Report on Merit Overseas Training

Institute for solid state physics, Department from Physics
D2 Takuma Hattori
Period of visit; 27 September 2018 – 21 December 2018

Overview

I stayed in Peter Grünberg Institute in Jülich, Germany from 27th September to 20th December. I joined Dr. Daniel Bürgler 's group and studied molecules on Co islands on Cu(111) with atomic resolution by a scanning tunnel microscopy(STM) in order to design a single molecular spin filter device.

This overseas training was fully supported by 2018 overseas student detachment program in the Institute for Solid State Physics.

Research

The spin filter element is a device used to align the spin direction of electron by taking an advantage of high spin-polarization of the ferromagnetic insulator. It is theoretically reported that a molecule on a ferromagnetic film could be applied to a single molecule spin filter. We have tried a direct observation for a spin polarization of a single molecule on a ferromagnetic film by a spin-polarized scanning tunnel microscopy.

Spin polarization of a conventional planar molecule on the surface of a ferromagnetic film can be induced by π-d hybridization. However, the molecular states are delocalized by the hybridization with the ferromagnetic film and thus the spin polarity could become lower. Therefore, by using a double decker molecule with a modified group and by changing a distance between the molecule and the ferromagnetic film, it is expected that the molecular states can be spin-polarized without delocalization. In my stay in Peter Grünberg Institute, I have investigated the local density of states of molecules on ferromagnetic Co islands on Cu(111).

The molecule shapes in STM image were different between molecules on ferromagnetic Co islands and those on nonmagnetic Cu(111). Thus, we have tried to measure local density of states of the molecules by scanning tunnel spectroscopy. A state appeared below Fermi energy which is the same energy as the d band sates of Co islands. This suggests that the molecule on Co islands hybridizes with the Co d state and it is expected that the state of molecule is spin-polarized. Thus, I have tried to conduct spin-polarized STM by using an antiferromagnetic Cr tip. However, I could not observe the spin contrast on the molecule.

Stay

Jülich, which Peter Grünberg Institute is located in, was an academic city like Tsukuba and many people in Peter Grünberg Institute described Jülich as a small village. Most people in Jülich are used to foreign people. Peter Grünberg Institute is located far away from the town and it is surround by the forest. I saw many signs which call attention to deer. It is a very fantastic environment for using instruments sensitive to vibration noises such as scanning tunnel microscopy I have used. In contrast, we are not allowed to conduct an experiment latter than 6 p.m. for safety reason. It was completely different from Japan where we can work at any time. It makes my experimental plan hard.

In December, I visited Christmas markets in Aachen, Cologne, and so on. I have understood how important Christmas is for Germany people.

Acknowledgment

This overseas training was supported by 2018 overseas student detachment program by the Institute for Solid State Physics. I kindly appreciate that Prof. Schneider Claus Michael for accepting my stay. I am deeply grateful to Dr. Daniel Bürgler and his group for assisting my stay and my research in many aspects. I also thank Prof. Komori Fumio for offering an opportunity for me to study abroad.

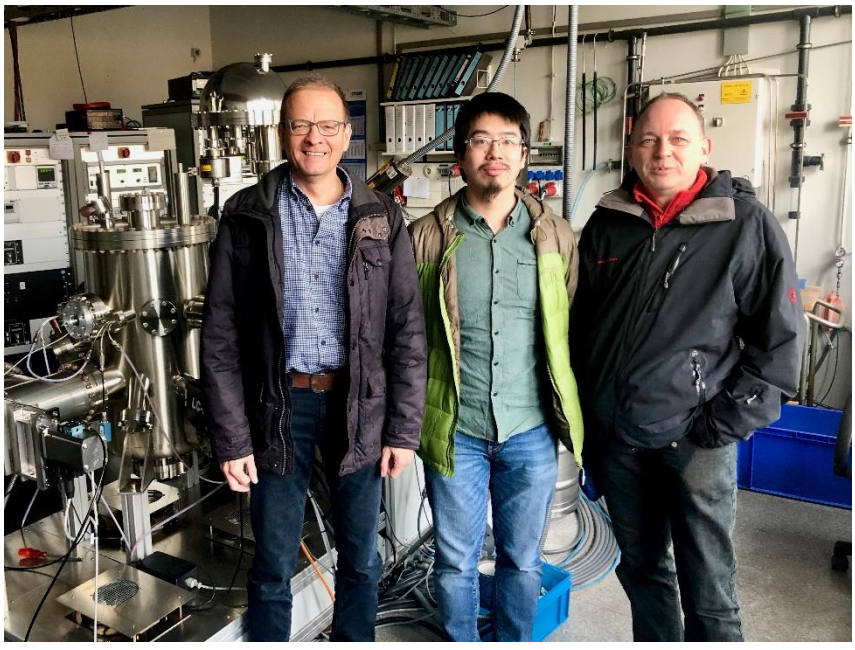

Figure 1 Photo with Dr Daniel's group; Dr. Daniel Bürgler(left) author(center), Dr. Matthes Frank