

Report on Visit to Ruhr-University Bochum by International Training Program

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I have a chance to study in Ruhr-University Bochum in long-term placement program of ITP. The program is successfully finished and this is the report of my stay. The program is performed with Prof. Dr. Uwe Czarnetzki group for 61 days from January 6 to March 7 in 2010.

Ruhr-University Bochum and Research group

Ruhr University Bochum is the state university on Bochum city in North Rhine-Westphalia. The university locates on the southern area from central downtown of Bochum. It takes only for 10 minutes by subway from Bochum Hauptbahnhof to university. The buildings of the campus stand on hill and there are many trees at the south part of the campus. If it is fine day, you can see beautiful scenery. The campus is really large. But we can easily go to lecture rooms and restaurant, because adjacent buildings composed of same department and they are combined with pedestrian deck. In the campus, there is calm and these research environments help me to make good study.

There are many departments in Ruhr University. The major of this research group is the experimental physics, and belongs to "Center for Plasma Science and Technology (CPST)" which is one of the plasma centers in Germany. Many plasma researchers not only Germany but also other countries come and study there.

At Prof. Dr. Czarnetzki group, they have emission spectroscopy, laser induced fluorescence method, and plasma is measured by these optical methods. Capacitively Coupled Plasma (CCP), inductively coupled plasma (ICP) and micro hollow cathode discharge is analyzed by using the comparison of calculation and optical measurement.

Research theme

I hoped that the experiment of study at this research group which makes active research about plasma physics, gives me

beneficial experiments. In my basic and master cause, I developed the application technique of atmospheric pressure plasma. And in Ph. D cause, my major study is plasma medical application for interaction of the plasma and biomaterial. My knowledge is disproportionate on sample and its measurement system, because my major study is application region. But in the course of my study, I found it very difficult to get correct data without control the state of plasma based on plasma physics. Plasma is dramatically changed on the condition. More over there is an individual difference of the biomaterials and which can be changed easily, it is difficult to find dominant parameter near the clinical setting. It is really important to get a deep understanding of plasma physics.

Before starting the program, I had a chance to talk about the study with Prof. Dr. Czarnetzki and I can make good study which is accommodate a program along my study of Ph. D cause. These electron density and electron temperature in micro hollow cathode discharge is generated in atmospheric pressure, is measured by using Laser Thomson scattering. This study was performed with Ms. Du. She is the Ph. D student of the research group.



Fig. 1 Ruhr University Bochum

Background of the study

Previously, plasma was controlled with the instrument parameter such as system of power supply, power applied on the electrodes, pressure and process gas. However, there are many kinds of plasma source and further refinement system is needed. It is very difficult to control the plasma enough by instrument parameter. Therefore, it is very important to measure inner parameter such as electron, ion and radical. Plasma diagnosis is performed with these parameters. The density and temperature of electron is one of the most important parameter of all.

In order to realize low cost and simple structure, the process in the atmospheric pressure is required to be established these days. In atmospheric pressure, distance of the electrodes is set short, because mean free path becomes shorter. Our micro hollow cathode plasma has many advantages which is easy to generate in atmospheric pressure, low power and high electron density should be realized by hollow cathode effect.

Probe method, micro wave using method and optical measurement are useful method to measure the plasma diagnosis. In atmospheric pressure, electron density becomes higher, because of that high pressure. We can't use probe measurement which is usually used in low pressure. Micro wave is useful only micro wave plasma and it is not good at our low frequency hollow cathode plasma. In optical measurement, Stark broadening of hydrogen Balmer-beta line is one for the famous method, but electron density estimated to be higher. Laser Thomson scattering is one of the useful method of noble gas based plasma.

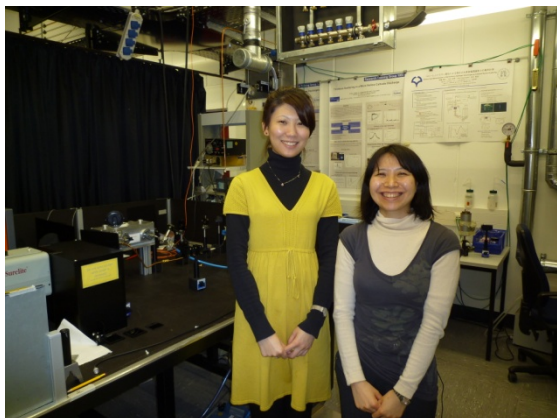


Fig. 2 Experiment at the laboratory

However, there is a big problem in micro plasma measurement. Laser beam should be focused on micro region and it is very difficult to get clear signal. For this reason, there is no exact measurement result before. It is important to measure the temperature and density of the electron in this plasma.

Progress of the study

At the first week, I had good chance to make experiment with many researchers. Dr. Luggenhoelscher took me around the laboratory. I could make experiments with Mr. Schuenge, Ms. Mueller and Ms. Du. I didn't have enough knowledge to use high energy laser then. Ms. Du teaches me the usage of the laser from basic technique for safety. In order to make me naturalize the laboratory life, I took lunch and coffee break with them. In this laboratory, they are in good society and they make discussions about study. I had a great time.

In the 2nd and 3rd week, experiment with Ms. Du started. We measured the characteristics of current and voltage between the electrodes of micro hollow cathode plasma. I read some papers such as H. Schoenbach, M. Moselhy, W. Shi, and R. Bentley, J. Vac. Sci. Technol. A Volume 21, Issue 4, pp. 1260-1265 (2003), Journal of Physics D: Applied Physics, A. Rousseau and X. Aubert, J. Phys. D: Appl. Phys. Vol. 39 pp1619 (2006) to better understand of micro plasma.

After the 4th week, we adjusted the optical axis of the laser system. It is very important to control the beam profile, because laser beam should be focused into the micro region. Almost all of the optical instruments set on the X-Y-Z stage move at micro meter intervals. Even if one optical instrument set on the system, beam profile was checked by using burn paper and beam analyzer. It took many times to check the beam profile which made to be collimated beam and focused. These efforts made the beam focused into the electrodes, and ideal beam profile was realized. After the adjustment, we set up inner optical system of the chamber and make adjustment of spectrometer. I also measured the lamp profile which would be used other process.

Study environment at the laboratory

I can get enough support from Prof. Dr. Czarnetzki, scientist, office administrator, Ph. D course and master

course students, and Engineer officers in the laboratory. They set up good space such as office desk and surroundings of PC work. My study life was really comfortable.

The weekly schedule of the laboratory, they have a meeting and seminar. The meeting was held on Tuesday 10 a.m. They made presentations of the weekly report. The seminar was held on Friday around 10 a.m. Students made report of the results of their studies. I had a good chance to study about the diagnosis of several plasma sources. Some doctors came from other research center also made presentation. I had required many things. The meeting and seminar was held in English. Nevertheless, I only had some basic knowledge of plasma physics before the ITP program. I could understand details, because they spoke fluent English.

There were many lectures which were made by the doctors came from other universities in the campus. I had many chances to attend the lecture from plasma diagnostics, plasma application and semiconductor to plasma cosmology. In addition, researchers came from domestic other research center, China and Bulgaria also studied together. In that laboratory, many students have the chance to make experiment at other university. I think there is really good place to study about plasma.

Life and sightseeing

When I arrived at Bochum city, Prof. Dr. Czarnetzki came to pick me up at Bochum Hauptbahnhof. I could make residential agreement of apartment easily. The first day of going to university, Dr. Luggenhoelscher took me to the university. When I went back to Japan, Ms. Du helped me and saw off. I stayed same apartment during my 2 months stay. It took 20 minutes walk to the laboratory. The apartment has shower room and kitchen, is very useful near the subway station. I could also use internet there. There is a simple explanation for the stay in English and German. But I felt confusion about garbage, laboratory members helped me

I took lunch at the restaurant called "MENZA" in the campus. The menu changed every day. Ms. Du and many colleagues gave me explanation politely, I could buy smoothly. Most people eat potatoes and pasta as a staple

food, but we can also eat rice. The rice is only indica rice, but dry carry and boiled with vegetables rice are same as Japanese style. They also eat many salads and boiled vegetables as subsidiaries, it is good for health. I bought breakfast and dinner at Uni Center near university. My cooking time became shorter and easy to eat, because there are many kinds of processed foods such as sausages, hams, jarred vegetables, canned fruits and breads.

I could speak only some words in German; it is difficult to eat alone. Friends of laboratory took me many places, I ate many kind of food; local dishes of Bochum, carry sausage, Chinese food, Mexican food.

Bochum city is located on the Ruhr industrial area. If you go south along Rhein River, there are many kinds of factory from car to beer. There are many solar cells on houses. If you go suburb, you can see many systems of wind power generation. I felt the German effort of making clean energy against for environmental problems.

I went to the mining museum in Essen city and Japanese section of the town in Düsseldorf city with friends. Professor recommended Germany Mining Museum in Bochum and festival of Düsseldorf in the middle on February. Both of the mining museums in Essen and Bochum, there is tunnels of mine under the ground. I saw the model of mining and display about the development of instruments such as Shovel, drill and lantern in Bochum city. I can learn details of the mining. The mining museum in Essen is larger than that of Bochum; rail line for the transportation of coal and many other mining buildings are also remained on the ground. There are many display of the local history, geological deposit near Essen city and pictures of medieval city surrounded by a moat. Pictures and sculptures in Germany which made by unknown people, are also realistic. I was strongly impressed and I could know that these exact records played important role on the great development since industrial revolution. I had a very profitable experience as a scientist, because if I were in Japan, there is little chance to see historical records of the Industrial Revolution.

It was a lot of snow this year, there were much snow on the ground from arrival to departure. I had no good chance to see beautiful flower scenery from the train's window. But I'm lackey, no train was delayed and train service ran smoothly. It was my first stay in Europe and traveling alone.

It was difficult to travel many places like seniors of last year. With warm help of many people, I could make good experiment a lot about German culture and my stay became meaningful.

Conclusion and acknowledgment

During this stay I usually talk in English. This system made my communication skills better. It was good chance for me to become an international researcher. I hope to keep in touch with the friends in Germany.

Before this program, I thought there may be many program because this was my first stay in Germany was a long-term study abroad alone. With many support, I could perform this program. It is very happy thing for me that the member of Ruhr University Bochum took care of my stay. I believe that this experience should play important role of further improvement on my Ph. D study.

Finally, I really appreciate for Prof. Dr. Czarnetzki and Research Center for Plasma ITP Secretariat staff at Nagoya University.