

MERIT Long-term Overseas Dispatch Report

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Destination: Institute of Porous Materials (IMAP) , France

Period: November 10th, 2023 – January 31st, 2024

Research Topic: Improvement of Column Resolution by MOF shaping

Research

Metal-Organic Frameworks (MOFs) are crystalline porous materials composed of metal ions and organic ligands. In our laboratory, we have used MOF-packed columns for polymer separation. Unfortunately, the irregular shape and size of MOF particles resulted in broad chromatographs. To address this, we started collaborative research aimed at improving column performance by refining the particle morphology of MOFs.

IMAP, a laboratory renowned in the field of MOFs, explores a wide range of topics, including innovative MOF synthesis, and applications in health, energy and environment. This lab is equipped with application techniques for mass production and MOF molding. Spray drying is one of the techniques for producing fine, spherical and uniformly-sized powders. We applied spray drying to MOF nanoparticles to prepare MOF particles ideal for column supports.

First, we synthesized several types of MOFs. Subsequently, spherical aggregated MOF particles were produced via spray drying, yielding 10 μm -sized aggregates suitable for column supports (**Fig 1** ;actual images are not included as the project is ongoing). Following my return to Japan, an IMAP graduate student visited Uemura lab for two months to evaluate the MOF column performance. Interestingly, we observed unique results that differ from conventional polymer separation mechanisms. Our research continues to study these mechanisms and refine the separation of polymers with closely related properties.



Fig. 1 (Left) Spray-dryer. (Right) Particles after spray-drying. Figures are taken from Buchi Webinar.

Research Life

IMAP has offices at the École Normale Supérieure (ENS) and the L'École Supérieure de Physique et de Chimie Industrielles de la ville de Paris (ESPCI). The lab hosts over 30 researchers, with more than half people from outside France, predominantly holding graduate degrees or higher—a notable contrast to

Japan. While there's no official core time, typical researchers arrive around 9:00 a.m. and leave at 6:00 p.m. I was impressed by how everyone was aware of their responsibilities and proactively managed their tasks within the lab.

This collaborative research adopts an exchange program style: I started working at IMAP, followed by an IMAP graduate student visiting to Uemura lab to collaborate on one research project. Many international students face a lot of troubles during their initial month, whereas I was fortunate to have a partner and was able to proceed smoothly. Completing a research project within a few months can be challenging, so the exchange style is advantageous as it effectively doubles our research duration. This exchange approach could serve as a viable option for anyone who is concerned about studying abroad or who plans to try challenging research.

Life in the France

During my stay period in France from November to January, I experienced colder weather and shorter days compared to Japan. Although this reduced outdoor activity time, it also offered unique seasonal experiences. Christmas markets appeared across the city from mid-November, providing a traditional European ambiance (**Fig 2**).

It's important to note the significant differences in prices and exchange rates pre- and post-COVID. An old online information indicated that the cost of lunch was 8€, but the actual price was over 20€. I stayed at "Cite Universitaire", a group of student dormitories (**Fig 3**). Although the price here was also much higher than the prior information, its convenience makes it recommendable for Parisian living. The cafeteria offered meals at only 1€ for French government scholarship recipients and 3.3€ for other students, which was economically beneficial.

Acknowledgments

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Fig. 2 Christmas market in Colmar where is famous as the setting of Howl's Moving Castle.



Fig. 3 The view from my accommodation. If your country has house, you need to ask your country's office regardless of which building you wish to stay in.