

Report on MERIT Overseas Dispatch

School of Engineering, Department of Applied Chemistry, Noji Laboratory

The 3rd grade in doctor course

Yoshihide Tokunou

Period of visit : 29 July 2018 – 7 September 2018

Overview

I have conducted an overseas dispatch at Advanced Water Management Centre in The University of Queensland (Brisbane, Australia) with Associate Professor Stefano Freguia. This dispatch for approximately 6 weeks was supported by Research Fellowship for Young Scientists of JSPS. In this report, I describe the background and contents of research, and the life in Brisbane.

Background

Cyanobacteria have an ability to thrive in nutrient-limited condition by virtue of photosynthesis, where metabolisms can be driven by solar energy. Recently, it was found that a part of energy gained by photosynthesis can be converted into electricity by serving electrodes to cyanobacteria. Towards development of cyanobacteria-based electrical technologies such as bio-photovoltaics and bio-sensors, the electron transport mechanisms from cyanobacteria to electrodes have been extensively studied. However, the electron transport pathways from cyanobacterial quinone pool to electrodes are still unclear, which is a key to enhance the photocurrent production and increase the quantum efficiency obtained from cyanobacteria.

During my doctor course research, I have studied about the electron transport mechanisms of iron-reducing bacteria. Based on the background of electrochemistry, I have succeeded in the identification of the extracellular electron transport pathway of iron-reducing bacteria. Anticipating that my research ability can be expanded to cyanobacteria, I decided to apply this dispatch to the laboratory of Dr. Stefano Freguia, who is leading the research of electroactivity of cyanobacteria. He is an Associate Professor in The University of Queensland, and I had had a discussion with him about bacterial electroactivity in a previous conference. He kindly accepted the offer of this dispatch.

Research

The research objective in this dispatch was to elucidate the extracellular electron transport pathway of cyanobacteria. I brought some electrochemical reactors from Japan for electrochemical analysis of cyanobacteria.

Prior to experiments, about two weeks of safety training should have been completed. The safety training was duty for all of staffs working in universities in Australia. During this period, I studied about the electron transport reaction of cyanobacteria and discussed with PhD researchers and students. Since this period made me strongly pay attention to the rest of time, this was a good occasion to reconsider what kind of experiments I can conduct here.

After completing the safety training, I started my research in the University of Queensland. I first measured electrochemical signals from cyanobacteria using electrochemical reactors. The obtained anodic current clearly responded to the light/dark cycle. However, the anodic current with comparable intensity was also observed even from medium, which was used as electrolyte. Therefore, I optimized the condition of electrochemical experiments, such as components of medium, applied potential, and pH. Although the optimization took about 2~3 weeks, I successfully diminished the background current from medium, and confirmed clear photocurrent generation from cyanobacteria. During the last 10 days, cyanobacteria adsorbed onto electrodes were electrochemically characterized using various techniques such as cyclic voltammetry and differential pulse voltammetry. The electrochemical data showed some interesting responses and provided insight into the electron transport pathways between cyanobacteria and electrodes. While I skip the details about the results, I am planning to continue the research and submit as a paper before graduation.

The life in Brisbane

I spent a really good and comfortable time in the University of Queensland. The basic working time was limited from 8 a.m. to 6 p.m., so I needed to really concentrate on the research to get some results. Since I stayed in the laboratory until around midnight in Japan, I learned a lot to manage experiments in limited time.

The temperature in Brisbane was around 20°C during the day. I sometimes went out the laboratory during the interval of experiments and did some paper-works on beautiful glasses outside under sunlight. On weekend, I was invited to some parties and short trips by Dr. Stefano or students in the laboratory. The good balance between research and vacation afforded me to think about my research direction. I hope that this experience allows me to keep some rooms in my mind and expand my research further.

Acknowledgement

I appreciate Prof. Stefano Freguia and members in the laboratory for kindly accepting my dispatch and helping my research, and Ms. Vivienne and Mr. Charles for office procedures for this visit. I thank JSPS for financial support of this dispatch and MERIT program for giving me a great opportunity. Finally, I acknowledge Prof. Hiroyuki Noji, Dr. Akihiro Okamoto, and all of the people I have seen in Australia.