficult to explain my research theme without presentation slides. Also, two secretaries who can speak Japanese took care of us in research and lifestyle, thank you.

#### • Lifestyle in the guesthouse

This time I used the university's guest house to stay for two months with Mr. Sadasue and Mr. Lu. The room was very large and there were all home electronic appliances and furniture such as television, bed, refrigerator, laundry machine and cleaner so I could use the equipment without inconvenience. I usually go to supermarket near the station to buy some foodstuff because I did my own breakfast and dinner. I experienced rare case in Japan that I bought something without price tag because it seems that Korean

culture has commodities without price tag. The Price except for meat was as low as the price in Japanese supermarket. At first I had a hard time because I don't understand how to buy vegetables. By the way about an network environment we borrowed wi-fi router from laboratory, so we were very comfortable.

It's very cold in winter in Korea. For example, there is a day when the highest temperature is minus degrees celsius. But the floor heating system was introduced at the guesthouse and not only the floor but the room was very warm. Even we were sometimes hot in the room because we don't understand how to do a temperature control very much. In addition the air was very dry so a snowfall is rare in Suwon city.

After January 2 Mr. Lu joined us. We started to share living quarters of three. It will be a good experiment for me to communicate in English with roommate. But the most difficult trouble was the turn of bathing.

#### • Lifestyle in rest day

I usually went around Seoul by train for sightseeing or shopping in my rest days. We can go to Seoul by train about one hour without changing the line and the price was not as high as in Japan that almost about 300 yen at round trip so I could travel easily to Seoul.

I went to the East Gate, Myongdong (Seoul's downtown). In Myongdong there were many shops around the streets and very ebullient. I was very surprised that almost all the salesclerks can speak Japanese.



Fig.3 Guesthouse which we stayed

After that I asked laboratory's members about it. They told me salesclerks in Myongdong can speak Japanese because Myongdong is business quarter for Japanese. Similarly there are business quarters for Europe, Korean and so on.

Else I went to Hwaseong Fortress which is a world cultural heritage in Suwon city. This is a fortress made in era of dynasty of Korea. I walked a round of a flat castle wall like the Grate Wall of China for about two hours. There are some wonderful gates on the way. That impressed me grandeur.



Fig.4 Suwon Hwaseong Fortress

#### Through life in Korea

At first anxiety filled my heart before I studied in Korea. There were so many worrying things such as a single life , sharing a flat ,whether Korean people could understand my words and so on. However, thanks to people who welcomed me warmly I could pass off without big accident for two months. I could experience the extraordinary and meet many foreigners and my field of vision is widened through coming in touch with different sense of values. I thought this experience is very useful in the society when is being increasingly globalized.

About research, I had become to see my theme from different point of view. It was not easy to communicate in English. But if I didn't talk positively, it don't go forward. I was able to come to feel the importance of conveying my thought positively.

There are many conditions which make me consider about not only the research. In addition this time had a chance communicate with not only Korean student but Thai student. That's why I had a good time in ITP. I want to study hard with the international consciousness that I learned this time for my future.

Finally I'd like to express my gratitude to professor Han, all CAPST members who welcomed me warmly and ITP staffs who gave me this opportunity.