

MERIT Report for Long-term Overseas Dispatch

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Overview

I visited and conducted research in Georgia Institute of Technology (Georgia Tech) in US from March 17th to May 9th 2018. During this period, I stayed at Prof. Seth Marder research group, which focus on synthesis of new materials for organic electronics. My research focus is not synthesis, but process of polymeric semiconductors and charge carrier transport in them. Based on this difference in specialty, we aimed to mix my and Marder group's knowledge to conduct a new research on chemical doping of polymeric semiconductors. I also conducted collaborative experiments with two other groups which are working together with Marder group from daily basis. One is experiments from an aspect of polymer physics with Prof. Natalie Stingelin research group, and another is experiments from an aspect of optical analysis with Prof. Carlos Silva research group. I also attended Material Research Society (MRS) 2018 Spring Meeting in Arizona during my stay, and gave an oral talk [1] on a new method of chemical doping in polymeric semiconductors, which was actually used in collaborative experiments.

Background of this visit

We have published a paper about a process of p-type doping in polymeric semiconductors, where I am the co-first author. [2] In this paper, we reported a new solution process for the molybdenum based metal complex, which was originally synthesized in Marder group. Prof. Marder got interested in our report and contacted us for a possible collaboration. Because simply sending materials each other is not enough to mix our knowledge to conduct a new research, we proposed that I visit Marder group, which was kindly accepted and realized under a support from MERIT program.

Research in Georgia Tech

Chemical doping of polymeric semiconductors is widely studied from viewpoints of carrier transport or application for thermoelectric generators. However, understanding of physical properties of doped polymeric semiconductors is still limited. We worked on this based on polymer physics and optical analysis in collaborative experiments with Stingelin and Silva groups. The sample preparation was conducted by the doping method which I developed in the University of Tokyo. In the collaboration with Marder

group, we worked on a method and evaluation of chemical doping of polymeric semiconductors, utilizing semiconducting and dopant materials synthesized in Marder group. We also had discussions on new molecular structures for polymers, which are expected to be beneficial for doping and carrier transport, based on my knowledge in carrier transport and some calculations on molecular orbitals.

In the development of doping method, we confirmed that the method we reported before [2] is applicable to other dopant materials. We worked on controlling doping concentration, and evaluated the doped states with polaron absorption in UV-Vis and change in molecular vibrations in FT-IR spectra. From these studies, doping concentration was confirmed to be controlled properly. We are planning electrical conductivity measurements and analysis on transport mechanism with the facility in the University of Tokyo.

Life in Atlanta and Georgia Tech

Many research groups gather in Georgia Tech to study new materials for electronics including polymeric semiconductors. Other than 3 groups I collaborated, I got a chance to discuss with members in 4, 5 working from aspects such as theoretical calculations, synthesis, and electrochemistry. These discussions were mainly done in poster sessions held a few times a month in the building I stayed. The campus is beautiful and large, where busses run inside. There are many trees and fields and we can relax even using equipped hammocks.

Atlanta is said to be the largest city in the south of US, where companies such as CNN and Coca Cola have their headquarters. The center of city is a beautiful place, with the memorial park for Atlanta Olympic. On the other hand, the city is known to have one of the greatest wealth gaps. The views and safety in residential areas in the north east and south west of city are very different. In the history museum, I learned Atlanta as a “progressive city” which played big roles in the civil war and Civil rights movement. I learned about the city of Atlanta from such different perspectives from my own experiments and written knowledge during my stay.

Acknowledgment

I deeply appreciate the MERIT program for its financial support, Prof. Seth Marder and the group members for kindly accepting my stay, and Prof. Natalie Stingelin, Prof. Carlos Silva and the group members for the opportunities of collaborations, and my supervisor Prof. Jun Takeya for his support, to realize this fruitful stay in Georgia Tech.



(left) The building I stayed in Georgia Tech. (right) A photo with collaborators.

[1] Y. Yamashita, J. Takeya et al., MRS spring meeting, EP08.02, Arizona, USA (2018).

[2] R. Fujimoto, Y. Yamashita, J. Takeya et al., *J. Mater. Chem. C*, **5**, 12023 (2017).