

STEPS Students Report

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From May 1 to June 30 I had the great pleasure of engaging in an experiment in the internationally known Japanese laboratory of Professor Kaoru Yamanouchi at Tokyo University. His group is doing state-of-the-art research in quantum chemistry. Throughout my stay in Japan, I was involved in the work concerning the terahertz (THz) single-cycle radiation generation. This sort of electromagnetic field at present day is attracting great attention of many scientists due to its useful applications. One of them which quantum chemists and physicists are interested in is THz-assisted electron diffraction (TAED) method that was suggested in Professor Yamanouchi's group. It allows one to retrieve the molecule structure information with atomic-scale spatial resolution and with the high temporal resolution (<10 fs). In cooperation with master's student Michihiro Kitanaka a few procedures to obtain and to adjust THz radiation beam were implemented. Firstly, exploiting optical rectification process and illuminating LiNbO_3 crystal with the 1030 nm Yb:YAG laser, the THz radiation was generated. The laser power during this stage was varied in the range from 6 to 20 W. Secondly, electro-optic sampling with the use of the 800 nm femtosecond laser was carried out. In order to detect THz pulse and measure its shape, ZnTe crystal was employed since it manifests birefringence property in the presence of THz beam and consequently splits the incident beam into two orthogonally polarized rays. Then their intensities were measured, and I made calculations, based on the intensity data of extraordinary and ordinary signals, to estimate the THz electric field value. The results showed us that THz beam properties are not suitable enough for the electron diffraction experiment and a few modifications of setup were required. Thirdly, to make the beam diameter wider and to get higher diffraction limit, one of the parabolic mirrors was substituted for a new one, and knife-edge scanning of the THz beam diameter was performed to confirm, that we had the expected width of the THz beam, and to check its collimation. Lastly, THz radiation power was measured to verify that it meets the requirements for THz-assisted electron scattering experiments. It differed from the input signal power by the factor of 10^{-4} , and then the THz electric field amplitude based on this data was estimated as $E_{\text{THz}} \approx 8 \text{ kV/m}$ that is enough for TAED experiments.

To sum up, I am quite glad that I got a chance to participate in such an experiment and that I have learnt many practical tips and tricks. My internship experience couldn't

have been more pleasant, all the members of Yamanouchi's lab were very kind and hospitable, and we had a lot of fun parties and different group events. They even have a softball team in the group, and I was lucky to train with them. In addition, almost every week there was a group seminar, on which members of the laboratory were discussing contemporary scientific problems and were making reports on their research achievements. It was also quite interesting and useful experience for me.

Finally, I would like to express my deep appreciation and thanks to Yamanouchi-sensei, Kanya-sensei, Hiroi-sensei and Kitanaka-san for their support and assistance. I wish all the members of the group the greatest success. And of course, I would like to extend my thanks to the STEPS program organizers for such a great opportunity to work with Japanese researchers.

