【Vol. 3】Report from Naoto Kamiuchi

Dear readers,

In the last report, I summarize my research in Prof. Miquel Salmeron's Group and my life in Berkeley.

It is significant to understand the mechanism of functional materials in order to improve their performance. In the field of catalytic chemistry, it is indispensable to analyze nanostructures of catalysts in situ. Environmental transmission electron microscopy (ETEM) and scanning probe microscopy (SPM) are powerful characterization methods to study nanostructures in atomic scale and in situ, as well as the spectroscopy such as X-ray photoelectron spectroscopy (XPS) and X-ray absorption spectroscopy (XAS). My research in ISIR, Osaka University focuses on the elucidation of the dynamics of nanostructures in catalysts during chemical reactions by ETEM observation. In Prof. Miquel Salmeron's Group, I tried to learn another in situ analyses and to reveal a reaction mechanism on the surface of a catalyst by using the in situ analyses.

In the group, there are a lot of SPM apparatuses such as low temperature scanning tunneling microscopy (LT-STM), high pressure (HP)-STM, Kelvin probe force microscopy (KPFM) and electrochemical atomic force microscopy (EC-AFM). In addition, photoelectron spectroscopy (PES), for example, ambient pressure (AP)-XPS and ambient pressure (AP)-XAS, can be used at Advanced Light Source (ALS), which is a synchrotron facility in LBNL. In my study, I mainly used the LT-STM because it is a basic STM and appropriate to learn the principle and skills of STM. The purpose of my research was to unveil adsorption structures of gas molecules on a metal single crystal as a model catalyst.

A lot of cycles of Ar sputtering and annealing were performed to clean the surface of the metal single crystal. After the treatment, the atomic arrangement of the single crystal surface was clearly observed. Adsorption structures of gas molecules, which are used in a famous chemical reaction on a catalyst, were formed after dosing them onto the clean surface. Furthermore, a peculiar co-adsorption structure of two gas molecules was successfully visualized for the first time. The findings about the adsorption of gas molecules will contribute to elucidate a reaction mechanism on the surface of a catalyst, because the adsorption is a fundamental phenomenon of a chemical reaction on a catalyst.

In this project, I learned the principle, method and data analysis of in situ analyses. In addition, I obtained some experimental findings about co-adsorption of gas molecules on a metal single crystal using the LT-STM. This experience will expand the range of my research in the near future.

In my daily research, I worked on the research of atomic-scale phenomena. In holidays, on the other hand, my family and I enjoyed the vast landscape of nature in United States

during vacation. The views at Yosemite National Park (Photo01, 02) and Grand Canyon National Park (Photo03-05) were impressive beyond description and breathtaking. My life in Berkeley was totally comfortable because of pleasant climate and the kindness of neighbors, except that the monthly rent of apartment was extraordinarily expensive (> $2,200 per month).

Finally, I would like to thank this JSPS program and all professors in ISIR for giving me a chance to study in LBNL. Especially, I gratefully acknowledge the kind support of Prof. Seiji Takeda, Prof. Miquel Salmeron and his co-workers.

Photo01 Tunnel View (Yosemite National Park)

Photo02 Half Dome (Yosemite National Park)

Photo03, 04, 05 Grand Canyon National Park