

## Visiting research at Positron Probe Group in AIST

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**Preamble.** In 2014 I was most happy to get the opportunity of being a visiting researcher to Positron Probe Group (PPG), Research Institute of Instrumentation Frontier (RIIF) at AIST from 1 October to 21 October. The opportunity was supported by the Japan Science and Technology Agency (JST) program “Japan-Asia Youth Exchange Program in Science (SAKURA Exchange Program in Science)”. During my stay at AIST, Dr. Nagayasu OSHIMA, Senior Research Scientist of PPG/RIIF/AIST, was my host researcher. In the 21 days, I had the opportunity to visit several research institutes and universities in Japan. Among these were Prof. Uedono’s Lab at the University of Tsukuba, the Spin-Polarized Positron Beam Research Group at the Japan Atomic Energy Agency (JAEA), ASRC as well as laboratories at AIST and KEK in Tsukuba.



写真: Tsukuba Central 2-4A AIST.

At these institutes, the directors of the labs introduced the equipment to me and introduced their main research fields and recent research results. Thanks to patient and clear explanations from all the respective researchers, I had the chance to learn about various positron techniques and to see at first hand the current status of positron research in Japan.

**University of Tsukuba.** On October 3, 2014, Dr. Oshima organized a visit to the Positron Annihilation Laboratory at Tsukuba University, along with fellow AIST researchers by Dr. Lixian Jiang and Dr. Brian O’Rourke. In Tsukuba University, assistant Professor Selvakumar Sellaiyan introduced the laboratory to us. We had saw a Slow Positron Beam line and three Positron Annihilation Lifetime Spectroscopy equipment in Uedono Lab. During the lab visit, Prof. Sellaiyan explained how they use PALS as a method for defect characterization

of semiconductor materials, insulating film (low-k, high-k), and thin metal films. Afterwards, he guided us around visit their beautiful campus with his three students and we had a group picture before the graceful lake located in the center of campus.

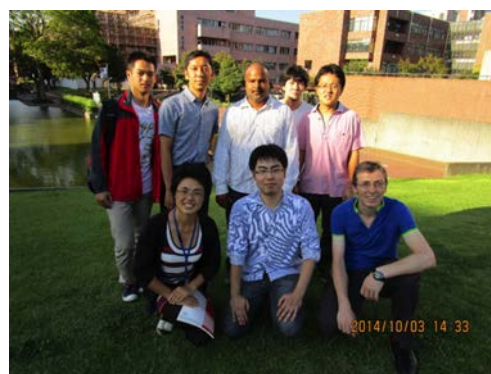


写真: Group picture at Tsukuba University. Back (L-R) Peng Kuang, N. Oshima (AIST), S. Sellaiyan (Tsukuba Uni.), T. Kakizaki (Tsukuba Uni.), T. Murayama (Tsukuba Uni.). Front (L-R) Jiang LiXian (AIST), T. Semba (Tsukuba Uni.), Brian O’Rourke (AIST).



写真: Conference in JAEA.

**JAEA.** On October 6, I had a precious opportunity to visit JAEA during an academic meeting between the AIST and JAEA positron groups. I introduced myself to all members at the meeting, and three Chinese postdoctoral researchers based in the JAEA positron group showed us their recent research results. The three post-docs at JAEA all graduated from Wuhan University and have worked in Dr. Kawasuso’s group for more

than one year. We talked in depth about the current situation of working and living in Japan and I found that they were satisfied with their research and life in Japan. After the meeting, Dr. Kawasuso showed us around his laboratory in where they have a wide variety of equipment, including spin-polarized positron beam based in both Ge-68 and Na-22 sources, a low-temperature STM and a slow Positron Beam. They are developing advanced positron beams and promoting materials research using those positron beams. From 2010 to 2014, they developed a highly spin-polarized positron beam and are now exploring its applications to magnetic substances and spin-related phenomena. They are also pursuing positron diffraction studies of metal-insulated transitions and magnetic effects associated with surface low-dimensional materials. Furthermore, they are investigating the SCC degradation mechanism of nuclear stainless steels.

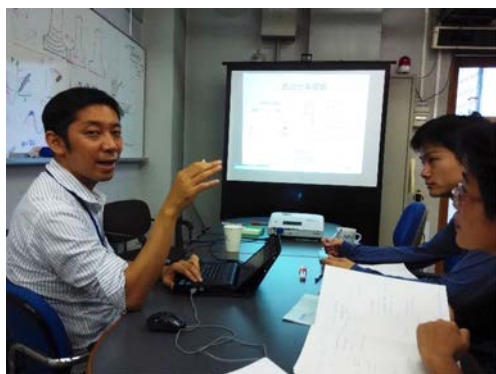


写真: Dr. Oshima's lecture.

AIST. During my stay at AIST, Dr. Oshima gave several lectures about the techniques of bunching and focusing slow positron beams, and patiently answered my questions every day. He also guided us around his lab, where he introduced the PPMA (positron probe microanalyzer) and high-frequency microwave cavity to us. The spatial resolution of PALS using the PPMA is two and half orders of magnitude smaller than that using conventional methods so that by scanning the sample the PPMA can obtain two or three dimensional positron annihilation spectroscopy images. He also invited other researchers in his lab to show me their research results such as development of a dedicated superconducting accelerator for positron production introduced by Dr. B. O'Rourke, the development of portable X-ray sources using carbon nanostructures introduced by Dr. H. Kato, a C-band RF gun for compact radiation sources introduced by Dr. Y. Taira, a positron re-emission microscopy apparatus introduced by Dr. H. Ogawa, and a slow positron beam system for in-situ lifetime measurements during ion beam irradiation introduced by Dr. A. Kino-

mura. Those researches described above are innovative and creative, for example, portable X-ray sources can be used to image object internal structure everywhere as more than 300 high-definition X-ray transmission images can be taken using two AA batteries as a power source.



写真: The commercial PALS system introduced by Dr. Masato Yamawaki (AIST).

On October 10, Dr. Kenji Ito warmly invited Dr. Lixian Jiang, Kuzuya-san (a research student from the Kyoto University reactor who was also staying at AIST during my stay) and I to visit his laboratory located the central AIST campus in Tsukuba. During the visit, Dr. Masato Yamawaki showed us around the lab and introduced the experimental facilities in detail including a slow positron beam system, a commercial PALS device and several RI based measurement systems. Additionally, we were shown an on-site positron lifetime inspection device, a very small and exquisite portable positron detector assembly using a sealed Kapton source, which can measure samples directly in situ.



写真: Annual Positron Conference at AIST.

On October 17, I was invited to attend the annual positron conference held by the AIST Positron Probe Group. During the conference, Dr. Oshima gave a presentation about the PPMA, and researcher Dr. H. Hagihara talked about the application of PALS. It is a good chance for me to know the de-

velopment of the newest research fields in Japan, like positron technology, carbon dioxide separation membrane, etc. After the meeting we had a small celebration party, and enjoyed delicious Japanese food.

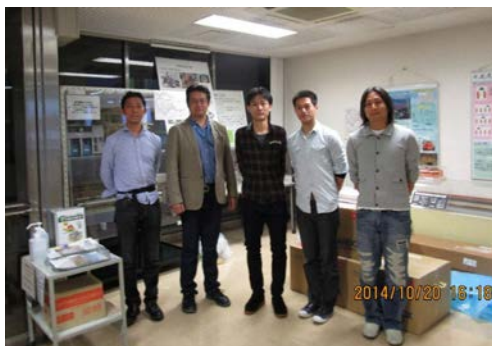


写真: Group picture in KEK. (L-R) N. Oshima (AIST), K. Wada (KEK), Y. Kuzuya (KUR), Peng Kuang, I. Mochizuki (KEK).

KEK. On October 20, Dr. Oshima took Kuzuya-san and I to visit the high energy accelerator research institute, KEK. Dr. Wada, a researcher at the Slow Positron Facility in KEK, gave us a great overview of ongoing studies in KEK including particle and nuclear studies, materials structure science, accelerator laboratory and applied research laboratory. Then, we had a tour of the Belle II factory which is searching for violations of the symmetry between particles and anti-particles and new physics laws conducted using large numbers of particles, such as B mesons, produced by the KEKB accelerator. We also visited the photon factory which has played a large role in the development of the synchrotron radiation science for more than 30 years since 1982. After that, we visited the Slow Positron Facility. In the lab, we were shown the slow positron beam line and associated experimental stations which presently consists of Ps-TOF (positronium time-of-flight) measurement station, a reflection high-energy positron diffraction station, and positronium negative ion station. The positronium negative ion produces pulses of Ps<sup>-</sup> ions. The Ps-TOF measurement, where the width and the frequency of the incident positron pulse are 1 ns–10 ns (variable) and 50 Hz, is used to measure the energy of positronium emitted from a solid surface. The reflection high-energy positron diffraction is for the analysis of the atomic configuration of a crystal surface by using reflection high-energy positron diffraction (RHEPD). Dr. Wada led me through the different experimental halls and explained working principle of those equipment in detail.

Summary. During my stay, I had the impression that there

are a great variety of advanced positron techniques and experimental installations in Japanese research groups. In addition, the daily management and safety facilities of all laboratories are of a very high level. Certainly, I learned much about positron equipment technology thanks to the experience of visiting to the different positron laboratories in Japan.

Besides the research activities I had the chance to visit other places in Japan such as Ginza and Sensoji Temple. Additionally, a highlight of my stay was a tour to Mt. Tsukuba (together with Dr. Ito and Kuzuya-san) and the park near to AIST. In our free Dr. Oshima and Dr. Ito kindly invited Kuzuya-san and I for dinner.



写真: Group picture at the top of the Mt. Tsukuba. (L-R) Y. Kuzuya (KUR), Dr. Ito (AIST), Peng Kuang.

As everyone knows, Japanese people are extremely friendly and helpful. In general, I could feel the enthusiasm of every one I met here as a smile was always appearing on their faces. I deeply appreciate the help I received from everyone I met during my stay.

Acknowledgements. I would like to extend my sincere gratitude to my teachers, Dr. Wang and Dr. Cao, who recommended and introduced me to Dr. Oshima at AIST. I would like to express my heartfelt gratitude to JST and AIST for giving such a precious opportunity and much support to me with the help from Dr. Oshima. I would also like to thank all members of the Positron Probe Group in AIST who gave me their help and time in listening to me and helping me work out my problems during my studying in AIST. I am also deeply indebted to all the other tutors and researchers I meet at Tsukuba University, JAEA and KEK for their direct and indirect help to me. Special thanks should go to Dr. Oshima, Kuzuya-san and Dr. Jiang who have put considerable time and effort into minimizing the difficulties I encountered in those days when I was studying and living in Japan.