I'm with Rohrer-Sensei Even Now*

Masakazu Aono[†]

The International Center for Materials Nanoarchitectonics (MANA),
National Institute for Materials Science (NIMS),
1-1 Namiki, Tsukuba, Ibaraki 305-0044, Japan

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My memories about Dr. Heini Rohrer are described together with my researches inspired by the invention of STM.

*Dr. Heinrich Rohrer
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As the last speaker of the Memorial session, I would like to show you a little more memories about Dr. Heini Rohrer. I always called him Rohrer-sensei [1]. So in this article also, I would like to call him Rohrer-sensei.

I am from the WPI Center for Materials Nanoarchitectonics, MANA. On behalf of all members of MANA, I sincerely thank Rohrer-sensei for being one of our senior advisors for a long time. Rohrer-sensei attended all the MANA International Symposiums from 2008 to 2012, and he made a question or a comment to almost all presentations. He also often had one-on-one meeting with MANA young scientists to encourage them. In addition, he held a science school, an event to show the fun of science, for junior high school students. However, to our regret, he passed away on May 16th 2013. We showed a panel with his photo at the entrance hall of our building (Fig. 1).

Invention of the scanning tunneling microscope, STM, by Rohrer-sensei and Gerd Binnig undoubtedly made a breakthrough in the history of the progress in nanoscience and nanotechnology. When I saw their paper on the silicon(111)-7 × 7 surface [2], my body jumped up from my chair saying, oh my god. At the same time, I felt that we will be able not only to see atoms but also to manip-

FIG. 2. Arrangements of the ion source, sample and analyzer in conventional (left) and impact-collision (right) ion scattering spectroscopy.

ulate atoms. So immediately I would like to start such experiments.

However, my situation at that time did not allow me to do so because two years before that, in 1981, I had published a paper on impact-collision ion scattering spectroscopy, ICISS [3]. At that time, I was studying surface structure by using low-energy helium ion scattering. Usually, we set the scattering angle arbitrarily, and by rotating the sample, we measure the intensity of scattered ions by electrostatic analyzer. One day I thought if we use the 180 degree scattering angle, i.e. complete back-scattering, the situation becomes very simple. We named the method based on this idea ICISS, impact-collision ISS. At first the scattering angle was not exactly 180 degree (see Fig. 2), but later we designed such a spectrometer by making a small hole in the channel plate as shown in Fig. 3. This was commercialized from Shimadzu Corporation, one of the biggest scientific instruments company in Japan, in

FIG. 1. Panel with the photo of Rohrer-sensei shown at the entrance hall of MANA building when he passed away.

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[†]Corresponding author: AONO.Masakazu@nims.go.jp

FIG. 3. Schematic illustration [4] and a photograph of coaxial impact-collision ion scattering spectroscopy apparatus.

FIG. 4. Photograph taken when I first met Rorer-sensei in 1988.

FIG. 5. Photograph taken in 2006 near the hometown of Rorer-sensei.

1991 as CAICISS-I. CAICISS means the co-axial ICISS. Owing to CAICISS, Shimadzu Corporation got one of top 10 new products award sponsored by Nikkan Kogyo Shim-bun, a daily industrial newspaper, in 1991. So, I had been busy in doing ion scattering experiments and could not start STM experiments. In 1986, I moved to RIKEN Institute. Then I started constructing our own STM.

At that time, we used a titanium carbide single crystal tip cleaved mechanically. I asked my friends to grow a titanium carbide single crystal rod. Titanium carbide is very hard. Its hardness is comparable to diamond. We etched the center part of the rod. The direction of its axis is inclined from 001 axis, because 001 plane is a cleavage face. So if we make a cleave, a very sharp tip is obtained. By using this titanium carbide single crystal tip, we made the imaging of HOPG graphite and obtained a very high resolution STM image. The paper reporting this image was published in 1988 [5].

At that time, we made nano tracking by using the very

sharp titanium carbide tip because I was interested in not only seeing atoms but also manipulating atoms on the surface. So, we tried that, and obtained very preliminary results.

In 1989, a few years after the above trial, I organized Atomcraft Project in the framework of ERATO Program of JST (at that time JST was called JRDC, Japan Research and Development Corporation). At the opening ceremony of the Aono Atomcraft Project in 1989, Professor Ryogo Kubo, Professor Minoru Oda and Professor Akito Arima gave speeches and encouraged me very, very much.

Just a year before the inauguration of the Atomcraft Project, I saw Rohrer-sensei for the first time at a traditional Unagi ("eel" in English) restaurant in Tokyo. The party at the restaurant was organized by Sakurai-san. Figure 4 is a photo taken at that time, where Sakurai-san, Rohrer-sensei and his wife Rose-Marie, Young Kuk, Tomi Hashizume, myself, Sakurai-san's wife, Miyako-san [6], and my wife are seen. At that time, I was very much impressed by Rohrer-sensei's character. So, I asked him to become the senior advisor of Atomcraft Project.

Just one year before the Memorial Session, Rohrer-sensei sent me a New Year Card with his message "Dear Keiko (my wife's name) and Masamurai (my nickname. Rohrer-sensei always called me so), with best wishes for the incoming 2013" and a picture of Ebenalp in Switzerland. He put this picture because we made a wonderful trip in Switzerland for six days in 2006. Figure 5 is a picture taken near his hometown. You can see "Heinrich Rohr Weg" [7]. On the trip, Rohrer-sensei drove a box wagon car, and we went up to Ebenalp. So, he sent me the New Year card. At the presentation in the Memorial Session, I was using the card as the desktop wallpaper on my computer.

That's all. Dear Rohrer-sensei, on behalf of the researchers of nanoscience and nanotechnology, I thank you very much for your invention of the scanning tunneling microscope, STM, with Dr. Gerd Binnig and Dr. Chris Gerber, and your vision for the future of nanoscience and nanotechnology, expressed by your simple words, "small is different," as well as your warm eyes to our Japan.

Comment, question and answer after the talk

C&Q: I forgot to say one thing about Rohrer-sensei. He loved Japan very much and came to Japan many times. Especially as for the natto, even some of Japanese do not eat it but Rohrer-sensei liked it very much, saying "it smells like a Swiss cheese". He liked to eat it with raw egg and rice. Do you have any comment on these?

A: He liked not only natto but also the raw eggs and nori ("laver" in English), black pepper, everything. Even in Switzerland, Rohrer-sensei's breakfast is white rice, natto, raw eggs and nori.

C: And he liked sake, rice wine. He did not drink in the morning, though.

- [1] (Note by Editor) "Sensei" is an honorific title in Japanese, which is used for teacher, professor, advisor, etc.
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- [6] (Note of the editor) "San" is an honorific title in Japanese, which means Mr. or Ms.
- [7] The German word "Weg" means "street".