Setsuro Tamaru and Fritz Haber: Links between Japan and Germany in Science and Technology

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ABSTRACT: Setsuro Tamaru was my grandfather. He worked with Fritz Haber in Germany on researching the ammonia synthesis process and contributed substantially to the development of scientific research and education in Japan. Although I had never met him, I felt his existence while I grew up, since our house was built by him and had many artifacts brought back from Germany by my grandfather; e.g., a Bechstein upright piano upon which I practiced piano every day and Fritz Haber’s portrait with his handwritten message hung on the wall. This is an account of my grandfather’s life, concentrating on his relationship with Fritz Haber. This story goes back to a time more than a century ago.

1. Early Years in Japan (1879–1908)

Setsuro Tamaru (1879–1944), shown in Figure 1, was born on November 1, 1879, in Morioka, a region in the northern part of the main island, Honshu, Japan. He was the fourth son of a former clansman of the Nambu clan, Juro (father, 1848–1892), and Shin (mother, 1850–1941). His father died when he was 12 years old so his eldest brother, Kinya,[1] supported the big family (his mother, grandmother Koto, and six siblings)[2] by working as a schoolteacher. In the Japanese patriarchal society of that time, the eldest son had the heavy responsibility of taking care of the whole family, so Kinya had to give up obtaining a higher education. But their lives after Juro’s death were still difficult.[3] Setsuro left his home for Tokyo to study at the First High School (in Japanese; a preparatory school for the Imperial University of Tokyo) and then proceeded to the Imperial University of Tokyo (the top institution in the country, presently the University of Tokyo), following in the footsteps of his elder brother, Takuro[2] (1872–1932), who was studying physics in the same university. In July 1904 he graduated from the Department of Chemistry with one sole classmate. The Meiji Government (1868–1912) awarded him a grant to study chemistry abroad for three years, so Setsuro Tamaru left the country for Germany in February 1908.[4,5] He first went to the University of Berlin to study under Walter H. Nernst (1864–1941, 1920 Nobel Prize in Chemistry), who

Fig. 1. Setsuro Tamaru (1916–1917 in New York). Photo from the family collection.
had just published his heat theorem, known as the third law of thermodynamics, in 1906. However, shortly after arriving, he moved to the group of Fritz Haber (1868–1934) in the Karlsruhe Institute of Technology, since he had heard that Haber was recruiting young scientists to study ammonia synthesis. The year 1908, in which Setsuro Tamaru joined Haber’s group, marked a significant time period.

2. Germany (1908–1914): Ammonia Synthesis

Fixation of Nitrogen

In the late 19th century, food shortages were a serious problem. Because famine crises were frequent, it was an urgent matter to solve the problem of food production by increasing the amount of nitrogen in a form that can be metabolized by plants. Since the middle of the 19th century, Chile saltpeter deposits in the high-mountain deserts containing sodium nitrate had been used as a source of nitrogen fertilizer. However, it was obvious from the limited reserves that these resources would be exhausted sooner or later. In 1898, Sir William Crookes (1832–1919) gave the inaugural address as president to the British Association for the Advancement of Science, in which he called on scientists to save Europe from impending starvation, stating:

“It is the chemist who must come to the rescue of the threatened communities. It is through the laboratory that starvation may ultimately be turned into plenty. . . . The fixation of atmospheric nitrogen is one of the great discoveries, awaiting the genius of chemists.”

So, many chemists, including H. L. Le Chatelier (1850–1936), William Ramsay (1852–1916, 1904 Nobel Prize in Chemistry), Friedrich Wilhelm Ostwald (1853–1932, 1909 Nobel Prize in Chemistry), Walther H. Nernst, and Fritz Haber, started research on the fixation of nitrogen. For example, a method to synthesize the fertilizer calcium cyanamide (CaCN₂) by reacting calcium carbide (CaC₂) in a nitrogen atmosphere was discovered by Fritz Rothe and tested for industrial use by Adolf Frank (1834–1916) and Nikodem Caro (1871–1935). Kristian Birkeland (1867–1917) and Sam Eyde (1866–1940) developed a method to convert atmospheric nitrogen to nitric oxide in electric arc furnaces. However, these processes required a large amount of energy and had low cost performance. Many researchers struggled to develop a method of synthesizing ammonia from the direct combination of nitrogen and hydrogen. However, it seemed near impossible due to the inert nature of nitrogen. Some raised the reaction temperature in order to increase the reaction rate, which unfavorably resulted in suppression of the reaction due to its exothermicity. Le Chatelier attempted the reaction under high pressure (200 atm) and at 600°C in the presence of metallic iron. However, a tragic explosion occurred, which almost claimed the life of one of his assistants, and Le Chatelier had to give up the high-pressure experiments.

In 1904, Haber and van Oordt initiated work at about 1000°C and normal pressure in the presence of an iron catalyst and revealed for the first time that a state of equilibrium existed in the system, as shown in Equation (1), where the ammonia equilibrium mole percent was 0.005–0.0125%.

\[
N_2 + 3H_2 \rightleftharpoons 2NH_3
\]

When Nernst learned about their result, he replicated their experiments at 50 atm and 685°C. He made calculations for a stoichiometric mixture at 1000°C and 1 atm (Haber’s experimental conditions), and got an ammonia yield of a much lower value. Nernst informed Haber about the discrepancy between their data, and Haber immediately remeasured the equilibrium constant with Robert Le Rossignol (1884–1976) at normal pressure with great care. In May 1907, Haber reported the new experimental data (0.0048%) at the meeting of the German Bunsen Society. However, Nernst harshly criticized the latest result in public, saying that “Haber’s highly erroneous data” were caused by the extremely low amount of ammonia production at normal pressure and that there was no hope for producing ammonia industrially from its elements. Scientists attending the meeting generally agreed with Nernst’s opinion. Haber was deeply hurt by Nernst’s onslaught and felt that his reputation was ruined. Setsuro Tamaru later explained the discrepancy between the results in an article as follows:

Professor Hideko T. Oyama, grand-daughter of Setsuro Tamaru, was born in Princeton, NJ, USA, in 1955. After obtaining her bachelor’s and master’s degrees from Ochanomizu University, she received a Doctor of Science degree from the Tokyo Institute of Technology in 1989. She carried out research in the USA for 15 years at Stanford University, Clarkson University, and Virginia Tech. She then worked at the National Institute of Advanced Industrial Science and Technology in Japan for nearly four years, after which she moved to the Department of Chemistry of Rikkyo University in 2006, where she is presently a full professor. Her research field is in the materials science of functional multicomponent polymeric materials. She especially focuses on the study of the relation between molecular structure, processing protocols, and the ensuing properties.
which has the lowest activity for ammonia synthesis. They happened to measure the amount of ammonia produced by iron present as a component of the reactor wall and reduced by hydrogen gas at high temperature.

Therefore, 1908 was a year in which Haber was fiercely driven to vindicate his work. Setsuro Tamaru was thus plunged into the middle of the controversy on ammonia synthesis.

Setsuro Tamaru and Ammonia Synthesis

After the meeting of the German Bunsen Society, Haber keenly felt the necessity of conducting the ammonia synthesis at high pressures. Haber and Le Rossignol promptly set up new experiments at high pressures and developed an epoch-making recirculation apparatus for ammonia production: the product was selectively removed from the system in the high-pressure equipment, while the reactants, hydrogen and nitrogen gases, were recirculated. The reactant gases could be delivered at a greater flow rate and this considerably increased the amount of ammonia produced. Le Rossignol reconfirmed his previous data at normal pressure reported in the meeting of the Bunsen Society, and more importantly he found that the ammonia yield at 30 atm was 28 times greater than at normal pressure.\(^8,13\)

It was Setsuro Tamaru’s task to carry out precise experiments to estimate the equilibrium constant of the ammonia synthesis in the presence of an osmium catalyst at high pressure. Haber was a very meticulous scientist and he compared the data at high pressure separately obtained by Le Rossignol and Tamaru.\(^14\) Tamaru recalled that Haber always expected his group members to obtain highly reliable and repeatable data, such that the accuracy of the equilibrium constant in ammonia synthesis obtained by Haber’s group was perfectly proved later when the process was commercialized at Badische Anilin- und Soda-Fabrik (BASF).\(^11\) Tamaru’s hard work was highly praised by Haber, who stated that “Setsuro works himself to death”. The contributions of Setsuro Tamaru to the success of the ammonia synthesis and its industrialization were obviously substantial, since his name appeared on four of Haber’s seven consecutive papers published in 1914–1915, which were entitled “Investigations on Ammonia: Seven Communications”\(^14–20\). The papers show that Tamaru carried out very careful experiments by improving the apparatus in order to estimate the precise equilibrium constant of ammonia synthesis. He accurately measured the amount of ammonia formed at normal pressure and at 30 atm over a wide temperature range by titration, as well as the heat of formation and specific heat of ammonia.\(^14,15,17–19\) This shows that Haber clearly recognized the significance of specific heats in the calculation of equilibria over a wide temperature range, which was also valuable for industrialization. It is said that the accuracy of Tamaru’s measurements was applauded by prominent scientists in Europe.\(^5\) Thus, Haber’s great achievements in ammonia synthesis from its elements were supported by competent researchers in his group who were very talented in experiments, such as Le Rossignol and Tamaru.

Haber’s series of papers\(^14–20\) were introduced in the award ceremony speech given for Haber’s 1918 Nobel Prize in Chemistry by A. G. Ekstrand (President of the Royal Swedish Academy of Sciences) as follows:

>Since the position of the equilibrium of the reaction depends, among other things, upon the heat of formation of ammonia and its specific heat, Haber in a series of seven articles in the Zeitschrift für Elektrochemie of 1914–1915, has extensively described experiments carried out to confirm these figures with the greatest possible accuracy.\(^7\)

On July 2, 1909, ammonia synthesis was successfully demonstrated at 820 K and ca. 180 atm using 98 g of an osmium catalyst in front of BASF researchers and at last the industrialization of ammonia synthesis was considered realistic. BASF immediately started to solve technical problems for full-scale production, in which Carl Bosch (1874–1940, 1931 Nobel Prize in Chemistry) greatly contributed to the high-pressure commercial process and Alwin Mittasch (1869–1953) to the search for the best catalyst. And shortly thereafter, in 1913, the first ammonia synthesis plant went into operation at Oppau.\(^8,9\)

Figure 2 is a photo of Haber’s research group in Karlsruhe taken in 1909.\(^21\) This period was Haber’s golden time in his long academic career, producing excellent papers one after another. In this period many scientists from various countries, including England, the USA, and Italy, were also working hard in the laboratory.\(^11\) Setsuro Tamaru recalled that Haber was extremely busy, but very cheerful and kind to everybody.

In 1911 Haber was appointed to be director of a newly founded research institute at Berlin-Dahlem, the Kaiser Wilhelm Institute for Physical Chemistry and Electrochemistry. Setsuro Tamaru was chosen from ca. forty members in Karlsruhe to accompany Haber with Gerhardt Just and Richard Leiser. They became the first three researchers employed by the new institute.\(^22\) The photo in Figure 3, taken in front of the new institute, shows the members. In those days, it was very rare for a young Japanese scientist to get a formal position in Germany, the world’s top country in science.

Since the beginning of the founding of the Kaiser Wilhelm Institute, it attracted quite a few prominent scientists from various places, including E. O. Beckmann (1853–1923), R. M. Willstätter (1872–1942, 1915 Nobel Prize in Chemistry), Albert Einstein (1879–1955, 1921 Nobel Prize in Physics), Carl Neuberg (1877–1956), and James Franck (1882–1964, 1925 Nobel Prize in Physics), and it quickly became a world-leading research center.\(^12\) Haber frequently invited visitors including Sir William Ramsay, Svante A. Arrhenius
(1859–1927, 1903 Nobel Prize in Chemistry), and Frederick G. Donnan (1870–1956) to his home (now called the Haber Villa) for dinner and enjoyed scientific discussions with them at the dinner table. Setsuro Tamaru was fortunate to be frequently invited to the social activities. Figure 4 shows a photo depicting Einstein and Haber in a corridor of the institute, which was taken by Tamaru and given directly to Einstein. Figures 5a and 5b show scenes of activities at the institute. Figure 5a probably shows Gerhardt Just demonstrating the ammonia synthesis apparatus. In Figure 5b, Otto Sackur (1880–1914), wearing goggles at the right end, and Alfons Klemenc (1885–1960) of Vienna University, squatting down, are collecting liquid hydrogen. In December 1914, the year that this photo was taken, Sackur was unfortunately killed by an explosion that occurred during the experiments.

3. Leaving Germany for the USA via England (1914–1917): Encounter with Richards and Takamine

In 1913 the international situation was so delicate that the slightest provocation could have touched off a war. Setsuro Tamaru said that because of the impending state of emergency Haber and he went to a bank together and withdrew all of their deposits to change them into gold coins. Finally, World War I broke out in August 1914. Tamaru was urged to leave
Germany, since his country, Japan, had entered into hostilities with it. On Tamaru’s departure Haber suggested that he escape to Switzerland for six months and then come back to his institute, since Haber did not think the war would last long. However, Tamaru actually escaped to England, accepting Ramsay’s invitation to stay at his home for a few days. He recalled that when he and Ramsay discussed science and the war, they got very excited and found themselves talking volubly in German, although Mrs. Ramsay had announced to Tamaru that she would impose upon him a penalty of a penny whenever he used German at the dinner table. According to Tamaru, Ramsay was not only a great scientist, but was also very talented in languages and knowledgeable about many matters.

During World War I, Tamaru could still stay in touch with his friends in Germany. Haber’s first wife, Clara (1870–1915), wrote him the following letter on January 15, 1915 (Figure 6): "I always think of you with true friendship, and when I see your room I feel sorry about our separation. It has been particularly distressful on Christmas Eve, which we celebrated quietly and calmly. All three of us have thought of you. . . . My husband works 18 hours a day, almost always in Berlin (not in Dahlem!) I have taken 57 poor children under care, and Hermann has been continuously sick since November. The last fourteen days have been so bad that he is only recovering slowly. We have not found quiet time. Also, there is the dismay and the dull pressure on us all, which holds back any mental move other than helping those who are in need, or to serve the country in any free minute. . . . God may give that you can come back to us in the future." This letter shows that Tamaru was treated as a member of Haber’s family, as he also acknowledged later himself. In the same letter, she also informed him that a severe explosion had killed Sackur and cost Just his right hand five weeks earlier, while they were working in the laboratory. The accident happened, indeed, when they were conducting experiments with cacodyl derivatives for military purposes.

The letterhead “Frau Clara Haber, Dr. phil.” in Figure 6 seems to indicate her certain pride to be identified as a scientist. She was awarded a doctorate from the University of Breslau in December 1900, just half a year before her marriage. She was the first woman to receive the doctorate at the university.

Unfortunately, four months after she sent the letter, on May 2, 1915, she ended her life by shooting herself in the heart with Haber’s army pistol. It happened while Haber was participating in the chlorine gas attacks in the Ypres sector of Belgium and briefly came back home between them. It was

Fig. 4. Fritz Haber and Albert Einstein photographed by Setsuro Tamaru (1914).23

Fig. 5. Scenes from the Kaiser Wilhelm Institute for Physical Chemistry and Electrochemistry. (a) Apparatus for the ammonia synthesis. (b) Collection of liquid hydrogen by Otto Sackur (right end) and Alfons Klemenc of Vienna University (squatting down) in 1914.12 Photos from the family collection.
Fig. 6. (a,b) Clara Haber’s letter to Setsuro, dated January 15, 1915.
thirteen-year old Hermann (1902–1946) who discovered his mother, Clara, dying. For a person who specialized in chemistry, her husband’s conduct of using chemical weapons in the war might have been intolerable. There are several speculations as to the cause of her death, about which no one actually knows. But the tragedy hurt young Hermann Haber severely, about which there is no doubt.

In the same year of 1915, Setsuro Tamaru moved to Theodore W. Richards’ (1868–1928) group at Harvard University. Richards was the first Nobel laureate in Chemistry (1914) from the USA and was highly recognized for his accurate determinations of atomic weight. Figure 7a is a photo of his group and Figure 7b shows Tamaru working in his laboratory. Although Tamaru was very thankful for Richards’ kindness in welcoming him with support from the Carnegie Corporation, Tamaru was disappointed by the academic level of Richards’ group, saying that it was no comparison with that of the institute in Berlin-Dahlem.\textsuperscript{[12]}

Furthermore, Tamaru heard Richards frequently saying that Germans do not understand human nature. He also specifically criticized Nernst, saying that Nernst had never contributed to science with original work and he complained that Nernst introduced him just as an expert in accurate determinations, not as a scientist. Tamaru wondered why Richards had
such a strong antipathy against Germans, since he had a large circle of acquaintances in Germany and another highly respected American chemist, Arthur Amos Noyes (1866–1936) in the Massachusetts Institute of Technology, had never made such comments. Soon Tamaru heard an upsetting story from Richards himself regarding Nernst’s heat theorem, which was as follows: Richards had measured the temperature dependence of specific heats for various materials, from which he noticed that the specific heat of liquid air became independent of temperature at very low temperature. When he told many chemists about his discovery, nobody actually paid attention, except for Nernst. Richards told Tamaru that Nernst sent him a letter saying that he was too excited to fall asleep the night they discussed this phenomenon because Nernst recognized its importance. However, when Nernst published the heat theorem, he did not give Richards any credit at all. That was a reason why Richards spoke ill of Germans and Nernst. So when World War I was over, Tamaru thought that it was his duty to clarify the truth as a scientist and told Haber about Richards’ claim. They carefully examined details of Richards’ papers together. As a result, they concluded that Richards simply elucidated the temperature dependence of the specific heat and that it was clearly Nernst’s achievements to deduce the heat theorem using a small part of Richards’ data. Tamaru also revealed that although Haber did not like Nernst’s spitefulness, he respected Nernst’s extraordinary talent to systematically deduce important rules out of small amounts of not highly accurate data. Dudley R. Herschbach’s (1932 Nobel Prize in Chemistry) recent article on Richards also describes Richards’ claim on the heat theorem and his antagonistic character.

Shortly thereafter, Tamaru moved from Harvard University to the Takamine Laboratory in New York. The founder of the institute, Jokichi Takamine (1854–1922), was a well-known researcher, as well as a great entrepreneur. He had a license for the exclusive production rights of Taka-diastase, digestive enzymes named after him, which were obtained by a method of extracting diastase from Aspergillus. This made him a millionaire in a relatively short time.

Tamaru and Takamine (Figures 7c–e) discussed the necessity of founding a national research institute to study pure science in Japan, since Germany, the USA, and France had successively established such institutes in those days: the Kaiser Wilhelm Society (1911), the Rockefeller Institute for Medical Research (1901) and the Carnegie Institution for Science (1902), and the Institut Pasteur (1887), respectively. Then, Takamine strongly appealed to Japanese scholars and business and political leaders for support for a new institute in Japan. Finally, in 1917, through the endeavors of Joji Sakurai (1858–1939, chemistry professor at the Imperial University of Tokyo) and Eiichi Shibusawa (1840–1931, businessman and industrialist), the Institute of Physical and Chemical Research (presently Riken) was founded to promote research in pure physics and chemistry in Tokyo. Setsuro Tamaru was asked to participate in the new institute and to help with its establishment. At last, in August 1917, Tamaru came back to his country after living abroad for nine years.

4. In Japan (1917–1944): Promotion of Science

Institute of Physical and Chemical Research (Presently Riken)

Setsuro Tamaru was placed in charge of the new chemistry building that was completed in the Komagome district of Tokyo in 1921, as well as the equipment within. Figure 8 shows design drawings for the new institute, which Tamaru modeled after buildings of the Kaiser Wilhelm Institute for Physical Chemistry and Electrochemistry. The chemistry building he designed had double-glazed windows in the north side of the building and the latest facilities in each laboratory, such as plumbing for steam, vacuum, gas, and compressed air. The temperature of the building was automatically controlled by steam heaters and radiators. In organic chemistry laboratories, showers were installed at the entrance, and ropes were set up for evacuation from windows. Tamaru had experience with the founding of the Kaiser Wilhelm Institute and this was surely useful for that of the Institute of Physical and Chemical Research in Japan. When the Great Kanto Earthquake with a magnitude of 7.9 struck the Kanto area (the middle region of the main island in Japan, including Tokyo) in 1923, it is said that not a single glass window was broken in the chemistry building, whereas other buildings were severely damaged.

In 1918–1920, Tamaru revisited Europe to purchase a substantial amount of reagents and glass equipment for the new institute. He also obtained apparatuses used for ammonia synthesis. At the new institute, Tamaru conducted research on the oxidation of ammonia, reduction of metal oxides, and formation of formalin via the decomposition of formate.

Sumitomo Collection

While Setsuro Tamaru was sent to Europe by the Institute of Physical and Chemical Research, he faced the stern reality that many valuable and priceless materials in science and engineering were scattered after World War I, and he was worried about the situation. Since the budget of the new institute was not sufficient to buy them, he got in touch with the Sumitomo Foundation for help. They were generous to provide 70,000 yen (at that time) so that Tamaru could purchase materials from the Fox Corporation (the spelling is uncertain), Germany. One third of the materials were valuable books on the history of science and technology published in the 1500s to 1700s.
Some gave evidence of their origin, e.g., a Latin version published in 1641 of Galileo Galilei’s “Dialogue Concerning the Two Chief World Systems” advocating the Copernican theory. Interestingly, Tamaru also collected over 1000 doctoral theses and many materials for university education: books on teaching methods and university syllabuses used in the departments of science and engineering of world-leading universities (e.g., the Massachusetts Institute of Technology, the Karlsruhe Institute of Technology, the University of Lausanne, the University of Berlin, the Berlin University of Technology, and the Swiss Federal Institute of Technology in Zurich (ETH)). Now over 20,000 books and journals including social and political sciences, literature, art, natural science, engineering, medicine, and pharmacy are preserved as the Sumitomo Collection in the Osaka Prefectural Library.

Setsuro Tamaru’s Collection

Setsuro Tamaru also collected old letters written by legendary scientists. They were probably found during his stay in Europe right after World War I, at the same time he was purchasing materials for the Sumitomo Collection. They include a letter from Antoine-Laurent de Lavoisier (1743–1794) to his cousin (Figure 9), which was written two years before Lavoisier was sent to the guillotine during the French Revolution. Others included letters of James Watt (1736–1819) (dated 1795), Réne Antoine Ferchault de Réaumur (1683–1757) (dated 1753), Claude-Louis Berthollet (1748–1822), and Justus von Liebig (1803–1873) (dated 1867, 1870, 1870, 1872), and a manuscript by August W. von Hofmann (1818–1892) (dated 1883). All of these were registered as Chemical Heritages by the
Chemical Society of Japan in 2012.[33] Since historical monetary inflation happened in Germany after World War I, Setsuro probably could purchase them with the Bechstein piano at very reasonable prices.

**Fritz Haber’s Visit to Japan**

Right after World War I, German scientists were suffering from serious financial problems. Hajime Hoshi (1873–1951, a Japanese industrialist and businessman), learned about their situation via Wilhelm Solf (1862–1936, German ambassador to Japan) and Count Shimpei Goto (1857–1929, a politician serving in various important posts such as Mayor of Tokyo, and Minister of Foreign and Home Affairs). Hoshi was very generous to offer a large donation from his private funds for a foundation to promote the sciences in Germany.[9,34] This gift was to show his gratitude to German scientists for educating Japanese for a long period beginning from the Meiji Era. In 1924, Hoshi invited Fritz and Charlotte (his second wife) Haber to Japan and they arrived in Yokohama at the end of October after a visit to the USA. The Japanese gave them an enthusiastic welcome (Figures 10a–c). Haber gave a series of lectures at various places and asserted emphatically that in order to develop the country, it was important to promote science and technology. Setsuro Tamaru assisted Haber as a translator of the lectures, accompanying him throughout the country, as shown in Figure 10d. Haber’s lecture series given in Japan were translated by Tamaru to Japanese and published as a book in 1931.[35]

Shin-ichi Hoshi (Hajime Hoshi’s son and a famous novelist in Japan) writes in his book that Haber shared with Hajime Hoshi unique speculations during his stay in Japan:[34]

“*The future of the food problem in Japan is not at all pessimistic. Science technology will enable the harvest of rice five times a year if gaseous fertilizer is invented. Cellulose in lumbers can be made edible.*”

These remarks show that Haber was full of ideas. However, after one century science technology is starting to turn some of his ideas into reality.

During the stay in Japan, Haber and Charlotte also visited Tamaru’s house in Kamakura (south of Tokyo), as shown in Figure 11. The baby in the arms of Setsuro Tamaru’s wife, Yasu, is Kenzi Tamaru[36] (1923–, the author’s father), who later also became a chemistry professor at the University of Tokyo and became highly recognized in the fields of surface...
science and catalysis, following the footprints of his father. Kenzi Tamaru is very proud of this picture, since it evidences that he actually met Haber (it is TRUE!). The house built in 1918 is now registered as a national tangible cultural property. Eventually, Haber and Charlotte traveled throughout Japan for ten weeks.[9]

Setsuro Tamaru accompanied them on the way back from Japan to Germany, traveling through Korea, Manchuria, Shanghai, Hong Kong, Singapore, Indonesia, Ceylon, and Egypt. Figure 12 is a postcard sent by Haber to Yasu Tamaru from Egypt, on the other side of which his English poem with rhyming lines evidences their joyful journey. Finally they arrived back in Berlin in mid-March 1925.[9]

Tokyo Institute of Technology

In 1926 Setsuro Tamaru moved to the forerunner school of the Tokyo Institute of Technology and contributed to the foundation of the first university of technology in Japan. In 1929 the Tokyo Institute of Technology was established, modeled after the Berlin University of Technology. Tamaru admired the Berlin University of Technology, since it was as active as the
Setsuro Tamaru actively conducted various research lines including work on fuel batteries and active carbon, whose approach was purely based on physical chemistry. The research on active carbon led to the founding of the Sankyo Active Carbon Corporation (in Japanese) in 1938, which started to produce active carbon in amounts of 10 t/month. The factory came under control of the Navy in 1941 and the active carbon was used for military materials such as gas masks. It is indeed ironic that Tamaru contributed to a countermeasure against poison gas, with which Haber was deeply involved during World War I. Kazuo Sato, Tamaru’s successor and professor at the Tokyo Institute of Technology, recalled that Tamaru had the firm faith that it was important to contribute not only to science by basic research but also to practical applications at the same time. And Tamaru emphasized that competent scientists can handle both. This clearly indicates that his research philosophy was strongly influenced by Haber and his experience in Germany. Tamaru also bore a heavy responsibility as president of the Chemical Society of Japan in 1930.

**Japan Society for the Promotion of Science (JSPS)**

Tamaru strongly felt the necessity of promoting science and technology in order for the country to develop and flourish independently. He set out to establish a new society in Japan, modeled after the Kaiser Wilhelm Society in Germany, which was founded in 1911 in order to promote the natural sciences. He published a book on the Kaiser Wilhelm Society in 1931 and galvanized Joji Sakurai, then president of the Imperial Academy, for its establishment. At that time, Tamaru was suffering from tuberculosis and his doctor prescribed rest. Kenzi Tamaru remembers that his father, Setsuro Tamaru, devoted all his energies to the founding of the society, although his mother, Yasu, begged him not to go out. Finally, in December 1932, the Japan Society for the Promotion of Science (JSPS) was established with the generous assistance of an imperial donation. Sakurai showed his deep appreciation for Tamaru’s dedication in his collection of posthumous writings. As a result, the amount of research funding rose and the number of publications increased dramatically. Most importantly, it led to the education and development of young scientists in subsequent generations who benefited from the support.

**5. Beyond One Generation**

Fritz Haber devoted himself to his German motherland beyond all measure during World War I, but he left Germany
in 1933, since the country came under the control of Nazism and he was Jewish. Soon after his grievous departure, he died of heart failure at 65 years of age on January 29, 1934, in Basel, Switzerland, during his trip. Tamuru received a long letter from Hermann Haber (Haber’s son) with the announcement of Haber’s funeral ceremony, shown in Figure 13. In Tamuru’s memorial address to Haber, he referred to Haber’s intellectual preeminence, which he admired for grasping the core of very complicated problems by deeply analyzing them and finding the best possible resolution.\[11\] And he commemorated Haber’s hard work and extraordinary leadership: specifically, before World War I for promoting science and technology by conducting superb research including ammonia synthesis, during the war for deploying scientific resources for the defense of the nation by developing chemical weapons, and after the war for rehabilitating Germany’s academia by dedicating himself to the Kaiser Wilhelm Society.\[11\]

The relationship between Haber and Tamuru lasted for 25 years and was very special. Tamuru recalled that whenever a conversation turned to the subject of poison gas, Haber was terribly knocked down. At one time Haber put his head on Tamuru’s shoulder and said repeatedly, “The world is in darkness. Everything looks dark. My life isn’t worth living.”\[11\] When Haber had to leave Germany in 1933, Tamuru and Hoshi invited him to Japan because they were worried about his safety.\[9\] But unfortunately Haber did not have the strength to endure a long journey so their offer could not be accepted. Setsuro Tamuru had always respected Haber and cherished his friendship with him.

After coming back to Japan, Setsuro Tamuru dedicated his life not only to fundamental research with practical applications, but also to the promotion of science and technology, following the example of Haber. He contributed to the establishment of the Institute of Physical and Chemical Research, the Tokyo Institute of Technology, and the Japan Society for the Promotion of Science, modeled after the Kaiser Wilhelm Institute for Physical Chemistry and Electrochemistry, the Berlin University of Technology, and the Kaiser Wilhelm Society, respectively. It could be said that Haber definitely influenced the foundations of Japanese academia through Setsuro Tamuru.

At last, after a long fight against tuberculosis, Setsuro Tamuru died on August 5, 1944, in the house that Haber visited. His ashes are buried in a Buddhist temple, Kaizo-ji, near his house.

During the last century, Tamuru’s son, Kenzi Tamuru,\[36\] also had a strong tie to the Fritz Haber Institute (FHI), the former Kaiser Wilhelm Institute for Physical Chemistry and Electrochemistry, which became the Max Planck Society. He has been a good friend for many years of Gerhard Ertl (1936—), a former director of the FHI and a 2007 Nobel laureate in Chemistry (Figure 14a). Ertl is highly recognized to have elucidated the mechanism of ammonia synthesis in detail, which proves that the expertise of the institute in this field is retained even at the present time.\[40\] Also, Kenzi’s son-in-law (i.e., my husband), S. Ted Oyama (1955—),\[41\] received the Humboldt Award in 2008 and spent close to a year at the FHI with Hans-Joachim Freund (1951—), present director of the Department of Chemical Physics. Both Kenzi and Ted are specialists in catalysis, and also studied the ammonia synthesis and decomposition, exactly like Tamuru. It is interesting that Setsuro Tamuru sowed a seed which has been growing in our family for over a century, as we still have close ties to the institute in which Setsuro Tamuru spent his youth.

The centennial anniversary of the FHI was held on October 26–28, 2011, in Berlin-Dahlem. Our family was invited to join the celebration. Kenzi at 87 years old gave a presentation entitled “Fritz Haber and Japan”, introducing Haber’s influence on Japanese academia, which until then was not recognized. The photo shown in Figure 14b at the Haber Villa of the FHI was taken after Kenzi’s presentation, in which I was wearing Setsuro Tamuru’s morning suit tailored one century ago in Berlin. (I appeared on the stage during my father’s talk. The size of the suit was a perfect fit on me!)
Figures 14c and d show some more scenes of the celebration. I was extremely happy to meet John C. Polanyi (1929–1986 Nobel Prize in Chemistry) and Haber’s daughter, Eva Charlotte Lewis (1918–), both of whom have had fathers working at the Kaiser Wilhelm Institute and were born in Berlin.

Lastly, I received my Doctorate of Science from the Tokyo Institute of Technology and research funds and a scholarship from the JSPS to conduct my research in both the USA and Japan. I am very appreciative to my grandfather, Setsuro Tamaru, for helping to found these institutions. I wonder what he would think if he should see his granddaughter benefiting from his contributions? I keenly feel that the connections between science, education, and history transcend generations.

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REFERENCES

[1] Later, his younger siblings supported Kinya for studies in England with a heartfelt gratitude to his dedication. He published a book, written in English, on General Nogi, who immolated himself with his wife on the death of the Meiji Emperor; K. Tamaru, General Nogi: His Personality and His Death, Maruzen, Tokyo, 1912.

[2] Setsuro had two brothers who became professors in science. One was an elder brother, Takuro Tamaru, a professor of physics at the Imperial University of Tokyo (formerly the University of Tokyo) and well known as an advocate of the romanization of Japanese and a mentor of a well-known physicist, Torahiko Terada. The other was a younger brother, Kanji Tamaru, a professor of metallurgy at Keijō Imperial University and later at Osaka Prefecture University.


[7] Á. G. Ekstrand, Award ceremony speech for the Nobel Prize in Chemistry 1918 (F. Haber), June 1, 1920.


[10] W. Crookes, Presidential address to the British Association for the Advancement of Science, 1898. Published in Chemical News 1898, 78, 125.


[21] Courtesy of the Fritz Haber Institute of the Max Planck Society.