

# Report on MERIT Long-term Oversea Dispatch

School of Science, Department of Chemistry

2<sup>nd</sup> grade in Ph.D course

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## Overview

I have stayed in a research group of Prof. Nita Dragoe of “Université Paris-Sud (Université Paris-Saclay)” in France from 1<sup>st</sup> December 2017 to 28<sup>th</sup> February 2018.

## Research

I worked on “Synthesis of high entropy oxides and characterization” during this stay. The idea of high entropy oxides (HEOs) came from high entropy alloys or multi-principal element alloys. HEOs are consisted of five or more species of cations. This multi cations induce a large configurational entropy, which thermodynamically stabilize a single solid solution at relatively high temperature. While HEOs are very recent topic because the first report was published in 2015, My host, Prof. Dragoe’s group reported some of interesting properties about HEOs, for example colossal dielectric constant and high lithium ionic conductivity. Therefore, the group is famous for studies on HEOs.

At first, I worked on “synthesis of a novel HEOs”. I tried to synthesize HEOs by solid state synthesis method, so I handled powder samples. This was a refreshing experience to me because I usually had synthesized thin film samples by vapor phase deposition method in Japan. Many types of composition were conceivable because multi cations are necessary for stabilization of HEOs. During the stay, I tried only 8 types of composition, but all of them did not work well. After much trial and error, I worked on “electron-doping into already known HEOs”. In order to present my originality, I brought an idea of my doctor thesis into the study of HEOs.

## Life in France

The university is located in Orsay, where it takes around 40 minutes from a center of Paris by train. The laboratory is located in a mountain valley, on the other hand, the nearest station and the nearest school restaurant are located between mountains. Therefore, I had to shuttle along mountain path at least twice a day. In addition, inconveniently, there are little shops and restaurants. However, it was so nice for a change to stroll when I became distressed about the research because there is much abundant nature around the university. I often saw small animals such as a squirrel in the campus.

In France, it is prohibited to work more than 35 hours per week, so opening hours of laboratory

are so severe, from 8 a.m. to 8 p.m. Most people work from 9 a.m. to 4 or 5 p.m. Basically, it is also prohibited to do an experiment on holidays. Thus, I was alien to night experiment and holiday experiment in France. On holidays, I often went to the center of Paris for sightseeing. On the first Sunday of the month in winter, there are no entry fees for the Louvre museum, the Orsay museum, the Palace of Versailles and so on.

I had difficulty with conversation during shopping while I could use English in most situations in the campus. However, most people seemed to be very kind when I said “Bonjour” at first and “Merci” at the last as an expression of my gratitude.

### **Acknowledgment**

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Figure (left) The building where our group experiment (right) Campus scenery