

MEIRT Long-term Oversea Dispatch

5th student, Engineering

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Overview

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I visited the laboratory of Professor Valentin Valtchev at ENSICAEN (École nationale supérieure d'ingénieurs de Caen) and CNSR (The French National Center for Scientific Research) in France. During the stay, I researched about preparation method of hierarchical zeolite SSZ-13 and optimized the preparation method to apply my PhD research.



ENSICAEN

Background for heading oversea

This research aimed to carry out the collaborative research about learning and optimizing the preparation method of mesoporous zeolite SSZ-13 which was required for my PhD research. Members in the laboratory of Professor Valentine Valtchev, the chairman of the international zeolite association (IZA), have wide spectrum of knowledge and high understanding on general synthesis of zeolite including preparation of mesoporous. Among the numerous types of zeolite, there is a zeolite called SSZ-13. SSZ-13 has small ordered micropores ($< 2\text{nm}$). And if SSZ-13 has both micropore and also mesopore ($2\text{ nm} \sim 50\text{ nm}$), which is larger than micropore, we called it mesoporous SSZ-13. Mesoporous SSZ-13 is expected to be the most suitable for carrying out the application of my doctoral research. However, since mesoporous SSZ-13 has many difficulties in preparation, there are only few studies reported on preparation of mesoporous SSZ-13. On the other hand, the laboratory of Professor V. Valtchev has been reported that succession in preparing of mesoporous SAPO-34, which has a similar structure to SSZ-13 by using fluoride etching. Therefore, in order to establish the preparation method of mesoporous SSZ-13, we conducted collaborative research to learn their experience knowledge. This was such a valuable opportunity for me to deeply learning about preparation of mesoporous zeolite.

Research

The objective of research during the stay of long-term overseas dispatch is to establish the preparation method of mesoporous zeolite, especially mesoporous SSZ-13. SSZ-13 has an ordered structure made of silica and alumina as shown in figure below. The silica part dissolves in the basic solution. The well-known basic solution is an aqueous solution of sodium hydroxide. Treating SSZ-13 with a basic solution dissolves the silica and opens the mesopores then become mesoporous SSZ-13, as shown in the figure below. Here, if the zeolite is excessively dissolved, the structure will be collapsed. On the other hand, if the zeolite is not dissolved or slightly dissolved, mesopores cannot be formed. Therefore, optimization of the preparation method for mesoporous SSZ-13 is necessary.

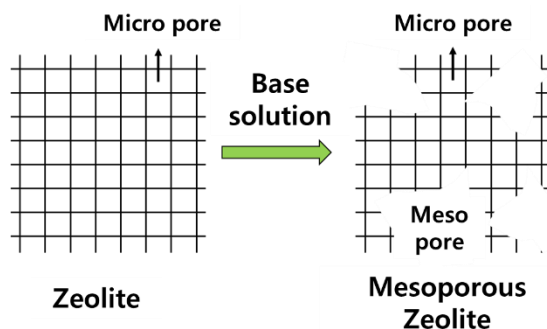


Figure. Schematical image of preparation mesoporous zeolite

During the stay, the preparation of mesoporous SSZ-13 was treated by two basic solutions, a conventional aqueous sodium hydroxide solution and an ammonium fluoride solution reported by Valtchev group as a previous study. As the treatment method, we carried out two methods: a hydrothermal treatment with stirring and an ultrasonic treatment. As a result, in the case of SSZ-13, it was confirmed that the structure of zeolite SSZ-13 is easily collapsed when treated with an aqueous sodium hydroxide solution compared to that treated with ammonium fluoride solution. It was also confirmed that the ultrasonic treatment was more effective method for opening mesopores than hydrothermal treatment. Based on these results, optimization of preparation condition for mesoporous zeolite SSZ-13 with various conditions such as temperature, concentration, and treatment time was carried out. Each sample was characterized by nitrogen adsorption, XRD and SEM.

Life in Caen

The city of Caen was a very small town, unlike the famous cities for sightseeing in France, but beautiful city. People living in Caen was mostly spoken in French and only few of them can speak English. So, there was a small communication problems. But, from this reason, I believe that I could feel the real atmosphere of France strongly during the stay of 3 months. Also, there were many universities in Caen, so I could feel the free and bright atmosphere of French students. Before I visited France, during the New Year period, I made a private trip in London. It was a very valuable experience to spend the New Year in London.



Photo at the center of Caen

During the stay of ENSICAEN, I worked on research on weekdays and went to the center of the city of Caen on weekends. And sometimes, I visit Paris to meet my high school friends who stay there. I have been thinking that foreign countries are unknown areas to me, so there must be full of new, different but impressive things. However, what I most felt and learned was that life is similar no matter where lives. We worried and thought about similar things even though we live in different countries.

Acknowledgement

The opportunity for this long-term overseas dispatch was a very invaluable experience. I would like to appreciate all the professor of MERIT, including Prof. Ikuhara, who gave me this opportunity. I also deeply appreciate the people of the UTEC program for financial support. I sincerely appreciate Professor Ogura for supporting me in preparing all the processes for this long-term dispatch. I also deeply appreciate Professor Valentin Valtchev, who gave me precious advice and support from research to life in France. Finally, I would like to thank all the members who helped me from experiment to life during my stay in France.