

# **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 in Korea for 60 days from December 3rd, 2009 to January 31st, 2010, I will report it as follows.

Sungkyunkwan university have two places of campuses in Seoul city and the Suwon city. I visited Center for Advanced Plasma Surface Technology (CAPST) of the Suwon city 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. The building was spacious and there were many facilities such as experimental devices for common use and clean room. 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. We had the meeting that contained professor from 9:30 on every Monday, and the student of the doctor course reported the progress of the study for a week. Active opinions flew from the both sides of the professor and student, and I was able to spend very significant time because I participated in substantial meeting every time. I was easy to be familiar with the laboratory because the study that I performed in Japan was about microcrystalline silicon thin film deposition and there were many similar research contents. As for the student of the laboratory, they are devoted to research and did their best for everything such as experiment or desk work, and there were many points that I should learn. There were the foreign students who came from China and Finland, and everybody had a global viewpoint and most of them wanted to study or work abroad in the future. In addition, I was

surprised that Korean students were superiority in language ability and all the members had English ability of daily conversation. I could argue in English in the meeting and felt that their routine custom of speaking in English was connected for improvement of their English ability. I could recognize inferiority in my English skill and take good stimulation by living together with them. I kept that I talked in English positively not to be defeated by them in mind.

Including Professor Han, the laboratory's members were so kind to me. Especially, I am taken care of by students, who took me out for dinner to the restaurant district near the university almost every day. When I decided the dish which I wanted to eat, I really had a hard time because I couldn't communicate in English in the downtown and read the Hangeul letters. However, I could eat a wide variety of Korean food and get used to Korean food culture quickly thanks to them because they introduced recommended cooking and explained it what kind of cooking it was. They worried whether the Korean foods suit my taste or not because almost all of Korean foods are very hot. But I really enjoyed eating them because I like hot food. I spent every day with being impressed good taste and service of the



Fig.1 The library of Sungkyunkwan university

Korean restaurant. We sometimes played Korea-style billiard after dinner and were able to deepen a close friendship each other. Not only I but also they were interested in each country's culture very much and they asked me about various things such as Japanese food, movie and so on. They had been to Japan many times for K-J workshop and I could hear their experiences. They asked sharp question by the viewpoint which is different from Japanese. It was often that I couldn't answer and thought that there are a lot of Japanese cultures which we don't know. The opportunities to think about one's culture increased thanks to their indication and I realized that cross-cultural communication was splendid opportunity to think about the both culture of own country and other country. Also, I got support very much in an aspect of living by the secretary of CAPST, Mrs. Kim who can speak Japanese well because she has stayed in Japan in past times. She could teach me the difference of Japanese culture and Korean culture because she knew the Japanese culture well. Therefore I was able to fit Korean life quickly.

I stayed at the guest house for foreign visitors which were next to Sungkyunkwan university for 60 days. I was able to live comfortably because the essential things for life such as household electrical appliance, kitchens, shower room and miscellaneous daily goods were prepared and furthermore it was close about 10 minutes by walk from CAPST. Korean winter was very cold and temperature could be less than -10 degrees Celsius, but I could keep a fixed temperature of the room by a floor heater called the Korean stove in the room and I was able to spend warmly.

Before I decided research contents in CAPST, I did simple self-introduction at the time of the first meeting and got the information about their research by their introduction. I could know the summary of their study and served as reference very much when I decided my study theme. Also, I observed the whole laboratory and received explanation about each experimental device. I felt that it is easy to make an experiment because the laboratory is large and neat cleanly. In addition, I could visit the laboratory of Professor Lee for the consideration of Professor Han. The laboratory of Professor Lee also performed the study of the field of etching and biomedical application, and there were many interesting study themes. I had an opportunity to talk directly with

Professor Lee, who introduced research contents and guided his laboratory. Finally, I discussed my research topic with Professor Han and decided to research microcrystalline silicon ( $\mu\text{c-Si:H}$ ) thin film deposition which is the same as my topic in Japan with Mr. Youn J. Kim who is doctor course student. I research gas-phase diagnostics of  $\text{SiH}_4/\text{H}_2$  microwave excited plasma for microcrystalline silicon thin film solar cell application in Japan. But I have never deposited microcrystalline silicon thin film on substrate and evaluated film quality. Therefore I thought that I can make use of researching and discussing with Mr. Youn J. Kim who has many experience of film quality evaluation for the future research in Japan.

To date the photovoltaic power generation attracted attention very much to improve both energy problem and environmental problem. The silicon thin film can be made by plasma enhanced chemical vapor deposition with  $\text{SiH}_4/\text{H}_2$  mixture gas and the research is performed for application to the solar cell. The silicon thin film solar cell is attracted attention because it can reduce silicon raw materials and energy payback time is short in comparison with the crystal silicon solar cell. In silicon thin film, microcrystalline silicon thin film has the advantage of wide-range spectral sensitivities and excellent stabilities against light exposure compared to amorphous silicon ( $\text{a-Si:H}$ ) thin film. However high-speed deposition technology becomes a key of high productivity and low cost because thick film is required due to low light absorption coefficient. In addition, improvement of the generation efficiency by the high quality of the film and the reduction of production cost by the large substrate are the assignment, too.

At first, I and Mr. Youn J. Kim made a presentation about our research results each other to understand each research before I start to research in CAPST. Each other studies the same field, but we are using different plasma source and different concepts. There were many things I didn't understand. I asked him on the spot and tried to understand it. Then we discussed about experimental detail and made research plan. The PECVD apparatus which I used in Korea had new plasma source applying for a patent.  $\text{SiH}_4$  and  $\text{H}_2$  mixture gas was supplied from cathode shower head in chamber and RF power of 13.56MHz was applied to it. As

the result, Capacitively Coupled Plasma (CCP) was generated. The facing electrode which set up glass substrate was possible to heat with a heater and we could deposit a thin film with constant substrate temperature. Furthermore, stick electrodes were installed between the RF electrodes and it was possible to generate secondary plasma by applying VHF(146MHz) or UHF (314MHz). So far the silicon thin film which made with this PECVD apparatus was evaluated by various analysis technique such as Raman Spectroscopy, FT-IR(Fourier Transform Infrared Spectroscopy), XRD(X-Ray Diffraction). This time, we decided to measure the emission of light in plasma such as SiH\*, Si\*, H<sub>α</sub> by Optical Emission Spectrometry (OES) as evaluation of the plasma because he already evaluated the quality of film by various technique. Also, we were going to observe microcrystalline phase and amorphous phase of film which is made in high crystallization rate condition and high deposition rate condition by Transmission Electron Microscope (TEM). I presented this research plan at the laboratory meeting.

I actually studied with Korean students and felt that they had many study themes and extensive knowledge. I think that it is because they undertake everything with the utmost energy. Therefore I was impressed that they use their time well and always advance toward the results of research. In addition, they can consider for results properly and I felt that they are superior to think about what to do next from the result by themselves. If they didn't have the knowledge about next experimental preparations, they consulted not only the students of the same laboratory but also the students of other laboratories and solved the problem. Then I felt a strong connection between students because other members willingly gave advice and actually helped them. That's why I thought that I should follow their attitude.

Finally, I made a presentation about the result of research in Korea to the laboratory's members. So far I had not made a presentation in English. Therefore it was a good experience that I could understand the difficulty of conveying research contents in English through the preparations and presentation during my staying. In addition, I think that my English ability improved by daily life conversation in English and presentation compared to past ability. After the last presentation, a teacher checked my presentation document

immediately and I could get the advice about my wrong point of English and improvement of the presentation. I could correct my mistake immediately and it was easy to enter my mind thanks to his quick teaching. I felt that the education of such teachers was earnest like Japan. On the other hand, they talked to us openheartedly at the time of year-end party and New Year party. Of course they were strict at the university, but I felt they really cared about the students. I'm very honored to research with the teachers for two months.

I had various valuable experiences by living in Korea through ITP. As the results, I experienced the difference of culture and the experience that were not provided at all when I was in Japan. For sightseeing, I visited the Changdokkung Palace designated as a world heritage and the Namsangol Hanok Village which has many Korean traditional houses. When I visited the Changdokkung Palace, there was the Japanese guide and I could observe Korean royal court before my eyes and was able to know how the imperial family lived there. When I visited the Namsangol Hanok Village, I could see various traditional houses and was able to imagine the state in the then house and life scenery. Traditional industrial art objects and old toys were put and it was the institution which anyone enjoys it and can learn culture. By the way, there are a lot of people professing Christianity in Korea. The people of the various generations prayed in a chapel when I visited the church on a holiday. There was the time when only young people pray and then they celebrated the person who has birthday on this week and spent happy time with singing a song and playing



Fig.2 Changdokkung Palace

musical instruments. It seems that there is the time when young people teach study to small children or play together. I had impressed that some religion were obstinate, but my thought really changed by experiencing it. These experiences became the property in my life because they changed my past concept greatly and I could widen my view of the world. I think that globalization in the world goes ahead in the future and the connection with the world becomes important. I am convinced that the strength that I have stayed in the foreign country is useful very much in my future.

At first anxiety filled my heart when I studied in Korea. There were so many worrying things such as whether Korean people could understand my words, whether I could communicate fluently, whether I could be familiar with Korean life and so on. However, I could meet many foreigners and exchange each opinion with them and my

field of vision is widened through actual study in Korea. I was able to talk about not only the research but also Korean culture or their private life and so on. It was difficult to communicate in English, but I was able to reaffirm the importance of conveying my thought to them. I listened to mental attitude as the engineer from Professor Han at the end of the year. He said that we should imagine the world and ourselves after five years or ten years and decide upon a definite goal. Then we should think about what we can do for our goal today. In addition, I learned that we always should act with looking at the world. 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.