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What one Japanese Scientist has seen, heard, and felt in Taiwan

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After World War II, the world economy was devastated, and countries lost much, but people worked together to rebuild based on freedom, democracy, fairness, and equality before the law. From then on, people are rewarded for their efforts and can travel to and from foreign countries. We can study abroad, freely participate in international conferences, and promote international cooperation. At the national level, we can compete in science and technology. If we create new industries and succeed in innovation, we can be proud of our country as the world leader in science and technology. The economy has grown, personal lives have become more prosperous, and borderless research has become possible.

Our generation has lived through those times. I received my degree in 1971 and considered the idea of going abroad after completing my doctoral program. However, the level of research in physical chemistry in Japan was already high at that time. Therefore, I remained in the laboratory of Professor Noboru Mataga, who was also highly regarded abroad[1]). In 1977, when I turned 33 years old, I began presenting my research at conferences in Europe and the United States. Since 1996, I had the opportunity to visit Hong Kong, Bangalore, Mumbai, Taipei, Singapore, Beijing, Trivandrum, and other Asian cities. After retiring from Osaka University, I received an offer from National Chiao Tung University (NCTU, in 2021 its name is changed to National Yang Ming Chiao Tung University〔NYCU〕by merging with National Yang Ming University) in Hsinchu, Taiwan, to set up a research laboratory, where I have been developing my research since 2008[2]). Hsinchu City has a science park famous for the presence of Taiwan Semiconductor Manufacturing Company (TSMC), which is now a hot topic worldwide. **This spring marked my 15th year in Taiwan. I want to take this opportunity to write a summary of what I have seen, heard, and felt recently.**

Taiwan has developed remarkably over the past 15 years. The scenery seen from the university has changed drastically, and many large apartment buildings can be seen. The average salary in Hsinchu City is said to have surpassed that of Taipei City to become the highest in Taiwan. I often see cars such as Mercedes Benz, BMW, Lexus, Volvo, etc., parked in front of a famous fruit shop in my neighborhood. Taiwan is renowned for its many motorcycles, but the percentage of electric motorcycles has increased among motorcycles. Many of the students in my laboratory are tall. I am 178 centimeters tall, but I sometimes consider myself small compared to them. The English ability of the students in the lab has increased. The clothes worn by the graduate students are also good. Although NYCU is a science and engineering university, there are many female graduate students. Naturally, job hunting is not segregated by gender; most of them have found jobs at electronics companies, where they work hard. I moved from on-campus housing to a private apartment when the COVID-19 pandemic broke out. This move allowed me to experience civilian life in Taiwan. I feel that many people are prosperous. According to a recent survey by a Swiss business school, Taiwan is the most competitive country in the world with a population of over 20 million (Nikkei Newspaper). Taiwan's economy certainly looks promising. Income must be increasing. Salaries of university professors have also risen.

I am still enjoying a safe and comfortable life in Taiwan. If I misplace my wallet or card, I don't lose it. I once left my hat on the bus on my way to school. When I returned home, I found the hat on the same seat on the same bus. I usually leave my wet umbrella outside when shopping at a convenience store or having lunch at the university cafeteria. I don't have to worry about someone taking my umbrella. When waiting for a bus or shuttle, if only a few people are waiting, they don't line up in a row. But they remember who arrived at the bus stop early. They signal with their eyes and get on the bus without any problem. Last year, the number of infected people decreased, and the restaurant reopened. I invited a Taiwanese friend to dine with me. The person softly declined my invitation, saying, "I want to be a good citizen." The late U.S. President John F. Kennedy once said during his election campaign. "Think about what you can do for your country before you ask your country to do something for you". I was reminded of his words a few decades later in Taiwan. From these experiences, I feel that the Taiwanese people are highly civilized. I believe that this high level of people awareness is the basis for the successful containment of COVID-19 in Taiwan. The Taiwanese government changed its policy from "zero covid" to "with covid" in spring 2022. Although the number of infected people has increased overwhelmingly, Taiwanese society has remained calm.

Prof. Masuhara and his students, the second from the right is Dr. Wei-Yi Chiang who is now a Professor of National Kaohsiung Normal University.

Looking back on my research and my research life in Taiwan, I can divide this period into three eras in my personal opinion. The first five years were the era of "welcome". When I arrived at NCTU, the president hosted a welcome lecture and gave me a budget to supplement my equipment. However, not many NCTU graduate students joined my lab. I was not popular with NCTU students. **The next five years were the era of "jealousy".** I am a chair professor, and I was told that the chair professors should assign fewer graduate students and that I should receive less money for scientific research because I was getting equipment from the university. **The recent five years have been an era of "indifference".** I am no longer the subject of conversation or harassment. I have become a genuinely ordinary person. Strangely enough, my popularity among NYCU students has improved, and more NYCU graduate students have joined our lab.

During this period, Taiwan's ability to conduct research has steadily improved. Compared to Japan, Taiwan is powerful in realization-oriented research, while Taiwan seems not much interested in exploratory research to find new physical and chemical phenomena. However, a Taiwanese friend told me that even if the U.S. or Japan discovers a phenomenon, Taiwan puts it to practical use when it proves useful[3]). In the Department of Applied Chemistry of NYCU, I belong, the total number of papers and the impact factor of each faculty member are shown in a graph. They compare it with the Department of Chemistry of National Taiwan University and the Department of Chemistry of National Tsing Hua University to see how advanced we are. In our Department, there have been already excellent professors since the 2000s, but many faculty members have recently achieved great numbers. After coming to NYCU, I realized that research results alone were insufficient to contribute to Taiwan. Thus, I have been actively developing my research through international human exchange. The activities of our Laser Bio-Nano Science Laboratory (Masuhara-Sugiyama Laboratory) are summarized in the next table. Many members of the Japanese Photochemistry Association (JPA) visited us. Friends from all over the world also visited us. We were surprised that many Japanese Super Science High School students visited us regularly. We were also happy that two Taiwanese graduate students became assistant professors at Japanese universities.

Taiwan-Japan Activity for 2008 - present by Laser Bio/Nano Science Laboratory

21 Researchers
Japanese Professors; 3
Assistant Research Fellows; 7
MOST Postdoctoral Fellows; 7

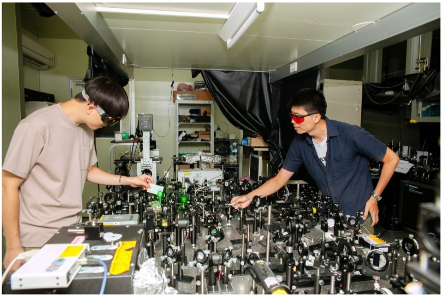
JSPS Overseas Research Fellows; 4

8 Promotions
Staffs/Postdocs Promoted to Japanese Universities; 6
Ph.D. Students Promoted to Japanese Universities; 2

123 Students
Ph.D. Students in NYCU; 14
Master Students and Undergraduates in NYCU; 57
Dual Degree Program Students; 7
Japanese Students Who Stayed in NYCU; 31
Our Students Who Stayed in Japanese Universities; 14

1566 Visitors
Japanese Professors we Invited to Department Colloquium; 72
Japanese Professors we Invited to our LBNS Lab Seminar; 103
Participants in International Summer Course; 1019
Super Science High School Students Visited NYCU; 372

(Note) "Japanese" and "International" include some foreign people from Australia, Belgium, Brunei, the USA, etc.



Masuhara laboratory, Dr. Shun-Fa Wang (right) is studying optical trapping of functional polymers.

Until 2019, I freely traveled between Japan and Taiwan, enjoying my research and research life in Taiwan. However, with whisperings of foreign pressure, my research life changed drastically after the advent of the COVID-19 pandemic. Since then, it became widely known that Taiwan's semiconductor industry is attracting attention. About two years ago, President Tsai gathered the presidents of the four national universities in Taiwan (Taiwan, Tsing Hua, Chiao Tung, and Cheng Kung) and explained measures to enhance semiconductor R&D and education. She took steps to establish new research organizations and increase graduate students. As a result, the atmosphere at the universities changed dramatically. In the background, the semiconductor industry is highly active, increasing its investments. It is said that each advanced semiconductor-related plant costs 1 trillion yen, and 20 plants are currently under construction in Taiwan, led by TSMC. The Nikkei Newspaper reported that about 16 trillion yen is being spent, and the whole of Taiwan is booming. My mind has switched from worrying about whether universities should conduct exploratory research or feasibility studies to thinking that a new paradigm shift in science and technology based on semiconductors is taking place in Taiwan.

Not only Taiwan but the whole world is in an uproar. When the COVID-19 pandemic began, I wrote that it was as if World War III had begun[4]). Then came the Russian invasion of Ukraine, which indeed started a world war. I am concerned about scientific research and systems' future in Japan, Taiwan, and Asia. In these times of significant change, we can refer to the changes in scientific and technological research before and after World War II. Before World War II, chemistry was said to be the study of experience. After the war, chemistry developed as the chemistry of logic based on quantum mechanics. Not only physical chemistry but also organic chemistry and biochemistry have greatly expanded by adopting quantum-theoretical concepts[5]). Along with this, a generational shift accelerated. **Once the spread of COVID-19 is over, the mainstream of academia will change significantly, and a paradigm shift will be realized. One of these, needless to say, will be the development of AI-based research.** Just as there was a shift from the chemistry of experience in the prewar period to the chemistry of logic based on quantum mechanics in the postwar period, it is expected that we will see a shift to AI-based studies. Researchers' and engineers' ideas and research patterns will also likely become AI-based. The generational shift will be further accelerated accordingly. Taiwan's research environment is extremely stimulating, and both universities and industries in Taiwan are positioned to anticipate and take advantage of this change.

What will happen to Japanese photochemistry and the Japanese Photochemistry Association

(JPA)? How will they cope? The JPA has withstood the harsh academic environment of the past two decades, and the JPA's membership has grown, and it has done admirably among academic societies of similar size. It may be hard for young people to believe. Still, in the early days of the JPA, Nobel Prize winners Dr. RyojiNoyori and the late Dr. Junichi Nishizawa of electronics engineering were also members. Their membership was probably because they expected that photochemistry would provide a new concept of science and technology. Several decades later, the JPA produced world-leading photochemistry such as photocatalysis, photoelectron transfer, Photosynergetics, plasmonic chemistry, optical trapping chemistry, laser ablation, and artificial photosynthesis. The world rewarded us with the Porter Medal. I hope that the JPA will continue to develop new exploratory research in the new AI-based trend and create new research seeds.

What about international joint research? There are agreements at various levels, such as between universities and research institutes. Still, top-down agreements are inadequate in content and often burden the young people who implement the agreements. **The approach we found to be the most effective in practice is to send our graduate students to the other side for a few months or more and have the other side send their graduate students to us to conduct joint experiments (see table). This approach is strongly supported by the Double Degree Program (DDP), which is a concrete, face-to-face, and practical approach.** It would be nice to develop DDP at the researcher level first, and then build up a track record, resulting in DDP at the graduate school or university level. We can share graduate students from both universities across the country, get research funding in both countries, and set up various settings.

I had the opportunity to work in an employment position that was more like a Double Appointment (DA) for three years. I had laboratories, staff, and graduate students both at NCTU (Chair Professor) and Nara Institute of Science and Technology (Specially Appointed Professor), and to promote common themes while taking advantage of the characteristics of each. Based on the differences between the university systems in the two countries, I was able to get a realistic understanding of the relationship between culture, customs, and scientific research. DA is not easily realized or even tried in Taiwan, and I have heard a lot of reasons for this. On the other hand, the effectiveness of DA has consistently been recognized, and I understand that the joint research between a Chinese university and an American professor reported by newspapers under the COVID-19 pandemic is a type of this DA. With the growing importance of economic security, **I have recently realized that both DDP and DA will be discussed from the viewpoint of scientific research security[6]) in the future.**

Now over 100 doctors from Masuhara Laboratory/Project are working as professors and researchers in 10 countries.

What about the Asian Photochemistry Association (APA)? While European and American photochemistry associations have individual members, the APA is a composite of national and regional photochemistry associations. When the APA was established in 2002, Japan had the most significant number of members and research achievements, so Japan was responsible for managing the APA. However, it was recognized at the beginning that Japan would not take a leadership role in appointing the APA president or in the organization of the APC (Asian Photochemistry Conference) [7]). During this period, the strength of the APA participating countries and regions increased greatly. In addition to Japanese, there were Hong Kong and Indian-American Porter Medal winners. The number of researchers outside of Japan has also increased. Some objected to this Japanese attitude of not taking the leading role. However, there are few APA members in Southeast Asia and the Middle East, which the APA should cover. Under these circumstances, the current war started following the COVID-19 pandemic. Although Japan is no longer by far the leading country, the JPA needs to continue to operate with consideration.

Currently, the entire world is suffering from the COVID-19 pandemic and other problems that have caused significant damage in all aspects: society, economy, politics, population, science and technology, academia, and university. Exploratory research based on Japanese culture, society, and traditions is increasingly necessary for the future, but a thorough understanding of global scientific and technological trends is essential for such original trials[8]). Taiwan's semiconductor industry, now the world's largest, became active in the 1980s. At that time, the U.S. electronics industry stopped making entire personal computers in its own country. It proposed and implemented a three-polar structure; the heart of the computer would be built in the West Coast region of the U.S., the devices would be manufactured in Taiwan, and the setup would be done in China. Taiwan proposed the idea of building a science park in Hsinchu, which served as a receptacle for the U.S. proposal. At that time, it was said that the world was in the era of science parks, and Japan also developed the Tsukuba area. However, only a group of national research institutes were built in Tsukuba, and private research institutes moved to other locations within a few years. It was a science park concept without a global strategy. Since the COVID-19 pandemic, it is now being said that this may be a second Cold War, and Japan needs to take a cue from the electronics industry trends in the 1980s and respond to global trends while simultaneously making appropriate judgments of its own. I feel this will make Japanese science stronger.

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Hiroshi Masuhara received the B.S. and Master degrees from Tohoku University Japan in 1966 and 1968, and the Ph.D. degree from Osaka University Japan in 1971. He has been working in interdisciplinary research areas in Departments of Chemistry, Synthetic Chemistry, Polymer Science and Engineering, Applied Physics, Frontier Bioscience, Life Science, Material Science, and Applied Chemistry in Sendai, Osaka, Kyoto. Osaka, Kobe, Nara, and Hsinchu. He started his experimental work from nanosecond ~ femtosecond time-resolved spectroscopy and photochemistry, has studied single nanoparticle spectroscopy, laser ablation dynamics, nanoparticle fabrication, manipulation and functionalization of single living cells, and laser trapping crystallization, and now focuses on optical assembling and swarming of nanoparticles at interface. By utilizing laser and microscope, he has been exploring new laser-induced molecular phenomena and elucidating their dynamics and mechanism. New interdisciplinary area of molecular photo-science has been opened, whose results are published as ~600 papers, ~120 reviews, and ~20 books. Particularly, J. Phys. Chem. counts more than 100, and he was honored to have the Hiroshi Masuhara Festschrift in 2009. This pioneering work attracted many young researchers and graduate students, and now over 100 doctors from Masuhara Laboratory/Project are working as professors and researchers in 10 countries.

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