

MERIT: Report for Long-term Overseas Dispatch

Catalytic Chemistry Laboratory
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Location : Xiamen University, China

Host Research Group : Prof. Ye Wang, Prof. Kang Cheng

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■ Abstract

From May 9 to August 2, 2025, I had the opportunity to visit Xiamen University in Xiamen, China, where I participated Prof. Ye Wang and Prof. Kang Cheng's research group. The primary objective of this visit was to investigate the unique reactivity of gold cluster catalysts by applying the highly durable Au cluster catalysts developed in my research to industrially significant reactions, such as alkane oxidation and selective hydrogenation of alkynes. This report outlines the insights and experiences that I gained through my research activities in Prof. Wang's laboratory, as well as through my daily life in China.

■ About the Research

The primary focus of Prof. Wang's laboratory was the development of catalytic materials for reactions of industrial relevance, particularly in the utilization of natural resources. Key research topics include the selective oxidation of lower alkanes (e.g., methane) to value-added compounds, and the selective hydrogenation of C1 compounds (e.g. CO and CO₂) and lower alkynes. For instance, they have reported that Au nanoparticles with an average diameter of approximately 5.9 nm, supported on mordenite, exhibit high catalytic activity under mild conditions for the selective oxidation of methane to methanol.

The catalytic performance of Au nanoparticles is known to be highly dependent on particle size. In particular, Au clusters composed of several tens to hundreds of atoms have attracted attention due to their potential to exhibit unique reactivity distinct from that of conventional nanoparticles. However, conventional Au cluster catalysts have generally suffered from poor durability, with significant aggregation occurring under reaction conditions, thereby limiting their practical application. In our present research, we enhanced the durability of Au cluster catalysts by utilizing non-covalent ligand-support interactions. Namely, partial ligand removal from the ligand-protected Au

clusters on solid support enabled the successful suppression of aggregation during catalysis via the non-covalent interactions at the interface between the remaining ligands and the support. This approach enabled application of Au cluster catalysts to harsh conditions that had previously been inaccessible to conventional Au cluster systems, which can expand the scope of Au cluster's potential applications.

During this overseas research program, I applied these newly developed catalysts to investigate their performance in the selective oxidation of methane to methanol and in the selective hydrogenation of lower alkynes. Although detailed results cannot be disclosed due to the inclusion of unpublished data, the gold cluster catalysts exhibited higher activity for methane conversion to methanol compared to previously reported Au nanoparticle catalysts. Notably, while conventional catalysts showed negligible activity below 80 °C, the Au cluster catalysts demonstrated moderate activity even at 50 °C. In contrast, challenges remain in terms of catalyst durability and reproducibility. In particular, further studies are needed to confirm that methanol is not being formed from residual organic ligands or other contaminants. Based on the insights gained during this research, I intend to continue with the rational design of new catalysts and the further exploration of their reactivity in relevant catalytic systems.

■ About the Life in the University

I found that universities in China maintain a highly organized system across various aspects of campus life. For example, access to the campus, individual buildings, and student dormitories requires facial recognition for identity verification, and security guards are stationed at the entrances of these facilities. Additionally, the use of analytical instruments is strictly regulated; when requesting access, one must provide the technical staff with detailed information about the samples, the purpose of the measurements, experimental conditions, and distinctions from previously reported studies. Although such a high level of control sometimes felt inconvenient as an internship student, I also recognized several advantages. The campus was extremely safe, and it was easy to consult with security guards or technical staff when facing difficulties. In particular, the security guards at the entrance of the dormitory kindly talked to me every day, which became a valuable opportunity to practice conversational Chinese.

Moreover, I observed that laboratories in China typically allow for a longer lunch break compared to those in Japan, providing an environment in which students can rest adequately and maintain their focus on research in the afternoon. From around 1:00 p.m. to 2:30 p.m., office lights are turned off, and many students take naps to refresh

themselves. At first, I did not feel the need for a midday rest and spent the time doing desk work at a café or similar location. However, after trying a nap once, I found that my research efficiency in the afternoon improved significantly. From then on, I actively incorporated short naps into my routine. I have come to realize that even a brief nap of just five minutes can help avoid fatigue and improve productivity, and I intend to continue this habit after returning to Japan.

■ About the Local Life

China's high-speed rail system, known as "gaotie", is remarkably affordable. For example, a one-way journey of approximately 250 km cost only around 2,000 yen. Taking advantage of this accessibility, I frequently traveled to cities outside of Xiamen on weekends using gaotie. In larger cities such as Fuzhou, the capital of Fujian Province where Xiamen is located, and Guangzhou, the capital of neighboring Guangdong Province, gaotie stations are directly connected to metro systems, making travels very convenient. However, in relatively smaller cities such as Quanzhou, Zhangzhou, Chaoshan, and Shantou, local transportation required taking buses or taxis. Navigating these areas involved communicating in my limited Chinese, which itself became part of the travel experience.

While some might associate China with strong anti-Japanese sentiment or concerns about discrimination against Japanese people, I did not experience such issues during my stay. On the contrary, I found that many Chinese people were kind and supportive, often helping me when I struggled to communicate in Chinese. For instance, when a typhoon caused the suspension of my return gaotie from Shantou, I was forced to extend my stay. During this time, hotel staff and station employees kindly provided me with detailed updates on transportation, allowing me to return to Xiamen safely the next day. Additionally, during a local tour conducted in Chinese, I had the opportunity to befriend a mother and her child who were also participating. The mother even shared local snacks with me, a gesture that left a lasting impression. This experience reinforced the importance of setting aside prejudice and approaching people and situations with kindness and openness. It is an attitude that I deeply admire and hope to integrate into my daily life going forward.

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