Report of the third overseas training

2015 / 2 / 23～2015/ 3/ 1

Massachusetts Institute of Technology, USA

東京大学
統合物質科学リーダー養成プログラム
MERIT
Materials Education program for the future leaders in Research, Industry, and Technology

Contents

Preface

This overseas training was conducted for 7 days from Feb. 23, 2015 to Mar. 1, 2015 as a part of Materials Education program for the future leaders in Research. Industry, and Technology (MERIT). 24 students who visited Massachusetts Institute of Technology (MIT), other universities and research institutes was chosen by “Department of Applied Physics”, “Department of Materials Engineering”, “Department of Applied Chemistry”, “Department of Chemical System Engineering” and “Department of Chemistry & Biotechnology” from Graduate School of Engineering, “Department of Physics” and “Department of Chemistry” from Graduate School of Science and “Department of Advanced Materials Science” from Graduate School of Frontier Sciences.

We visited MIT on Feb. 24 and observed facilities of MIT in the morning, and then we visited Prof. Lionel C. Kimerling from Department of Materials Science and Engineering. We can act by ourselves from Feb. 25 to Feb. 27. The details of these activities are written in the part of personal report.

Finally, I sincerely appreciate all the instructors including Prof. Toshihiko Koseki, who is the program director, Prof. Masashi Kawasaki, who is the program coordinator, and Assistant Prof. Takeshi Momose and Special Lecturer Masaki Nakano who are the leaders of this overseas training. I deeply thank all the people who helped and supported this training.

All the members of this overseas training

Schedule

2/ 23

11:00　Departure from Narita international airport

13:36　Arrival at Boston Logan international airport

2/ 24

9:50　Arrival at Massachusetts Institute of Technology

10:00～11:30　Campus tour

13:30～16:30　Lab. tour of Prof. Kimerling’s group

16:30～18:00　Dinner with the members of Prof. Kimerling’s group

2/ 25

Free activities

2/ 26

Free activities

2/ 27

Free activities

2/ 28

9:03　Departure from Boston Logan international airport

3/ 1

20:35　Arrival at Narita international airport

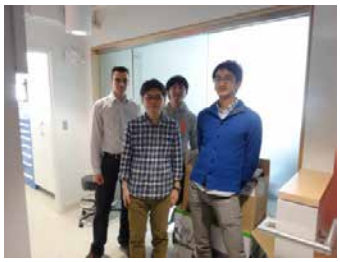
Yusuke Sugita, Department of Applied Physics

I joined MERIT overseas training program and have visited several research institutes in Boston for about one week. In particular, we could organize the visiting plan in three days from February 25 so that I decided to go to the laboratories of condensed matter theory, condensed matter experiment, and cold atom experiment. I report the contents I experienced in the three days.

The picture with Mr. Vijay.

First, I visited the Liang Fu group in the condensed matter theory division of MIT on February 25. Mr. Vijay introduced us to the colleagues of the Fu group and we presented the research themes with each others. The Fu group conducts the extensive study on topological phenomena in the condensed matter physics. Mr. Vijay studies the entanglement spectrum in the topological states and another member analyzes the emergence of topological phenomena in the real materials.

Next, I visited the Hoffman laboratory in Harvard University on February 26. This laboratory researches the nanoscale electronic and magnetic properties of the materials using the scanning tunneling microscope (STM) and the atomic force microscope. The STM equipment is connected to the molecular beam epitaxy equipment to keep the sample clean. The members of the Hoffman Lab explained the way of observing the surface state of the topological insulator by STM and the surface magnetic structure by the spin polarized STM.



The picture with Mr. Preiss.

I also visited Hidenori Tanaka, who is the Ph. D. student of Harvard University. He told me various experience in the life at Harvard University. According to his talk, it seems that many students in America have the frontier spirit and tend to try challenging topics of physics, such as non-equilibrium physics and quantum biophysics.

Finally, I visited Greiner laboratory in Harvard University on February 27. This laboratory simulates quantum phenomena using ultra cold gases in

optical lattices. Mr. Preiss guided the experimental equipments and introduced their recent research results. It is of the great interest that they can observe the quantum dynamics phenomena, such as the Bloch oscillation, using the clod atom systems in optical lattices. In addition, Mr. Preiss told us that the recent trend is to simulate the phenomena induced by magnetic field and spin-orbit coupling in the condensed matter.

I became confident in the research communication in English through this overseas training though I was aware of the need to study English. I would like to continue the challenge to the overseas research activity. Last but not least, I thank MERIT staff for giving this precious opportunity.

Report: MERIT overseas training

Department of applied physics M1
Keita Hamamoto

【Feb. 24th Visit to Kimerling Lab.】

We all members visited Kimerling laboratory in MIT. We saw so many kinds of experimental stuffs such as light emitting device made of Germanium crystal and the equipment for optical measurement and crystal growth. I could manage to understand the explanation about the experimental setup and background theory although I had not got used to the sound of English. They can find the impurity or disorder with atomic-scale spatial resolution and eliminate them by thermal annealing. This technique enables them to fabricate highly pure single crystal of Germanium. Honestly speaking, I am not so familiar with experimental equipment, but I did not feel that these are extremely better than that in Todai. We carried out a variety of discussion with students in laboratories close to Kimerling lab. When it came to the topic of other than research, it was very hard to catch what they said, but it was not impossible if I could ask again correctly. During the discussion, one Chinese student asked us "So large number of Chinese and Korean students are studying in MIT, but why you Japanese don't study abroad?" Since I could not answer clearly at that time, I consider carefully after arriving Japan. There are institutional problems such as credit exchange and economic assistance but the largest problem is the conservative nature of Japanese. For the latter problem, this overseas training can be the foothold to overcome the large barrier.

【Feb. 25th Visit to Fu Lab.】

On the first day of free activity, we visited to Liang Fu's laboratory in MIT. They study about, for example, topological crystalline insulator and topological superconductor theoretically which is very similar to our laboratory; Nagaosa lab. This visit was realized due to the close relation between Fu's group and Nagaosa

group and help of Nagaosa-sensei. Since prof. Fu was very busy because of doctoral thesis and America Physical Society, a student named Sagar assisted our visit. At the beginning, he guided us around the laboratory of condensed matter theory in MIT. It was true that discussion plays the central role in research activity in the US. Students in different laboratory share the same room, transparent doors encourage them to go in and out, and there are so many blackboards, chairs and desks in hallway. Although our department mimics them, it was more thorough. Sagar called some students and they gave us the introduction of their research using one of these blackboards. I was impressed that the explanations and motivations were very clear even though these students were suddenly asked to talk about their study. Research topics were very similar to those of ours, but they didn't rely on numerical calculation. They used only paper and pens (or blackboard and chalks) and they piled up abstract and conceptual discussion. They showed us the proof of the existence of topological phase transition in extremely general system. Their logical thinking and large amount of knowledge impressed us so much.

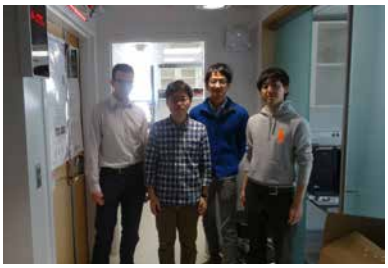
【Feb. 26th Visit to Hoffman Lab.】

On the second day, we visited the Hoffman's laboratory in the Harvard university. They synthesize the so many kinds of thin films and explore the surface state of materials using STM measurement. At the beginning, they showed us a small room which was floating by something like a air dumper and completely eliminated the external vibration. In this highly vibration-free room, they can observe the surface state of material in atomic scale resolution at low temperature and with strong magnetic field. STM measurement equipment is connected to the molecular beam epitaxy (MBE) chamber, therefore, they can explore the fresh surface of air-sensitive thin films. I asked whether they can observe a skyrmion which is my research topic and whose size is around 100nm, and their answer "100nm is too large to see the whole shape." surprised us. The

knowledge about what we can do experimentally is important for theorists.

After the visit to the Hoffman's lab., we met Hidenori Tanaka who was once a colleague in our department and is a Harvard student now. They told us the much about the daily life in Harvard and Boston. According to him, in the department of physics in the US, they study the fundamental subject such as quantum mechanics and statistical mechanics again using advanced textbooks at the first grade of graduate school. This high level basic knowledge enables them to make a sophisticated discussion.

【Feb. 27th Visit to Greiner Lab.



On the final day, we visited the Greiner laboratory of the Harvard university. They study about cold atom experimentally and recently they have succeeded in high-speed switching between superfluid and Mott insulator. In cold atom system, they can make arbitrary shape of potential energy and modulate the strength of interaction between atoms, this system can play the role of simulator of electrons in solid material. Especially, for us, theorists, a bit "artificial" situation and systems with unrealistic values of parameters can be realized in cold atom, we should know what we they can do and what they cannot. The Harvard university is very famous for cold atom since they have realized the Bose-Einstein condensation experimentally and there are many laboratories in both experiment and theory divisions In Greiner lab. They can observe atoms atoms with very high spatial- and time-resolution and can watch the dynamics of them. This technique enabled them to clarify the difference of the 1-dimensional dynamics due to the statistics of bosons and fermions. The theoretical back ground was sophisticated, we could have a meaningful discussion. Experimental facilities such as densely assembled optics and ion trapping system were impressive.

【Overall impressions】

In this overseas training, I visited mainly experimental laboratories. I didn't think that the experimental equipment in MIT or Harvard is much better than those in Todai. However, in terms of interaction between laboratories and rich personal relations are quite better than those in Japan. This oversea experience let me realize that the research life abroad is very attractive and now I fell the hurdle is lowered. I still have a bit anxious about my English skill, but there were no large inconvenience in discussion of research topic.

【American Physical Society March Meeting】

After the activities in Boston, I moved to San Antonio, Texas to attend the APS march meeting. Many student from all over the world attended that meeting to have a result to make a presentation in an international conference. Honestly speaking, the levels of presentation were not so high. Therefore I attended only the sessions which are highly related to my research and invited talk, but there were so many sessions that I had to walk around whole days. Here again, the main purpose of participants was probably to make personal relations. Actually, so many speakers were caught by audience after presentation and had discussions. I really wanted to talk there and establish the connections with researchers all over the world.

【acknowledgement】

I wish to acknowledge all the parties concerned for their assistance of our visit.

Especially, let me express my sincere gratitude once again to Nakano-sensei and Momose-sensei for their kind treatment for us.

Dept. of applied physics, Year 1 Hidetoshi Masuda

We had three days of free activities time and I visited Checkelsky lab and Zwierlein lab in MIT on the first day, Hoffman lab in Harvard on the second, and Gedik lab in MIT on the third day.

2015/2/25 Joseph Checkelsky lab (MIT)

Checkelsky lab is experimentally working on strongly correlated systems and topological materials. They not only conduct measurement experiment but also synthesize bulk samples by themselves, which is rare in USA. Ms. Ye Linda showed me the lab facilities. They have variety of synthesis equipment that has been used in other labs, and several measurement systems under setup. After that, I discussed with Ms. Ye, Dr. Suzuki Takehito and Mr. Aravind Devarakonda on my research topic. Ms. Ye, Who was doing her research in University of Tokyo since last year, talked me about her recent research topic and unique point of MIT compared to UT.

2015/2/25 Martin Zwierlein lab (MIT)

Zwierlein lab is working on ultracold atoms and laser trapping technique. Mr. Zhenjie Yan showed me the laboratory, including the room in which the first Bose-Einstein condensate of ultracold atoms was realized. Although I could not see many of the labs because of dangerous laser experiments, I was really impressed to see complicated optical systems and measurement equipment. Mr. Yan also explained about his research. They are tryng to mimic superconducting state in real condensed matter and obtain better understanding of strongly correlated system by tuning interaction between fermions. After that, Mr. QingYang Wang who graduated Dept. of Physics, UT and then joined Zwierlein lab.

2015/2/26 Jenny Hoffman lab (Harvard Univ.)

Hoffman lab is doing research on solid state physics using Scanning Tunneling Microscopy (STM) and Atomic Force Microscopy (AFM). Dr. Zhihuai Zhu showed me the laboratory. STM and AFM are highly sensitive

technique that can offer high resolution of atomic scale. Care was taken to avoid external vibration and obtain high quality data. Furthermore, samples grown by molecular beam epitaxy method are measured in-situ in order to obtain atomically flat and clean sample surface. Establishment of synthesis condition is one of the hardest part of the research.

2015/2/27 Nuh Gedik lab (MIT)

Gedik lab uses various kinds of optical measurement techniques. Dr. Daniel Pilon showed me the laboratory. They have rich variety of optical measurement equipment, including spin- and time-resolved angular resolved photoemission spectroscopy, TeraHertz laser generation, pomp-probe spectroscopy and circular dichroism. Several instruments including ultrafast electron diffraction were under setup. This rich variety is their strong point; although other labs have more sensitive and high-performance, almost all information on electronic structure of a material can be obtained in Gedik lab. He also talked me about difficult point in instrument setup and interesting point of optical measurements.

Others

Here I describe on overall impression of the overseas training; including what I felt while I talked with students in Kimerling lab, Ms. Ye and Dr. Suzuki in Checkelsky lab an Mr. Wang in Zwierlein lab.

Mr. Wang strongly emphasized that variety of students are studying in MIT and Harvard compared to UT. Most of the students are from other universities; some are marvelous in mathematics and physics; some are not very good at physics but are talented in electric circuit and handworks. This diversity is an excitement in MIT.

Other interesting point is frequent interaction with other laboratories. Physics department holds exchanges and colloquiums frequently, and condensed matter physics students sometimes attend to colloquium on astrophysics. Now we have some chance of such an exchange with other fields in MERIT program, but chance is limited to other students in UT.

Michika Onoda

R. Yoshida lab, Department of Materials Engineering

Here I report details of trainings during three days free time. This is the outline of the schedule of trainings:

1st day: Presentation, discussion, lab tour at Andersen lab, MIT.

2nd day: Presentation, discussion at Balazs lab, the University of Pittsburgh.

3rd day: Lab tour at Whitesides lab, Harvard and social gathering of department of materials engineering of MIT.

1st day: Presentation, discussion, lab tour at Andersen lab, MIT.

In Andersen lab, they are mainly focusing on bio-inspired (such as mussels) materials and polymer/polymer gel chemistry. Because my research theme is also one of the bio-inspired polymer materials, I have a strong interest about their researches. In discussion with Prof. Andersen, we could dodge actively opinion. It was very fulfilling time. Also I can partly hear about their future plans. Actually in the lab I have an American friend who I have been known for three years in an international program. In this stay, I met her for the first time in three years. It was very good stimuli to discuss our research topics.

2nd day: Presentation, discussion at Balazs lab, the University of Pittsburgh.

In Balazs lab, their main research topic is simulation of gel and polymer materials. Our research group, R. Yoshida lab, have a connection with them through corroborative research. So they entertained me very carefully and kindly. I really appreciate about that. On the discussion day I have a chance to have one hour seminar

Dinner with Balazs lab members.

about my research topic. The discussion was very tough for me because it was first time for me to speak English for over an hour. I got many questions and comments, so I learned more than I expected. It was very good experience. After my talk they started presentation practice for the annual conference of APS. So the seminar was last for about five hours. It was not short time, but they kept discussing actively including severe questions. I was strongly overwhelmed by them. During my stay in Pittsburgh, they invited me to dinner and short sightseeing. I could listen a lot of topics about research life. I cannot express enough my feelings of appreciation.

3rd day: Lab tour at Whitesides lab, Harvard and social gathering of dept. of materials engineering of MIT.

Whitesides lab is very famous laboratory in the field of chemical engineering. It is the largest chemical engineering laboratory in the Harvard University. In the lab tour I could have a chance to listen about several research topics. Every research theme are filled with full of ideas and all researches are very interesting. Also I was surprised to hear that all research theme were generated by Prof. Whiteside.

With Dr. Alok of Whitesides lab and my friends

After the Lab tour at Whitesides lab, I moved to MIT. In the MIT, fortunately I could attend social gathering of department of materials engineering of MIT thanks to my American friend in Prof. Andersen lab. In the social gathering, there were many students and professors. I could exchange my opinion with them. One Ph. D students are coming from Asia after he got Master degree. I talked a lot with him about study abroad. It is true that there is a risk to study abroad, but I learned that nothing happens if I afraid to take risks. Also I had a chance to have one professor. I also wanted to visit her laboratory, but in this stay I could not visit because we did not have convenient day. Fortunately I can have short discussion with her. She said to me to have a discussion when I get next chance to visit MIT. I felt honored. In Boston, there are MRS Fall Meeting. In near the future I want to realize the visit.

Acknowledgement

This overseas training were conducted with the help of a lot of persons concerned. Dr. Momose and Dr. Nakano lead us in the stay. Prof. Ichikawa support my request and permit to visit the University of Pittsburgh. Secretariat of MERIT kindly did many procedures about this program. In my stay, many professors, researchers, students and my friends hosted me and gave me a precious experiences. My friends in MIT hosted me very kindly and helped me many times. Also I can share the experience of this program with MERIT students, and there are a lot of person I cannot list up hear who helped me. Thank you very much for all.

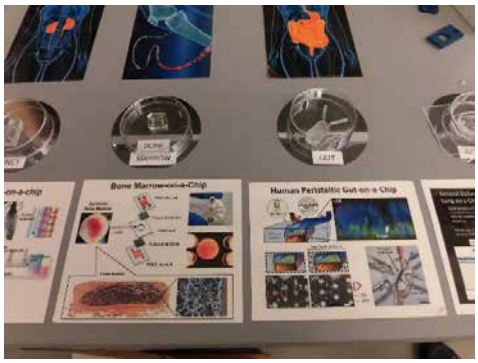
Department Materials Engineering　M1　Hiroto Satake

In this program, I went to Boston where world's leading universities and research institutions such as MIT and Harvard gathered and visited their laboratories and communicated with researchers. This experience was very stimulating for me and affected the stance on my research activity. My research field is biosensing and I visited laboratories where the studies about biology and biosensing were conducted. Here I want to report about that visiting.

On first day, I visited Liber laboratory in Harvard University. In that laboratory, the techniques about silicon nanowire were studied and sensing of biological phenomena such as the activity of mouse brain's cell was conducted as an application of nanowire. The shape of nanowire is very fine and more suitable to monitor inner phenomena of biological samples compared with dish biosensor I usually use. Nanowire was produced by CVD process and many kinds of devices can be made by changing gas fraction.

CVD equipment (Liber lab)

On the second day, I visited Silver laboratory in Harvard Medical School. This laboratory was studying very various biological phenomena relevant to cell reprograming and one of their studies was micro flow device which imitated the environment of organs and could be used to elucidate the mechanism and to monitor the effect of medicines. The most impressive thing was that the scale of one research institute was very large and equipment and human resources were very satisfactory compared with ours. For example, about the control of temperature, this laboratory had many freezers which were set to maintain the appropriate temperature to save different samples such as -80℃to cells, -30℃to enzymes and 4℃to medium and the



Micro flow device imitating organs (Silver lab)

room whose temperature was kept 4℃ for work and reaction process. Moreover they had a transmission electron microscope to observe biological molecules and facilities to produce biosensors by oneself. I think their environment was best to study biology because they could ideally control the condition of biological phenomena, analyzers and biosensors.

On the third day, I visited Mizuno laboratory in Harvard Medical School. Ph.D. Mizuno is an expert on the study of articular cartilage and now studying the culture system to cultivate regenerative chondrocytes in the condition of hydrostatic pressure loading. In the discussion, he gave me much valuable advice about my study from the perspective of cell and sensor, so I want to apply them to future research.

This overseas training was very significant for me because the experience I gained through this program broadened my outlook to the study of biosensing.

Acknowledgement

About this overseas training, I would like to thank professors who planed this program, MERIT staff members, Prof. Momose and Prof.Nakano who led us in this training and all members in laboratories I visited. Thanks to their support, I had very meaningful time without getting involved in trouble. I am deeply grateful to them.

Naoto Yoshinaga, Department of Materials Engineering

Research Activities

We visited the laboratory of Prof. Kimerling on 24th February and had a relationship with Kimerling lab members. In this meeting we had a chance to ask questions to Prof. Kimerling and he told us the policy to be "a good leader". He also said that it was important to acquire the comprehensive knowledge for having a relationship with those who major the other fields. It is the same to the concept of MERIT and I felt happy because MERIT program is correct to develop world-class leaders.

From 25th to 27th I also visited two laboratories in MIT, Prof. Hammond laboratory and Assistant Prof. Johnson laboratory. Prof. Hammond have reported a lot of research results about drug delivery system (DDS), which is also our research field. Firstly they showed me the experimental room and devices. These experimental environment is almost same to ours. I thought that The University of Tokyo was not inferior to MIT and we had to be proud of our university. After the lab tour, I discussed researches with Hammond lab members. The opportunity to discuss researches with her laboratory members was very significant for me. Because we had much time to discuss it, I could ask the details of their studies.

From 26th to 27th I visited Assistant Prof. Johnson laboratory. Assistant Prof. Johnson came to The University of Tokyo. At that time I asked him to visit his laboratory and he allowed. In this visit I mainly discussed their researches with almost all students. I was very surprised at their high level of awareness. Even younger students had the pride about their studies and I thought that I needed to put more effort in.

The chance to explain my study to outside people in English was the third time. In terms of speaking and listening to English, I am still inexperienced. However I got the confidence to talk in English because I could tell my thought thoroughly.

Through this oversea training trip, I was able to gain many valuable experiences. Also this trip gave me motivation to do researches with more effort. Because there were a lot of activities during this trip, I felt that it was a quick 5 days. However, I

convince that this trip will be provisions for the future. Above all I would like to value the relationship to those who I met in Boston.

Acknowledgement

This oversea training trip was financially supported by MERIT. We thank Dr. Nakano, Dr. Momose and all MERIT staffs. I also thank Prof. Kimerling, Prof. Hammond, Prof. Johnson and all people I met in this trip.

Overseas training program report

Department of materials engineering 1st year master's student
Watanabe Laboratory
Jaekyun Hwang

I am looking forward to going this overseas training program because not only it is my first USA visiting, but MIT is one of the most famous university in the world. However, I suffered from making appointments with MIT professors. I think they are very busy for their researches, and many of them misunderstood about this visiting is finding position opening. I met Professor Ceder directly at NIMS, Tsukuba for talk to him, and also I make an international phone call. After long communications, I can make appointments for this visiting, and finished this program successfully.

2/24(Tuesday, Common schedule)

・MIT campus tour, discussion with Prof. Kimerling and staffs

Real schedules in this visiting are start from Tuesday, and it just looks like a rehearsal of schedules from tomorrow. Even research topic is different from my research, it is quite interesting to discuss with MIT staffs for research topics, or just chat. Most interesting session was talking to MIT students after lab tour. Unfortunately, time was not enough to talk long, I can hear about student's life in MIT.

2/25 (Wednesday, 1st day of self-schedule)

・MIT Ceder Lab (Prof. Gerbrand Ceder)

First day of self-scheduled period start from visiting Ceder group. Professor Ceder is very famous for first principle calculations to batteries and 'The Materials Project'. Unfortunately, I cannot meet Professor Ceder directly because he is absent in this visiting period. But, I can meet some postdoctoral assistants. Firstly, they introduce their lab members, and facilities.

Very impressed point in first introduction is their member's diversity. Certainly main research of Ceder laboratory is first-principle calculations,

however, background of 1/3 of lab members is experimental research. And, they have full set of experimental equipment from synthesize new cathode materials to assemble, and evaluate Li-ion batteries. Then, they can experimentally verify their own calculation results very efficiently. I think this is very enviable point, because of Watanabe laboratory, which I belong to, has no experimental ability. And, they also said this kind of internal collaboration, and fast-communication accelerates their research without time-wasting.

Experimental discussion in Ceder group is most helpful for my research directly in this visiting schedule. Because of 'The Materials Project' and their outcome is very similar to my research in terms of methodology. They give me some important comments and ideas for my research.

2/26 (Thursday, 2nd day of self-schedule)

・MIT class 3.70 (Prof. Harry L. Tuller), Library tour

I choose the class 3.70 because of their subject is very similar to my research, energy problem. The title of this class is 'Materials Science and Engineering of Clean Energy'. Contents of this class has some fuel cell systems, same as my research, however, I cannot choose specific class by fixed visiting schedules. Say from conclusion, I was very lucky to choose special class. This class is not an experimental class; however, professor prepares some simple experimental materials each class.

Class topic when I visit was thermoelectric generation. Class started from basic physical concept of thermoelectric effects, and proceeded to latest research topics. Then, took some simple experiments for calculate efficiency of Peltier device which handed out before starting class. At the end of the class, professor threw some questions about government policies, role of companies, realistic possibilities, and so on.

Contents of class were very well-organized for growing up both theoretical concept and sense of realism. Most impressive point was they ask questions during class, and said 'at the previous slide, why ~?'. Also, many students told their own ideas to professor's question.

Also, I visit some MIT & Harvard libraries, and some libraries in Boston.

All MIT libraries I visit were open for visitors, and easy to feel their atmosphere. And 3 libraries provide group study space by 24/7; of course ID card is necessary for using this service. Of course, sleeping is very important, but this system may be able to help some students. On the contrary, all of Harvard libraries did not allow entering of public. Also, I visit Boston public library, and Boston athenaeum, and they are focused on American history, and arts.

Fig. 1. Letter from Elizabeth I, Queen of England. Boston public library.

Fig. 2. Before starting the

2/27 (Friday, 3rd day of self-schedule)

・MIT Electrochemical energy laboratory (EEL, Prof. Yang Shao-Horn)

Final schedule was visiting EEL, Electrochemical Energy Laboratory. Here is mainly experimental laboratory, and I want to hear about their opinions for my research as experimentalists. Of course, this laboratory also has wide spectrum of lab member's background. Such as, someone is a specialists for synthesize new materials, someone can analyze materials by state-of-the-art method, and someone running first principle simulations. This discussion is

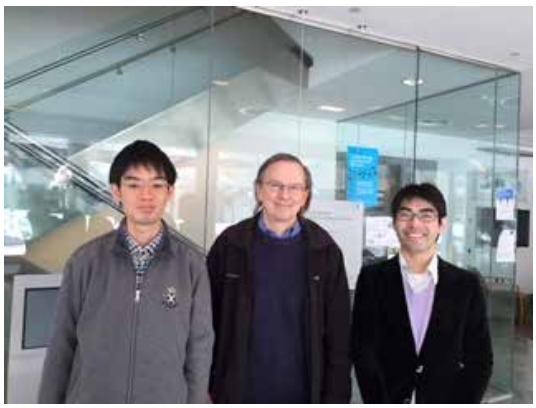
also very helpful meeting for my research. Because our laboratory has no fuel cell experts and I can check, and learn about many things about fuel cells. It is very interesting to present each research with latest papers.

The Department of Applied Chemistry, M1, Kiyohiro ADACHI

I visited 4 laboratories for 3 days in this oversea training and I report about that.

Szostak Laboratory

On the third day of the oversea training, I luckily had a chance to meet with Prof. Szostak in Harvard University. He was awarded the Nobel Prize for Physiology or Medicine in 2009 for the discovery of how chromosomes are protected by telomeres. He is now working on various topics to seek for the origin of life



Ozawa-kun, Prof. Szostak and me.

Ozawa-kun and I met with him in the lobby and there we had a discussion. He kindly gave useful advice after our brief presentation. Then, he told us his recent research topics. He explained so clearly that I was able to understand even though they are remote to my research field. Since they were an exploration for the origin of life with chemical methods, I felt them interesting. In fact, a former member of my laboratory now belongs to his laboratory, and this fact shows that cross-cutting research is possible.

Buchwald Laboratory

I visited Buchwald Laboratory with Hayashi-kun in the afternoon. First, we met with Prof. Buchwald. He has a humor and gave us a calling card written in Japan. I managed to give him a presentation on my research topic in English, but I could not talk about other topics except for research nor understand his American jokes. After the discussion, a Japanese student, who can speak English very fluently, showed us around the laboratory. During this tour, I was happy to talk with many people there, especially with a postdoc who wrote a paper related to our research topic last year.

Swager Laboratory

I visited Swager Laboratory on the 4th day. He is a friend of my boss and has 5 Japanese members in his laboratory. Unfortunately, he had gone out, but I enjoyed

talking with during lunch. His laboratory is divided into two groups, one of which was supported by US Army maybe because his chemical sensor was useful. The laboratory was much larger that that in Japan, and there were so many blackboards and whiteboards so that they can discuss everywhere. He had a technician, who helped his members in many ways.

Langer Laboratory

On the 5th day, I visited Langer Laboratory, one of the biggest laboratories in MIT. Since Prof. Langer was always extremely busy, a postdoc from Vietnam showed us around the laboratory. He was also so busy that we had a short tour and brief conversation. It was unforgettable that he said, 'I want to find new science that no one had ever found.'

Closing Remarks

I found there were many Asian people when I walked on the street in Boston. I tried to hear what they spoke to know if they were Japanese or not, but I could only hear word I could not understand; they spoke Chinese or Korean.

On the 2nd day, we hold a party with Prof. JJ group in MIT, and most of the students were from China. When I asked why the had come to the USA, they answered,

'This is a good place to do research.'

'This university is the best in this field.'

'I want to be the No.1.'

An MIT student who sat down next to me when I was taking a rest on the bench asked me,

'There are many students coming from China and Korea, but why don't Japanese students study abroad?'

We Japanese student may get behind of Chinese and Korean students at least in terms of the will. A lot of students from China and Korea were so vital and had a passion for research. The eyes of Japanese students in MIT were shining.

Now I am writing this report and when I look around I find people around me just do what the have to do without light in the eyes.

It is often said that Japanese technology is the best around the world. We can do research to lead the world, and actually many Japanese scientists really do that. However, when I reflect on myself, I find that I was content with the current circumstances and had not been doing my best. Now I remind myself these famous words again—'Stay hungry, stay foolish.'

I want to finish my report by thanking MERIT staffs, those who welcomed me, MERIT 4th friends and all the people I met in Boston.

Department of applied chemistry, School of Engineering
First year graduate student

Yoshihide Tokunou

Through the free time in the over-sea training, I succeeded in developing my ability for academic aspect. I got much knowledge and got struck with some ideas about research. What I learned in this over-sea training is not limited to such academic aspect. I summarized to 3 points I learned in this over-sea training.

1. Experience about language barrier and culture
2. Experience about accosting and communicate with students in foreign country
3. Way of thinking about doctorial course and research

Before coming to boston, I supposed that I can talk and discuss with student in MIT to some extent. However, I could scarcely have talk even in ordinary conversation, mainly because I could not understand what the students said. In only 7 days I could not develop the ability to speak or listening to English, but I recognized the gap and barrier between my ability and required ability. Furthermore, I experienced about not only such English gap but also cultural gap. Considering the possibility about working abroad in Ph.D in future, this over-sea training provided me good opportunity and motivation for development of English ability and adaptation for foreign culture.

And also, I learned to be active in foreign country. In 2nd day and 3rd day, I went to Boston University, which I did not plan to go, and communicated with the student in the University in order to visit the laboratory, which I really wanted to go. Such an experience gave me confidence, because such activity resulted in visiting the laboratory.

In this over-sea training, I talked with students in Boston and know the way of thinking about doctorial course and research. I was very interested

and excited because each student had each way, and some students had different philosophy. Considering that we can 'feel' such a philosophy face to face, over-sea training has a great advantage.

Hiroyuki Kaneko
Department of Chemical System Engineering

24th February

Although jet lag and poor humidity caused bad physical condition, I attended campus tour, visited laboratories and discussed students with other MERIT members. In the tour, it was difficult for me to understand unfamiliar native-English. However, I enjoyed the atmosphere of MIT, which is something humorous as well as advanced. Episodes about "dome hacking" and unique structure of the building of computer technology were especially interesting.

MIT : at 10th building "Dome"

In the afternoon, we visited Prof. Kimerling's group. Prof. Wada kindly taught me not only his research topic but also features of MIT and manners for international communication between researchers. What I learned there greatly helped my visits from the next day.

25th February

I visited Prof. Dunwei Wang's group at Boston College (BC). Unfortunately he was absent, so I asked Dr. Chu Du to introduce their laboratory. Their field is quite similar to mine, and we know each other well. They have sophisticated technology about atomic layer deposition (ALD) method. I appreciate it that I could have a look at and study the machine very well. They had various "recipes" for many types of metal oxides. The ALD machine itself is common one, but it looked to be

BC : Merkert Chemistry Center

tuned by students carefully.

I also learned equipment which the students were setting up by themselves, and learned the method to analyze the data. The method, a kind of unique impedance spectroscopy, was very exciting for me because it measured kinetics at surface electrochemically.

In this trip, I send them gifts; a deodorizing spray with photocatalyst, a small screwdriver set and a set of frictional ballpoint pens. They laughed because the gifts were not something to eat, but looked enjoying them.

26th February

I moved to New Haven to visit Prof. Gury Brudvig's group. Due to train sick by Amtrak I feel bad a little, but large campus of Yale University healed me. The group are studying about water oxidation using light with complex. He has met my supervisor at some conferences.

Yale : Kline Chemistry Lab

During my visit, a student and the professor had some interesting discussion about organic matter production by reduction of CO_2 or another organic matter. My research topic is also related to reduction of water, so it sounded interesting, but it was too fast for me to comment upon it, which was a regrettable experience.

Fortunately, I could talk about my research to Prof. Brudvig and get precious comments from him. I got nervous in explaining, but managed to tell him key points, I guess. His comments are all essential. Also, he advised some points to improve the visibility of my graphs. He stated his impression of my gifts that they were very impressive and he never forgets me with them.

After discussion, Ms. Julianne kindly introduced the experimental room and her experiment. In their laboratory, what we don't take care so much was taken care there. There were many things to learn about how to

measure accurately the photoelectrochemical property, for example.

27th February

After having a look around the campus of Harvard University, in MIT I visited Prof. Yuriy Roman's group. One of my senior students from my department belongs to there, and he kindly coordinated this visit for me. Their research is reforming fossil gas and sugar, and heterogeneous catalyst. These topics are in the field of chemical system engineering, which is my field too, but not so similar to photocatalyst. I needed to change my presentation slide a little for them, which was good chance to make difference in slide for different audiences. Unfortunately, Prof. Roman had little time to meet me, I had to finish my presentation in 10 minutes or so, but he is very exciting and friendly, and replied to me with a good rhythm during it. This is why I felt so good with giving my presentation.

MIT : A sign for Department of Chemical Engineering

He also looked enjoying with my gift. He demonstrated the frictional pens for other people. I'm very happy for him.

I also had a look around the experimental rooms. The equipment like the system of waste liquid and high pressure N_2 gas looked quite nice, compared with my laboratory. On the other hand, I found a hand-made machine, which looked like that the student had so much labor to set up it. I felt an affinity to it.

Summary and acknowledgment

One of my theme for this study trip was to find an answer to these questions; what are the students' personality in MIT, Harvard and so on, and what are they thinking about? What I felt in this training was that I

can feel an affinity to their thought for research and university, which let me feel comfortable. However, there is a large difference between them and us, I think. They have much larger desire to discussion than us. As Prof. Wada told us, their works are based on perfect understanding and strategy. Prof. Wada said from the viewpoint of teacher, “Japanese students follow teacher’s suggestion obediently, but MIT students never accept it until they are satisfied with close examination.” I guess this style leads to sophisticated research achievements from them.

I am deeply grateful to Mr. Nakano, Mr. Momose, who leaded us for this training, Prof. Wada, who took care of us in MIT, and the MERIT program, which gave me this great opportunity. I would like to express my gratitude to the three professors, who spared their precious time to accept my visit. I would like to make best use of what I experienced in this training for my life as a graduate student and a researcher.

Department of Chemistry and Biotechnology　M1　Koki Sano

【Through the Program】

I had an incentive experience, which I had never had in japan through this MERIT program.　I had a chance to talk not only with MERIT students but also with American students and I could widen my view.　I was motivated to work harder to do my research by this program.　My activities are as follows.

【2/24　Visit to MIT Kimerling Laboratory】

We all joined MIT campus tour and visited Kimerling laboratory on the first day. Undergraduate students took a charge of the campus tour and introduced their campus to us as they talked the history of MIT, so I was really interested in this campus tour.　I thought that I had to know the University of Tokyo deeper like MIT students in order to talk with other students.　After watching Kimerling laboratory, we had a party with the member of Kimerling laboratory.　I felt mainly three things when we talked together; 1) they have own opinion and are independent, 2) they know not only their research but also global issue, politics, history and culture, 3) they really enjoy their research as they do research efficiently.　About 1), when I discussed with them, I intensely felt they had a strong backbone.　They decided what they did.　I think self-discipline is important. About 2), I felt this point when I talked Japanese politics and culture with them.　I am Japanese, so I have some knowledge of Japanese.　However, because they are American, I was surprised when they knew a lot about Japanese politics and culture and Asian issue.　I really felt that at least I had to know the knowledge of my own country when I talk with foreigner.　Furthermore, I would like to study not only my research but also wide knowledge with curiosity.

【2/25 Visit to MIT Holten-Andersen Laboratory】

I visited Niels Holten-Andersen laboratory, Department of Materials Science and Engineering, MIT on the second day.　He studies bio-inspired soft materials, especially focuses on the adhesive ability of blue mussels.　I had a chance to discuss my research in front of the member of the laboratory.　Because my work is also about bio-inspired material, we had a meaningful discussion. In the middle of discussion, I received not only aggressive questions but also good comments and then I understood how high the quality of the laboratory was.

I would like to introduce one episode, which is so impressive for me.　After the meeting, one student came to me and said that she knew professor Kolle, who studied the similar research to mine

and he might give me a good advise. Then, she took me to the professor and introduced him to me though she had a class at that time. Surprisingly, I succeeded to make an appointment of discussion on the next day. I was really surprised by her aggressive and active behavior. Taking into account that department of her and that of professor Kolle are different, I think distance between professors and students is so close and their interaction is active beyond their department.

【2/26 Visit to MIT Swager Laboratory and Kolle Laboratory】

I visited to Swager laboratory, which I had an appointment before and Kolle Laboratory, which I had an appointment the day before. After I had a lunch with postdocs of Swager laboratory, I visited the laboratory with them. Unfortunately, Professore Timothy Swager was absent because of a conference, but postdocs kindly introduced their laboratory and I had a good time. Swager laboratory is a huge laboratory, where they study not only fundamental but also practical research. They mainly study chemical sensor, liquid crystal and electrochemical research based on π -conjugated polymer and established venture companies. Therefore, they have huge area and the area of experimental desk is about four times larger than our desk. Of course, they have much amount of measurement machines and I envy their ideal environment.

After that, I visited Kolle laboratory and discussed with him. Professor Kolle study elastic fiber with tunable structural color based on mechanical stimuli. My work is also about structural color and I had a meaningful discussion. Especially I had a passionate discussion about the future perspectives of structural color.

【2/27 Visit to Harvard University Whitesides Laboratory】

I visited Whitesides laboratory on the forth day. Professor George Whiteside is one of the best chemist as you know. He studies quite various researches and has highest h-index in chemists in life. This time, Dr. Tayi, who is a postdoc in Whitesides laboratory and stayed in our laboratory few years ago, kindly introduced his laboratory and Harvard University. The objective of Whitesides laboratory is ”to fundamentally change the paradigms of science”. They use whole floor and different themes are studied in different room. Therefore, I was taken to postdocs and had a chance to talk with their research. First of all, I really surprised by their broad research theme, such as burning, metamaterials, cheap chemical sensor based on paper, photo-detector using commercially available cheap scanner, inspection of density using magnet sensor based on density, etc… Here, I felt there are mainly two directions. One is fundamental research to unclear the question of scientists or to investigate techniques which help our future lives. The other is practical

research to produce breakthrough idea, which directly lead to industry. Though many laboratories aim to these two objectives, Whitesides laboratory really think of these two things and they do not compromise. I was also shocked to hear that they scarcely synthesize molecule. I think one of the advantages of chemists is the ability to synthesize designed molecules. However, does the compound synthesized by tens of steps come to be practical? I think one answer is an easy method like a Whitesides laboratory if one really wants to make practical materials.

【Acknowledgement】

I would like to express my sincere gratitude to Dr. Momose and Dr. Nakano, who led us to Boston, people in charge of MERIT program, who gave me a chance to visit Boston, and members of each laboratory, who kindly accepted me to visit. I am sure that this experience made me grow a lot. Again, thank you very much.

Dept. of Chem & Biotech (Master's 1st year)
Kazuki Nakayashiki

2/24 Campus Tour & Lionel Kimerling Lab @MIT

Fig. MIT campus.

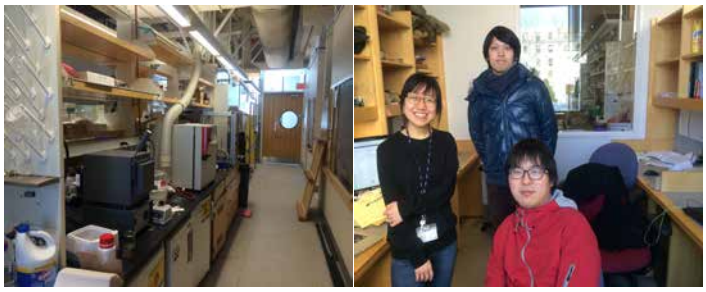
On the first day, we went to the campus tour in MIT. We divided into 2 groups and walked around the campus. In MIT, there were many facilities such as a pool, an archery ground and a gym. The students can use these facilities freely. And there are five dormitories and the students there interact with each other actively. These interactions result in the interaction of the other research field. The laboratory was open to the public, so we can see what they do. Although their study is based on a free idea, the safety is most important. This research style attracted me strongly._

Left Fig. Kimerling Lab

Right Fig. Party with Prof. Kimerling

In the visit to Lionel Kimerling laboratory, we were explained about the semiconductor based on gallium. So far, it was said that gallium did not become the semiconductor. Kimerling group overcame these stereotypes. And they developed these techniques into some applications, especially in the case of a sensor. The lab members made the equipment from the beginning. They take care of the creativity and idea. After the lab visit, we talk with each other in a room in MIT campus. They have a different will for getting the degree of Ph.D and they are ambitious. It was very encouragement to me because they are the same generation.

2/25 Yogesh Surendranath Lab @MIT



Left Fig. Yogesh Lab, Right Fig. with students

On the first day of the voluntary activities, I visited to Yogesh Surendranath group in MIT. In Yogesh group, they clarify the reaction mechanism occurred in the surface of the inorganic materials and develop the application for the catalyst based on the electrochemistry. I discussed our research with Ph.D students using a whiteboard or PC. We exchanged of our ideas and understood mutually. It was very stimulating experience because we were the same age. However, it was a difficult to tell what I want to say in English, and I was embarrassed.

2/26 Timothy Swager Lab @MIT

Left Fig. Lunch, Right Fig. Swager Lab

On the second day of the voluntary activities, I visited to Timothy Swager group in MIT. In Swager laboratory, they research on the development of the sensor for some explosives and synthesis of the 2D polymer monolayer. Some post doctors taught me about the usual life in Boston and the research style. In MIT, the security for the treatment of the reagents was very strict. And in Swager laboratory, each person has each theme and this independency results in the active discussion with each other. The opinion from the person who has the different view was very stimulating because these opinions may lead to a new discovery.

2/27 George Whitesides Lab @Harvard

Left Fig. John Harvard
Right Fig. Lecture hall

On the third day of the voluntary activities, I visited to George Whitesides group in Harvard University. In Whitesides laboratory, they research on ranging from the catalyst imitated the biomolecule to molecular self-assembled materials. We met a few of post doctors and heard their work. I was very impressed by the technique about the float. When they use the strong magnet, the materials in a solution float by the gradient of the density and they can arrange the materials in a solution as they desire. And they utilized this technique to the diagnostic method for the sickle cell disease. These research styles based on the free ideas inspired me strongly. And I wanted to follow a point to raise a study based on the curiosity to a practical use level.

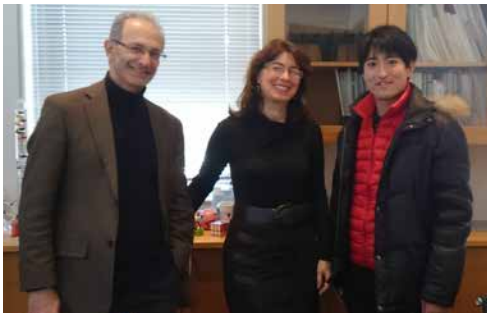
Throughout the whole

In experiencing a laboratory visit as well as a life in Boston, I broadened my outlook for various things. I noticed that the place where we live is very small by seeing Japan from the outside. And I strongly apply for the studying abroad more than before. I think that the free ideas, interactions beyond the field and active discussions contribute to the development of a science technology as well as a research largely. Thorough this program, I could wipe out my stereotype grown in Japan. I want to research with a drastic idea. I thank the person concerned MERIT and all people who I met for giving me some good opportunities.

Department of Chemistry and Biotechnology

M1 Masanari Nakayama

Dr. Michael Aizenberg (Harvard University)



First, I visited Dr. Michael Aizenberg who is a member of Wyss Institute for Biologically Inspired Engineering. He told me about the history of Wyss Institute and I learned Wyss Institute has worked as a bridge between academic society and industry. In addition he showed me around a variety of facilities in Wyss Institute and explained about equipments related to biotechnology and synthetic organic chemistry.

Prof. Joanna Aizenberg (Harvard University)

Next, I visited Professor Joanna Aizenberg in School of Engineering and Applied Science. I really appreciate she took time for me from her busy schedule. Three people in the photo above are Dr. Michael Aizenberg, Prof. Joanna Aizenberg and me from left to right, respectively.

Prof. Timothy Swager Laboratory (MIT)

Dr. Ishihara, Dr. Inamoto Dr. Kawasumi and Dr. Goya in Swager Lab showed us around the facilities. I learned differences from Japan about the way of storage for scientific glassware and chemicals.

George M. Whitesides Laboratory (Harvard University)

Dr. Alok S. Tayi in Whitesides Lab introduced their researches. I was really impressed by the research projects based on extremely free ideas. After that, he showed us around the campus of Harvard University.

At last, I appreciate the staff members who prepared this overseas training, Dr. Momose, Dr. Nakano, Prof. Kato, who helped me make appointments, Dr. Michael Aizenberg, Prof. Timothy M. Swager, George M. Whitesides and menmers in each lab.

Department of Chemistry and Biotechnology, Aida Laboratory
M1　Keiichi YANO

I stayed Boston area in US from Feb. 23th to Mar. 1st in the program of overseas training organized by MERIT. I visited several laboratories in MIT and Harvard University and I would like to make a report about these visits.

Kimerling Group @ MIT

On Feb. 24th, all of the attendees visited a group of Prof. Kimerling who is interested in engineering of semiconductor at MIT. We had a talk given from Prof. Wada (visiting professor) and three students in Kimeriling group concerning their individual researches. I'm especially attracted by the talk given from Prof. Wada. He explained about "why does germanium not emit the light?", "how does he realize a laser made by germanium?", "what is the application of germanium laser if realized?" in understandable way even for the person not familiar with the semiconductors (but in English). It was sincerely fruitful for me to understand the significance of germanium laser.

Fig.1 MIT Great Dome from Killian Court.

Holten-Andersen Group @ MIT

Accompanied by Mr. Michika Onoda from dept. of material engineering, I and my colleague, Mr. Koki Sano, visited Prof. Niels Holten-Andersen in MIT on Feb. 25th and we had a chance to present our research themes in front of lab members. In Holten-Andersen Group, inspired by mussels tightly adhering to rocks in seawater, they studied unique materials utilizing metal-coordination bonding between catechol moiety and metal ions. Although my research theme concerning liquid crystals might be not familiar with them, they gave me a critical advice about the formation of liquid crystalline phase. After our presentations, Prof. Holten-Andersen kindly introduced his research. I enjoyed the way of presentation (I called it as an "American style") and also the research not yet published and discussion about it.

Swager Group @ MIT

On Feb. 26th, I visited Swager Group in MIT. Swager Group has two laboratories, one is in MIT and the other is in Institute for Soldier Nanotechnologies (ISN), and we visited both of them. In ISN facility, since there were the pictures of soldiers with the word of "Enhancing Soldier Survivability", it was strongly came to my mind that the research related to military affairs are studied in this facility. In MIT, the laboratory is so spacious that each person can use one desk and one hood equipped with personal reagent storage individually. In terms of safety managements, the obligation is appeared to be safety glasses alone and no need for lab coats. Since in our laboratory we must wear lab coats and safety glasses during experiments, it seems to me that in US safety managements might be less considered than in Japan.

Whitesides Group @ Harvard University

On Feb. 27th, I and four members (Mr. Koki Sano, Mr. Kazuki Nakayashiki, Mr. Masanari Nakayama and Mr. Michika Onoda) visited Whitesides group kindly introduced by Dr. Alok Tayi. We had short talks from four postdocs in Whitesides group about their individual research. Their research themes are widely diverse such as nano-patterning using colloidal particles, tough fabric made by pressure-bonding Kevlar, paper-based diagnoses for the detection of HIV, and the detection of impurity by means of magnetic levitation. Although their research themes seemed to be different, I felt that they put emphasis on "cheap", "easy" and "universal" technology and materials.

Fig.2 Group photograph at Harvard university. (left) Mr. Onoda, Mr. Nakayashiki, Mr. Nakayama, Mr. Sano, me and Dr. Alok Tayi (right).

Remarks

I felt that scientific research in US seems to be strongly goal-oriented research, not only for daily life but also for military affairs with taking care of cost and environmental issues at the same time. I also felt the cultural deference between US and Japan. In

Japan, homogeneity is regarded as important. Meanwhile, in US, people do not want to be homogenous each other and to be different from others. Following US cultures, to be different from others and show my presence, I trained to convey my opinion and caught up the responses in English as much as I could during staying in Boston. I'm going to continue this way after going back to Japan.

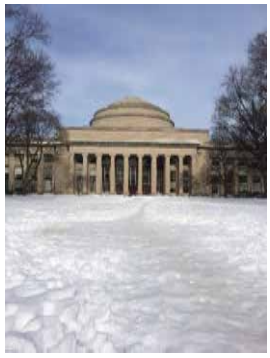
Acknowledgements

I indeed feel thanks to MERIT office members for giving us a good opportunity of overseas training, and also feel thanks to Dr. Takeshi Momose and Dr. Masaki Nakano for organizing whole MIT visiting program. In addition, I sincerely appreciated to Prof. Kimerling, Prof. Holten-Andersen, Prof. Swager and Prof. Whitesides to accept our visits. In Boston, I would like to say thanks to Prof. Wada, Ms. Erica Lai, Dr. Ishihara, Dr. Inamoto, Mr. Tsujimoto, Mr. Goya, Dr. Kawasumi and Dr. Alok Tayi for the kind introduction of each laboratory. Thanks everyone!

Sakurako Tanida (Department of Physics)

From February 23th to March 1st, I participated the over sea training course of MERIT program. We visited universities in Boston and discussed research topics. I would like to report my activities during stay in Boston.

Feb. 24th



We visited MIT as group and observed its facilities in the morning. MIT has many buildings, which underground passages and corridors connect. It is useful especially when it shows. Actually what surprised me the most is many snow. It was lucky for us that we did not have snowy day during our stay in Boston. In the afternoon, we visited Kimerling Lab and received explanations about their experimental facilities. Their research topic delve into optical materials properties and it was flesh for me.

Feb. 25th

I went to Brandeis University, which no other participants of this over sea training had plan to visit. It takes about 20 minutes to go to the Brandeis station from downtown. I visited a lab and discussed about research topics. They work for study of active-matter and some of their experiments use molecular motor. I also use this protein in my research, so that the discussion was beneficial for me.

Feb. 26th

I went to see Ph.D defense at Harvard medical school. An impression of this PhD defense was different from that in University of Tokyo. There were many people in large seminar room including two babies. The speaker explained his three research with humor. The presentation was explicit and easy to understand.

Feb.27th

On the last day, I visited MIT again. I met a student majoring in organic chemistry. She finished the University of Tokyo last year and entered Ph.D course of MIT. Talking with her provided new knowledge about chemistry. At the same time, her flesh words about studying abroad stimulated me.

Department of Physics　Takeru Nakayama

I visited three groups during free time of three days: Liang Hu group in MIT on the first day, Hoffman group in Harvard Univ. on the second day and Greiner group in Harvard Univ. on the third day. In the following, I will report the details of their visiting.

Liang Hu group

Liang Hu group is one of the groups in condensed matter theory group at MIT. They focus on the topological nature that systems have. Recently, Prof. Liang Hu theoretically predicted topological crystalline insulators, which possess unique surface states protected by crystalline symmetry. In this visiting, we had Mr. Sagar, who is a Prof. Liang's student, explain the whole theory group and we discussed with a Prof. Senthil's student. After lunch, we had Mr. Sagar introduce his research topic. However, because I could not understand spoken English and did not have sufficient knowledge about quantum entanglements, I regret asking irrelevant questions.

With Mr. Sagar.

Hoffman group

Hoffman group in Harvard Univ. experimentally studies high temperature superconductor and topological insulator by use of scanning tunneling microscopy and magnetic force microscopy. As I am majoring in theoretical condensed matter physics, this visiting is a good opportunity for me to know the experiment environment. We had the student show the laboratory then I was surprised at a noise and vibration prevention system. My colleague who is majoring in experimental condensed matter physics is also surprised that.　It can also be said to any students in my visiting groups, they intelligibly explained the experimental equipment and research topic as the beginners understand and they looked fun.　I would like to view this attitude as important when I talk to the beginners about my research topic.

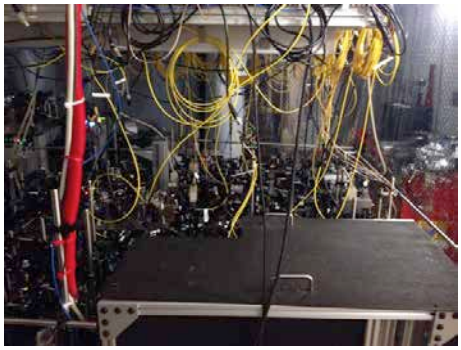
With Prof. Hoffman.

Greiner group

On the third day, we visited Greiner group in Harvard Univ. Harvard Univ. and MIT give high priority to ultra cold atom, Greiner group also is one of the experimental cold atom groups. The reason why I chose this group from many cold atom groups was that Greiner group deals with the topics closely

related my research. It is often said that the advantage of ultra cold atom is that extraordinary controllability of physical parameters compared with conventional condensed matter physics. From theoretical view, it is suitable for verifying the theory of strong correlated physics. However, I had doubted its convenience before I visited.

In this visiting, we had Mr. Philipp, who is a Prof. Greiner's student, explain the research topic with posters and we visit the laboratory. I was surprised that they can count the number of particles in single cite in optical lattice. Then, my doubts are cleared away. Moreover, I exited in the experiment that demonstrates the quantum random walk of the particle in strongly correlated Bloch oscillations in tilted optical lattices by used this technology.



Complex optical instulments

Review

In this training, I felt the language barrier. I learned that I can convey my thought if I do adequate preparation. However, without smooth conversational ball rolling, it is difficult to develop each other's research. And this training was also a good chance for research exchange. Especially, meeting researchers closed to my research really stimulated me. Actually, the emails about my paper, which I submitted after this training, from the students where I visited encourages me.

Acknowledgement

I appreciate Dr. Momose, Dr. Nakano, MERIT secretariat and teachers organized this training, and everyone who accepted my visiting. I also thank MERIT students including Mr. Sugita, Mr. Hamamoto and Mr. Sumi, who contacted Prof. Hoffman.

Department of Chemistry M1 Naoya Ozawa

On the morning of February 24th we took a campus tour of MIT, and that afternoon we visited Kimerling Lab. In the part for individual visit from 25th to 27th, I visited Szostak Lab (Harvard University), Drennan Lab (MIT) and Langer Lab (MIT).

The morning of February 24th: Campus tour of MIT

The guide was a student at MIT. The campus had no fences or gates and was open to the public. There were many buildings with various curious shapes. One of the most interesting things the guide told us was the culture of "hacks". "Hacks" are clever pranks by students, and one of the most famous one was placement of a car on the Great Dome.

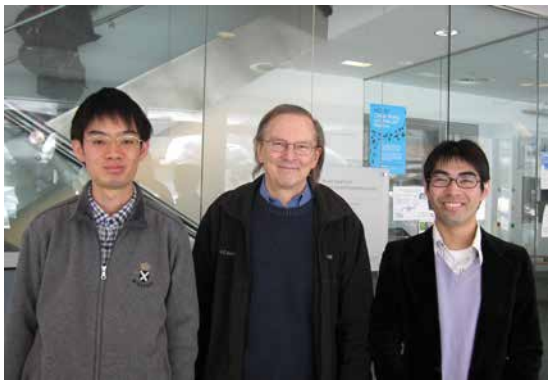
The afternoon of February 24th: Visit to Kimerling Lab (MIT)

The research of Kimerling Lab is centered on interaction between semiconductor and light. Four members of the laboratory explained their research showing us the instruments. Although I knew little about the topics, I managed to understand their work thanks to their clear explanations.

In discussion with members of the laboratory after the tour, I heard that, while many international students studied at MIT, few Japanese students studied there. It seems that students in other countries than Japan are eager to study abroad.

February 25th: Visit to Szostak Lab (Harvard University)

In contrast to MIT, most of the buildings in Harvard University were made of bricks and looked historic.



In the morning, Mr. Adachi and I met Prof. Szostak in the campus. Prof. Szostak developed a methodology that is fundamental to my research. He received a Nobel Prize for research on telomeres. First, I made a short presentation on my research, and the professor gave me some valuable comments. Then, he explained his research for us. His current research focuses on the origin of life. As a model of primitive cells, his group is studying growth of vesicles and non-enzymatic replication of RNA.

In the afternoon, Dr. Kamat, a postdoc in the group, gave me a tour around the laboratory. The laboratory is located at a research institute of MGH 4 km away from the campus, and shared a large room with other groups. After the tour, she introduced me to other members, and we had discussions about each other's research and research life.

February 26th: Visit to Drennan Lab (MIT)

This laboratory investigates the mechanism of metalloenzymes using X-ray crystallography.

First, I talked with Prof. Drennan. One of the most interesting facts she told me was that, in addition to a presentation on their theses, students at MIT had a training course in which they wrote a detailed proposal and received criticism from the faculty. According to the professor, the course is painful for students but is a very good experience.

Then a postdoc, Dr. Bridwell-Rabb, gave me a tour around the laboratory. The laboratory was equipped with robots for screening of crystallization conditions and an X-ray source. Most rooms had a glovebox for manipulation of oxygen-sensitive proteins.

After the tour, a student in Drennan Lab, Mr. Kang, kindly introduced me to Pentelute Lab. The core technology of this laboratory is chemical synthesis of proteins, and I saw a custom-made peptide synthesizer in operation.

February 27th: Visit to Langer Lab (MIT)

I joined Mr. Adachi in visiting Langer Lab. This laboratory is researching drug delivery systems and tissue engineering. A postdoc, Dr. Nguyen, gave us a tour. This laboratory has more than one hundred members, and occupied about four fifths of one floor of the Koch Institute. The laboratory has about six subgroups and has numerous projects in total. I was surprised at his ability when I heard that Prof. Langer understood and contributed to all of the projects.

Acknowledgements

I thank Prof. Kimerling and the member of his group for welcoming us, Prof. Szostak, Prof. Drennan, Prof. Langer, and the members of their groups for kindly accepting my visit, my supervisor for introducing me to Prof. Szostak, the MERIT program for arranging this trip, and Dr. Momose and Dr. Nakano for leading.

Department of Chemistry, Solid State Chemistry laboratory, Dai Kutsuzawa

1. Ramanathan lab.

   I visited Dr. Ramanathan group of Harvard university on the 1st day of free time. His group does great work of electronic device using correlated electron system such as vanadium dioxide, samarium nickelate and so on. Unfortunately I was given only 30 minutes to discuss my study with Dr. Ramanathan because he had the other appointment before and after my visit. Since he spoke at a fast pace and had adept understanding, he taught me a lot of advices such as techniques for synthesis, properties of my target material and so on despite short discussion time.

2. Hoffman lab.

   I visited Prof. Hoffman group of Harvard university on the 2nd day of free time. Her group is eager to uncover new physics and applications which are inaccessible to bulk material by combining layer-by-layer growth and atomic resolution imaging. They synthesize thin film by molecular beam epitaxy and observe the film on a nanoscopic scale by scanning tunneling microscope and atomic force microscope. What I was most surprised was that all of equipment were operated under 10^{-11} Torr. Because I also use the vacuum system routinely but the vacuum pressure is no more than 10^{-9} Torr. I supposed that much technique and money were needed in order to obtain and maintain the higher vacuum.

   At last of the visit, I could talk with Prof. Hoffman a little bit. When I told her that I tried to synthesize a novel functional oxide thin film, she said, “Please let me know when you would synthesize it. That’s because we can measure the electrical property at the atomic level”

3. Ross lab.

   I visited Prof. Ross group of MIT on the 3rd day of free time. Unfortunately I could not meet with Prof. Ross but I could talk with master course students and they showed me around the experimental rooms. Her group is famous for functional magnetic oxide. Her group has high technological skills to fabricate thin films using pulsed laser deposition and to pattern materials using block copolymer. At first, the students introduced their own studies to me. But I’m ashamed to say I asked them a lot of irrelevant questions because I was not familiar with the field so much. However I could get much knowledge about it thanks to their clear explanations.

Next I talked about my study but I supposed they were interested in not only how to fabricate the material but also how to apply it.

4. Summary

Thorough this training, I could get much knowledge and experiment not only about special field but also about non-special ones. Besides, the experience has been very good for me since this was the first time for me to go abroad.

At last, I really appreciate Dr. Momose and Dr. Nakano who escorted us and all of MERIT clerks who gave us the chance of the training. Thank you so much.

Shun Hayashi (Department of Chemistry)

I participated in the oversea training of MERIT program. Here I report the activities in three labs I visited and what I learned from this training.

Feb. 25th: Buchwald lab (MIT)

On the first day of the free activities, I visited Prof. Buchwald's group in MIT. The focus of Prof. Buchwald's work is developing new reactions catalyzed by organometallic complexes. He is known for the coupling reaction of aryl halide and amine called Buchwald-hartwig reaction. The current research areas are developing reactions catalyzed by palladium or cupper complexes and developing catalytic reaction system with flow reactor. He gave me some advices for my research topic about base catalyst from the view of the reaction development. Ms. Ichikawa, who was a classmate in department of chemistry in university of Tokyo and is now a Ph.D. student in MIT, gave me a lab tour. Members in the experimental room gave me brief introductions about their research topics in spite of their business. It's somewhat hard for me to understand their talks, but they gave me a motivation to study English because it's interesting to discuss in English with structural formulas and reaction mechanisms on the windows of draft chambers.

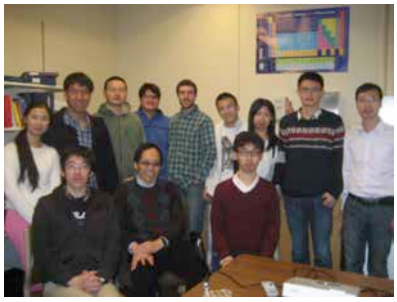
Feb. 26th: Swager lab (MIT)

On the second day I visited Prof. Swager's group in MIT. The focus of Prof. Swager's work is designing functional polymers applied as chemical sensors and liquid crystals. One of his main works is development of polymer that can detect TNT, a main component of explosives. His lab belongs to institute of solider nanotechnology. In fact there was a statue of American soldier in the front of a experimental room, which reminded me of the financial support for military research. Though unfortunately Prof. Swager was absent, postdoctoral researchers from Japan gave me a lab tour. They gave me some advices about the way to choose residence, the tips to buy daily necessities, and the way to overcome the language barrier. My anxiety to go abroad faded a little by finding how they enjoyed the research in foreign country.

Feb. 27th: Wang lab. (Brown university)

On the third day I visited Prof. Wang in Brown university. The focus of Prof. Wang's work is the fundamental behaviors of nanoclusters using photoelectron

spectroscopy and computational techniques and the discovery of fullerene-like boron cluster had an important impact on the field of cluster science. He gave me the opportunity to introduce my research topic to group members and I could get many advices including the one for the result of mass spectrometry. He showed me three apparatuses for mass spectrometry and photoelectron spectroscopy. The one I knew from his paper had been modified and I could learn the principle of the modification. When I entered the experimental room, I was surprised because it was very quiet. In our experimental room, there is loud noise coming from the vacuum pump to reduce the pressure of the apparatus. On the other hand, in his group some of the pumps were isolated in another room and were connected to the apparatus with steel tubes. I could see the apparatus for electrospray ionization mass spectrometry (ESI-MS). The solution of the sample in the syringe is sprayed at ambient atmosphere to be introduced into the apparatus through the capillary. To keep the measurement condition, the introduction part was covered with a transparent box with a window and the humidity in the box was kept stable. Because the conversation in this group was smoother than the first day I visited to America, I was able to have confidence for my English a little.


Wang group

What I learned from this training

In this training I could feel the atmosphere of foreign laboratory, and the barrier of studying abroad was reduced. Although it was hard for me to buy even a couple of coffee on the first day, I got used to the native English and I got a confidence that I could stay abroad. However I found not only the difficulty of speaking English but also the lack of my knowledge. I realized once again the importance to continue to learn in the wide range of fields. I heard that the number of visiting students from Japan was much less than those from China of Korea. It would be sure that the level of the university and laboratory in Japan was high enough so far, but I found that we needed to keep hungry sprits in mind.


Boston from the air
MIT is behind the frozen river.

Acknowledgement

I gratefully thank the organizers of MERIT program for giving me the opportunity and Assist. Prof. Momose and Assist. Prof. Nakano for their support.

Keisuke HIRATA (Master 1st)
Department of Chemistry, School of Science

We went to Boston, where we stayed a week from Feb. 23. All of the students visited Kimerling Laboratory at Massachusetts Institute of Technology (MIT) on Feb. 24. We can visit any laboratory from 2/25 to 2/27.

2/24 Kimerling Lab.

Kimerling group of MIT is famous for research on semiconductor such as MOSFET and so on. We could observe CVD (Chemical vapor deposition) apparatus for thin film growth, a setup for measuring optical properties. After the observation, we communicated with Kimerling's students, which was a great experience. I felt that I had to improve my English skill because I was not able to communicate with the students very much. It was surprising for me that there were plenty of Chinese and Korean students. Japanese students were much less than those, which appeared to be strange for me.

2/25 Mark A. Johnson Lab.

Mark A. Johnson group of Yale University is now mainly researching on IR spectroscopy of clusters that are aggregates of a few to hundreds of atoms. Our group theme is also cluster science, therefore the visit to Johnson's Lab. was exciting. Experimental setup is a giant vacuum system whose length is about 4-5 m and various technology is employed to improve the setup. This is applicable to our experimental setup, so I learned a lot of things from this visit. In addition, I was surprised to feel comfortable even if there was a gigantic setup. This is because experimental room was larger than that of Japan in U.S.A. Johnson's members were kind enough to answer my questions. It was very

Fig1. The picture with Johnson's members

fruitful visit.

2/26 Timothy Swager Lab.

Swager laboratory of MIT is famous for molecular censor using π -coordinated polymers. The experimental setup is not so different as that of Japanese laboratories, but I was impressed with the large experimental space. For example, each student has its own draft chamber.

2/27 Lai-Sheng Wang Lab.

Lai-Sheng Wang's laboratory of Brown University is famous for photoelectron spectroscopy (PES) of isolated clusters. 8 members are Chinese people in total 10 people since Prof. Lai-Sheng Wang is Chinese. However, they spoke only English in the Laboratory. First, I made presentation about my research theme. I thought that I was not able to express everything. This is why I'm now trying to improve my English ability and express my research in both Japanese and English. There are three vacuum setups and one synthesis room. Every vacuum setup is so big that I felt how large the experimental room is in U.S.A. I found some technology that can be useful in my research, so this visit was also meaningful.

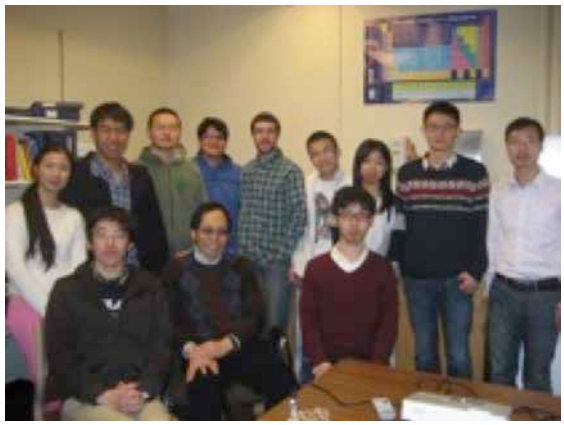


Fig1. The picture with Wang's members

Remarks

I visited 4 laboratories at MIT, Yale University and Brown University. I have learned a lot about research itself, how to progress research, and how to grow up myself. Especially, I found it significant to express myself and get feedback. Japanese people are often said to be shy, however I think we don't have to be shy when we research. I'm going to take an action by myself.

Acknowledgement

I deeply appreciate all the people of the MERIT office, especially assistant professor, Takeshi Momose and special lecturer, Masaki Nakano, for giving us an opportunity for this overseas training. I sincerely appreciate Prof. Kimerling, Prof. Johnson, Prof. Swager, Prof. Wang and all the members of these laboratories for your help and support. I thank my instructor, Prof. Tsukuda for giving me a lot of advice very much. Finally, I express thanks to all the members of the 4th MERIT students who participated in this overseas training.

MERIT Overseas Training

Department of Frontier Sciences
Advanced Materials Science
Masayuki Kishi

【Summary】

This MERIT Overseas Training was performed from Feb. 23 to Mar. 1, 2015. On Feb. 24 all the student visited Kimerling Lab. at MIT, and on Feb. 25-27 I visited Prof. Podzorov Lab. and did an interview in MIT museum.

Through the training I learned it important:

・To have wide interest and make friends who you can ask about the research with ease.

・To consider and analyze carefully when you do experiments.

・To tell your research to people who are not familiar with your research.

【Kimerling Lab. in MIT】

On the first day all the students visited Kimerling Lab. The visit was composed 2 parts: Lab. tour and discussion. In the Lab. tour post doctors explained to us clearly on the research themes. What impressed me the most in the discussion part was what Prof. Wada and Prof. Kimerling talked, that there are world's leading researchers in every fields in MIT and it is easy to discuss with them and start collaborations. That is because I don't understand well even what the neighboring Labs do and I don't often have the opportunity to discuss with students in other Labs. I was surprised that Researchers in MIT are really quick workers. As always told in MERIT seminars or lectures, I recognized the importance to have wide interest and make friends you can ask about the research with ease.

【Podzorov Lab. in Rutgers University】

I visited Prof. Vitaly Podzorov in Rutgers University in the first half of my free visit time. He is one of the most famous researchers in physics of organic semiconductor and Prof. Takeya introduced him to me in the conference held in Japan in last autumn. He toured me in the Lab., let me attend a colloquium in the university and thankfully invited me a dinner with Prof.

Ramamurti Shankar who gave the lecture and Prof. Piers Coleman and Premi Chandra.

In the Lab. tour Prof. Podzorov and a post doctor explained well on the research and machines. I was able to ask questions which otherwise I cannot do. What made me re-consider most was that it is important to consider and analyze data carefully when you do experiments. Although the machines in the Lab. were relatively old, he publish exciting papers by doing careful experiments and analysis. Of course I getting it in my head, I was able to experience the fact directly by visiting his Lab.

After the Lab. tour I attended a colloquium. Prof. Podzorov was one of the coordinators of the seminar and he let me take part in. The professor was Ramamurti Shankar, who wrote famous quantum mechanics textbook "*Principles of Quantum Mechanics*" and the lecture was about "Tragic tale of the mathematical genius Ramanujan". I enjoyed the lecture because it was the first lecture that I take in overseas and the contents was not so hard. However, sometimes I couldn't catch up with the English and couldn't understand his jokes, which was really frustrated. What I thought is different from Japan was that students discussed very actively and that continued even the class was finished. I will learn the way they discuss. In addition to the colloquium, I had dinner with four famous professors; Prof. Shankar, Prof. Podzorov, Prof. Piers Coleman and Prof. Premi Chandra. They talked to me supposing that I speak English fluently, but I sometimes couldn't catch up, which made me really mortified. I need to practice listening to the fast English.

【Interview in the MIT museum】

I interviewed Ms, Joan, a staff in the MIT museum in the last half of my free visit time. The purpose of this interview was to ask what researchers are required for scientific communication. The reason why I get interested in this theme was I heard that in Europe and the U.S., it is strongly recommended, or even obligated in some areas, for researchers to introduce their research to non-professional people; on the other hand in Japan most researchers seem not to be so interested in telling what they research to

citizens. I wanted to know the merit for researchers to give such lectures.

The MIT museum leaded the scientific communication from 1971, setting its mission to engage the wider community with MIT's science, technology and other areas of scholarship in ways that will best serve the nation and the world in the 21st century. The museum opens many sciences cafés and exhibits the work of MIT students. Although the interview was not so long because she was busy, I could hear valuable talks.

First, almost all the students exhibiting their work say that it was really great opportunity to explain their research to non-professional people. This is exactly valuable training the same as what MERIT aims. It should be more difficult to tell non-professionals than to tell researches in other field, so students should consider well to have the audience understood. I thought the communication skill is trained through this kind of training.

In addition, the communication makes the researchers consider the ethics or what the society really want. Usually we wrote abstractions for papers or conference, but we rarely asks ourselves whether it is really longed for or pay attention to other factors for a technology to come true for example ethics. These communication makes researcher not forget these kinds of facts.

【Accknowledgement】

I express gratitude to MERIT program and Prof. Ichikawa, the executive committee of MERIT program, Asst. Prof. Nakano, Asst. Prof Momose for accompanying us, Kimerling Lab, Podzorov Lab, MIT museum for giving me the opportunity to visit, Prof. Coleman, Prof. Chandra and Prof. Shankar for giving me the nice dinner time.

Hiroki Sumi
Department of Frontier Sciences, Advanced Materials Science

I have visited Silvera Lab, Hoffman Lab at Harvard University and Gedik Lab at MIT for three days. I report experimental instruments and experience in each laboratory.

(1) Issac F. Silvera Lab

Silvera Lab is conducting research for phase diagram of hydrogens with super high pressure method. This research is not only in the field of the condensed matter physics but also in that of cold atomic physics. At Harvard Univ., there used to be Prof. Bridgeman, who is an innovator of high pressure physics. It is impressing me that the high pressure technique has been passed down for a long time.

Prof. Silvera has welcomed and discussed me for about one hour. After that, he and his colleagues have shown me their equipment and explained their research to me. They have their own diamond anvil cell per a person, a few set of optics experimental equipment and large dilution refrigerator for low temperature experiment (Fig. 1). It is very regrettable that I did not have an English skill enough to communicate with them.

(2) Jenny Hoffman Lab

Hoffman Lab is conducting research for electric state and physical properties in 2D thin film with STM, AFM, PFM and so on. All of them are so expensive equipment that they rarely can be seen in Japan. But it is unbelievable that these equipment for measurement is jointed to MBI, which is also an expensive instrument for synthesizing a thin film. It cannot be realized in Japanese laboratories because of the too expensive cost and I was shocked to the financial difference between Japanese laboratory and the global laboratory.

(3) Nuh Gedik Lab

Gedik Lab is conducting researches for electric state and optical

properties in strong correlated electric systems with many kind of optic experimental methods like SHG, terahertz light, electron beam diffraction and photoemission spectroscopy. In Gedik lab, there are more than 4 sets of complex optic experimental instruments and the highest time-resolved photoemission spectroscopy instrument. I am dreaming to study there when I succeeded synthesis of a new material as a experimental researcher.

This overseas training is coordinated by leading graduated school, MERIT, especially Prof. Wada, Lec. Momose, Lec. Nakano. I acknowledge their favor. I will work harder with this precious experience.

Sei Takizawa

March 23, 2015

MERIT overseas training report

MIT 2015 winter

This overseas training was very fruitful to me overall. Seeing actual systems, visiting laboratories and having discussions with professors really impressed me, and made me realize the different view of science and working as a researcher. Since this report is going to be open to public viewer, I am afraid that I cannot precisely illustrate what I have seen in each laboratories or contents of discussions because most of them are confidential or patent-related sensitive issues, yet I would like to report what I thought is fairly important in viewing the difference between our research environment and there.

First day Kimerling lab MIT

We visit the Kimerling laboratory first day. we were divided in to the three groups and listened to 4 researches in turn. All of the researchers and students were very passionate and thus there are many interesting discussions.

Second day Beach lab MIT

Google building inside MIT, there are many private corporations

At the Beach lab MIT, I see the equipments and experimental laboratories. Quite interesting system of MIT was there are many shared equipments, from the basic one like the water cutter to the cutting-edge one like the 3D-printer. These are really useful when we consider making systems from the parts-to-parts, and also for prototyping equipments for developing new way to fabricate, process or evaluate device.

Discussions with PhD students and a postdoc there was very exciting. Especially the postdoc of the Beach lab was quite impressive in the sense that he has worked with the dynamic domain wall motion, and wrote many important papers. We had a nice dinner together discussing with difference between academia in Japan and States, student life in general and about magnetic domain wall motion.

Third day Philip Kim lab MIT

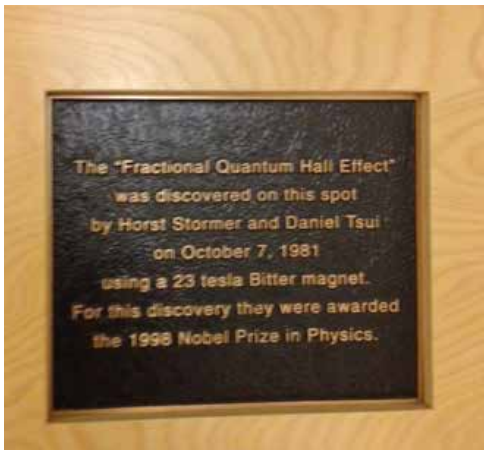
Inside Harvard university, there is the building for advanced material science. There are places for shared equipments and each of instruments has director and manipulator. To use those instruments, researcher has to take tutorial sessions and

through this session, researcher can learn not just how to use these instruments, but how to apply these instruments in advance to fit for each specific samples.

Fourth day Moodera lab MIT

Moodera lab is inside the bitter magnetic laboratory of MIT, which of course took its name from Francis Bitter, well known for Bitter electromagnet. Discussion with the professor was pretty fruitful and it was true honor and prejudice for me to talk with him.

Francis Bitter magnet laboratory, where many researcher made a famous



The place where "Fractional Quantum Hall Effect" was discovered.

Finally, I would like to appreciate all of the accommodator from both MIT and UT, especially Dr.Nakano and Dr.Momose for giving us such a great opportunity.

Takeshi Morimoto

Okamoto&kida Laboratory,

Dept. of Advanced Material Sciences

In this overseas training, I worked at MIT in the first day, and visited three laboratory during three days of free action. I will write contents of actions and impression at each place here.

2/24 MIT all member action

We joined MIT campus tour in a.m. We walk around MIT campus with a MIT undergraduate student. I was impressed that she and other MIT student was proud that they were MIT student and worked on many things actively. I had same impression many times after this tour.

In p.m., we visited Prof. Kimerling Lab. and had research introduction and party. Their research region is not too far from mine. So I was able to understand rough idea of their researches. Students talked very explicitly about their researches meaning and strong points when they were asked about it. It was impressing for me because it was a little difficult for me to answer for these kinds of questions.

2/25 Nelson Lab. Visit

In the first day of free action, I visited Prof. Nelson's group. I was very happy for me to be able to visit them because their research region is very close to mine. When I visit Prof. Nelson's room, He talked about his researches and its idea. Although I don't write about it here because it is very professional, his avid approaches were very impressing. His purpose is very clear and he chooses the most appropriate method to achieve it and develops new method if there is no appropriate method. I have looked at Nelson's group papers and have some knowledge about their researches but it was more interesting to hear the research idea by his own words. I will be able to this kind of talk with all of researchers in the world by English. I was very excited by this thought and re-realize the importance of English.

After the talk with Prof. Nelson, I gave my research presentation for him

and his students and discussed it. All of them asked me many good questions. I thought his student was very competent because their questions were very accurate. Of course, it might be my bias. This discussion was very fruitful for me because I was able to know impression of other researchers about my research.

Last of my visit, I had look around experimental laboratory and facilities. They have huge rooms and many facilities. I thought they were very strong rivals. I had a feeling of closeness when they asked "Do you use this same mirror in your laboratory?"

2/26 Hoffman Lab. visit

At the second day of free action, I visited Prof. Hoffman's laboratory in Harvard Univ. Although I visited them with many friends, they kindly accepted our visit. They use STM technique and I didn't have so much knowledge about STM. However, they kindly answered to my basic questions. In their laboratory, they can make sample with MBE method and they can measure the sample by STM without putting out the sample. This system was very interesting for me. I had known that this system was very grate and expensive by asking for my friends after this visit. This visit was not so long, however, it was good experience for me.

2/27 Gedik Lab. visit

At the last day of free action, I went back to MIT and visited Prof. Gedik's laboratory, who researches optical physics. Although I was not able to meet Prof. Gedik, I had look around all experimental rooms. The most surprising thing about their laboratory was abundance of their facilities. Pump – Probe system with THz, time resolved electron diffraction, time resolved ARPES and so on. This abundance is very grate as one laboratory. Although there were under construct system, they could get almost all information about transient electronic state by their facilities. Students also said it was their strong point.

Lastly,

Although I had a little difficulty about communications because of my poor English, this training was really meaningful for me. I thank for all people who gave me this good chance. I will work much more hardly to maximize this experience.