

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

## Affiliation Graduate School of Engineering, Nagoya University Name Keisuke Sadasue

I report that I participated Inter National Program (ITP) and stayed at Sungkyunkwan University in Korea 60 days from the date of December 9, 2011 to February 6, 2012.

### **【Dispatch destination】**

Sungkyunkwan University campus has two places in the city of Seoul and Suwon. Seoul campus has a faculty of physical education and the humanities. This time, I visited to the Center for Advanced Plasma Surface Technology (CAPST) of Suwon campus undergraduate science gathering.

In CAPST, they research about functional thin films fabricated using plasma process. I visited the laboratory of Professor Han serve as the director of the CAPST. Professor Han's laboratory has been focused on the formation of functional thin films using plasma enhanced chemical vapor deposition (PECVD) and magnetron sputtering, and has excellent device and equipment about thin films.

### **【Research】**

#### <Research in Korea>

In our laboratory, we have been focused on ultra-hydrophobic thin film using PECVD and SAM. So, I decided that I learn about ultra-hydrophobic thin film in Korea.

#### <Introduction>

Hydrophobic thin films have been applied to various things such as a front glass for automobiles and a display of mobile phones. In general, we call hydrophobic that the contact angle exceeds  $90^\circ$  and ultra-hydrophobic that the contact angle exceeds  $150^\circ$ . In order to improve contact angle, it is necessary to surface roughness structure and hydrophobic functional groups. In nature, lotus leaves have these structures and show ultra-hydrophobic. In recent years, many researchers focus on "biomimetics" that is inspired by



Fig.1 CAPST

its function and structure of organisms to reproduce artificially them for application to various fields of materials science and engineering, and medicine etc.

#### <Purpose>

I tried to fabricate ultra-hydrophobic thin film on the glass substrate using PECVD with the aim of the contact angle is over  $150^\circ$ . Also, I examined how it changes surface structure and functional groups with the change of conditions.

#### <Experiment>

I did experiment with Mr. Joon S. Lee who is a master course student. At first, we formed silicon oxide film on the glass substrate using RF capacitively coupled plasma CVD apparatus. We supplied OMCTS with oxygen gas as a precursor from the shower head of the upper electrode. The bottom electrode has a structure that can be applied to the substrate RF bias that we can control the hardness of the silicon oxide film by RF bias. Then, we took hydrophobic treatment by PECVD using HMDS with hydrogen gas. In this research, we changed RF power supply and the flow rate of hydrogen gas. We evaluated the samples using RGA to

analysis of residual gas in the plasma, AFM for surface morphology, contact angle measurements for surface energy and FT-IR to investigate the chemical bonding state.

<Results>

Fig.2 shows that value of the contact angle with the change of RF power. With the increase in RF power, the value of contact angle was improved. In addition, when we input RF power to 140W, the value of the contact angle was increased to non-linear. Because of this, we can guess that the structure of the film changed when we input RF power to 140W.

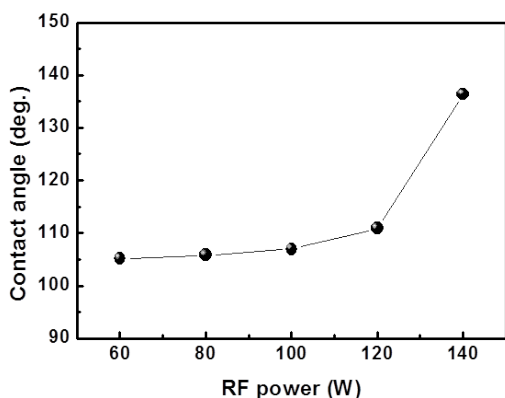


Fig.2 Contact angle measurement

Fig.3 and 4 show the results of AFM and FT-IR when we changed RF power. According to the both of the results that changed non-linear when we input RF power to 140W, we can consider that we could obtain much surface structure and hydrophobic functional group.

The data is omitted, increasing the flow rate of hydrogen gas, the value of the contact angle is further improved, and some samples showed ultra-hydrophobic.

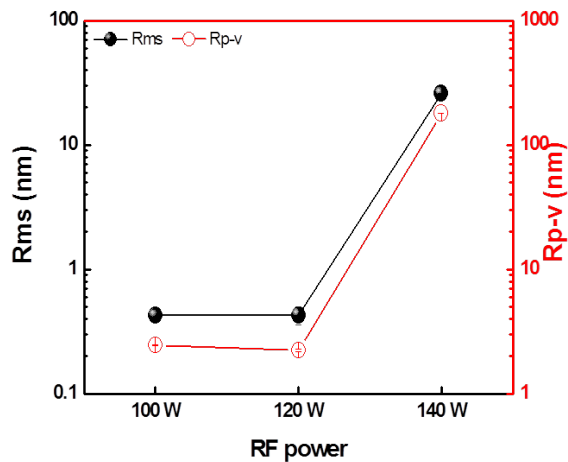


Fig.3 AFM

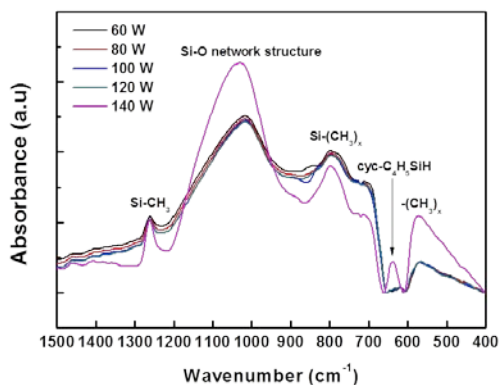


Fig.4 FT-IR spectrum

**[Livelihood]**

<Laboratry>

Basically, I go to the laboratory about 10 o'clock every day. In the morning, we usually did desk works such as reading papers and making documents for conference. I read some paper about hydrophobic film that Mr. Lee recommended me. We mainly did experiment in the afternoon. At night, I have had returned to home at about 19 o'clock but mostly Korean students seemed to stay late at night.

The first two weeks, I mainly looked on the facility in CAPST. It was very stimulating for me that I have never seen some experimental apparatus in CAPST.



Fig.5 PECVD system that I used

I used to take lunch at the dining room in the campus. And there are three places in the campus.. The price is about ¥200~300 that it is cheaper than Japan.

In the laboratory, we often took delivery for the dinner. There are not only Korean food but also Chinese food and pizza, so I think that it has been developed than Japan.

I went to the ski only once with member of the laboratory. It was great experience for me to do winter sports in Korea. Besides, they took me to various places such as Korean sashimi and cuisine. It was very compliments that I had a chance to go out for drink several times during my stay. I learned for the first time that they have a habit of drinking beer mixed with shochu in Korea.



Fig.6 ski trail in Korea

<Guesthouse>

The guesthouse that I stayed this time is located in approximately 5 minutes by walk from the university. There

are fully equipped with furniture and a bed, refrigerator, internet access so that I was able to live in the same way as Japan. In addition, there is equipped with floor heating so that it was very comfortable. In Korea, it is always below freezing temperatures from December to February and often snow, so the floor heating was great equipment.



Fig.7 the view from the guesthouse

<Holidays>

Basically, it was off on Saturday and Sunday that I went to Seoul by train for sightseeing. It took about an hour to the Seoul station and the interval of the train was not deferent from Japan. There are many people around Seoul and Myeong dong. In addition to the direction of Seoul, I went to Chang'an gate which is a World Heritage Site. I was able to walk over the wall like the Great Wall of China.



Fig.8 Chang'an gate

### **【Summary】**

It was a great experience for me that I stayed and conducted research for 60 days in Korea through long-term ITP. It was the first time for me to stay in a foreign country that I was very anxious in the beginning, but I was able to finish ITP safely because Korean students were very kind and gentle for me. Also, I realized the difficulty of communicating in English. I will try to actively communicate in English with foreign students in my laboratory.

In a study, it was good stimulating for me that I learned about the attitude and thinking of the research of Korean students. I want to conduct research in the future to utilize what I have learned this time.

Finally, I appreciate ITP officials for giving me such a great opportunity and Professor Han and all the members of his laboratory for supporting me staying in Korea.