

Plasma Research and life in Japan

Tokyo Electron Miyagi Ltd

Cedric Thomas

Introduction

I have been in Japan for over 10 years now, coming at the beginning of 2009 as a post-doctoral fellow. It has been a fruitful journey as I could extend my knowledge and work on different applications, from fusion science to advanced equipment for semiconductor industry. Allow me to tell you my story and my thoughts about the life and research in Japan.

From France to Japan: the beginning

I got my PhD in 2008 from Aix-Marseille University in France about the interactions of carbon surfaces with hydrogen beams (ions and atoms) and plasmas, as a model of chemical erosion occurring in tokamaks (thermonuclear fusion reactors) [1]. During my last year, I was able to have some contacts with Prof. Hamaguchi from Osaka University and prepared some application to the JSPS grant program. At the same period, an International Joint Laboratory was being created between my laboratory in France (laboratoire PIIM), CNRS, National Institute for Fusion Science, Kyushu University, and Osaka University to increase collaboration between France and Japan on thermonuclear fusion research.

After getting the JSPS grant, I moved to Japan in beginning of 2009 to join Prof. Hamaguchi's group at Osaka University. At that time, I was not able to speak or read Japanese. During the

first few months of my stay, I could find a place to live, study Japanese and discover Japanese (mostly Kansai) life and culture. The language barrier was obviously the most difficult hurdle to overcome but I have to say that the support given by lab members, Osaka University and the JSPS program was amazing. In a few month, I could master some basics of Japanese, so daily life became easier and I could get more into the Japanese culture. There are many differences between European and Japanese cultures that it would be too long to describe. But I remember when I was introduced to some of Japanese parties such like 花見 (hanami) and 忘年会 (bounenkai). In addition, I discovered so many interesting spots and festivals (まつり) in Kansai area that it made me fall in love with Japan.



Fig. 1 Osaka famous neighborhood

I totally spent 3 years at Osaka University, continuing some work on beam experiments with Prof. Karahashi and trying to build a new

experimental bench. Researching about fundamental interaction of hydrogen and materials for plasma application [2] also lead me to look more into industrial applications and semiconductor industry.

Moving to Tohoku University

Then, in 2012, I moved to a new position at Tohoku University, in Prof. Samukawa's laboratory. My role was to research about neutral beam etching and its application on nano-patterning for quantum dot fabrication (called nano-disks, ND). The process included patterning by bio-template and etching process of Si, III-V, and III-N materials. Quantum dots (QD) are nanoscale crystals that can transport electrons and can emit photons. QD properties are defined by their size which is typically in the range of a few nanometers. From this top-down approach, the point was to etch through a stack of different material of several nanometers-thickness. The main advantage was to reduce size of QD to less than 10nm in diameter and to avoid material stress, uniformity and lens shape issues happening in a bottom-up process.

In addition, etching damages were reduced thanks to the use of Neutral Beam technology, developed in the laboratory [3]. A plasma is generated in an ICP source separated from the process chamber by a biased carbon electrode with high aspect ratio aperture array. Charged particles coming from the plasma are effectively neutralized by colliding the inner walls of the aperture and UV irradiation from the plasma is eliminated.

We had several breakthrough about the III-V

nano-disk system and eventually, we were able to fabricate a ND light emitting diode which showed an intense and narrow photoluminescence (PL) emission [4].



Fig.2 Cherry tree blossoming at Katahira campus, Tohoku University

At the time I joined Prof. Samukawa laboratory, there were multiple on-going projects with several Japanese semiconductor companies. It was impressive to see so many collaborations compared to my experience in France. Of course, such collaboration with industry also exists in France but I felt that Japan has reached a higher level (which I could already experience in Osaka).

Moving to Sendai made me discover a different region of Japan too. Coming from Osaka, I found the difference quite appealing! My most precious discovery was about the people: while people can be loud and somehow short-tempered in Osaka, Sendai people are calmer and more distant (you might think cold to some extent). I realized that we had the same kind of differences in France. Indeed, Marseille, the city in South of France, is known for its loud and short-tempered population while North-East of

France (where I am from) is more similar to Sendai: people usually say that we are cold! Even if separated by thousands of kilometers and having different culture, still some aspects seem universal.

Academic to Industry

Overall, I stayed 4 years at Tohoku University and then decided to join a Japanese company when the opportunity happened. I already knew about it from my work in Tohoku University as we had some collaboration. We even visited the office in Sendai to present our research. So in April 2016, I became an employee of Tokyo Electron Miyagi Ltd, a subsidiary of Tokyo Electron.



Fig.3 View of Tokyo Electron Miyagi

Tokyo Electron is a semiconductor production equipment manufacturer and has more than 10000 employees in USA, Europe, and Asia. At Tokyo Electron Miyagi, in Sendai, we are specialized in etch tools. I have had the chance to join the R&D department for process and tool development. My current job consists in supporting our customers by developing etching processes that meet their criteria for their

advanced nodes. This is a quite exciting challenge as we are working on cutting edge technologies. Another challenging point was the environment: compared to academic world, it is more difficult to communicate inside company as not as much people are familiar with English. But since I joined, I can see the results from all the efforts made internally to increase English proficiency. This goes side by side with the company opportunities to work abroad of Japan. As a foreigner living in a different country, I can say that it is a great chance to be able to spend some time abroad of your home country.

Concluding remarks

Along these over 10 years living in Japan, I have realized how much I learnt from it. Facing a different culture is sometimes overwhelming but I was lucky to have the right persons around me: students, colleagues, co-workers, bosses, and friends. Reflecting on my career path so far, I believe that nothing is impossible as long as you work hard for it. And Japan is one of the great place to achieve your goals.

I think that plasma research in Japan is still one of the top. The synergies between academia and industry is strong (especially in semiconductor industry) and other fields are not too far behind (plasmas for medicine and bio-applications, fusion plasmas...). Hopefully, this can continue or even grow up.

Finally, I'd like to say that I have met really talented people in the Japanese plasma community and I am really thankful to the conversation we could have together. My wish is to meet even more people in the future, as it

seems I will continue my stay in Japan for a bit.

参考文献

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